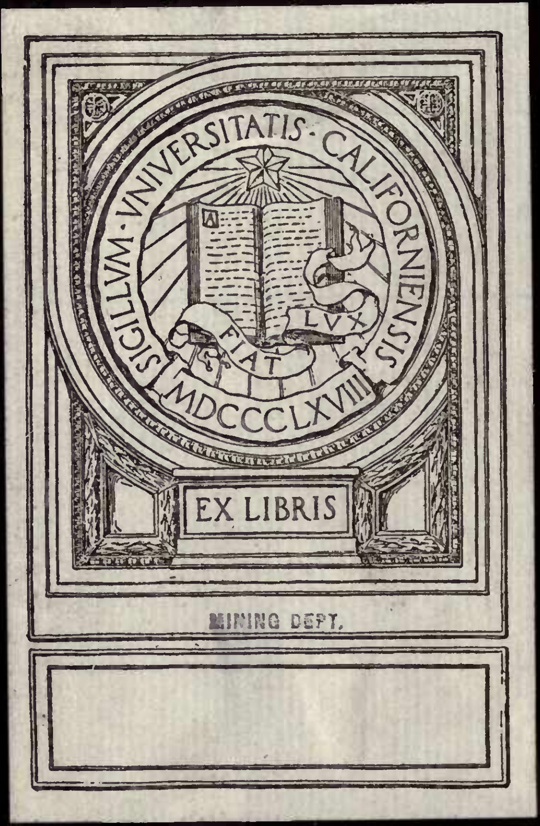

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# PREFACE.

NEARLY twenty-four years have passed since the last edition of this work was published; a long period, and one in which the science of Mineralogy has made very rapid progress. In fact, this quarter-century has probably been a time of more active mineralogical investigation than any like period in the past. A striking indication of this is given by the many new periodicals, recently started, which are devoted largely if not exclusively to Mineralogy. These include: Groth's Zeitschrift, started in 1877, of which the 19th volume is just completed; Tschermak's Mittheilungen, begun in 1872; the French Bulletin, begun in 1878; the English Mineralogical Magazine, begun in 1876; the Förhandlingar of the Swedish Geological Society, begun in 1872; the Italian journals, the Rivista di Mineralogia, begun in 1887, and the Giornale di Mineralogia, begun in 1890. Further the St. Petersburg Mineralogical Society, which published nothing for a number of years, commenced again with a new series in 1866 and has issued an annual volume regularly since then. Moreover, the always valuable Jahrbuch für Mineralogie has more than doubled its size.

This catalogue of new periodicals, which might be further extended, is a striking proof of the activity of mineralogical workers since 1868. Further evidence of this is given by the fact that within this time nearly one thousand new names have been introduced into the science—unfortunately not all "new species," although this has been claimed for most of them.

Still again, it is only within this period that the importance of the optical investigation of minerals has been fully recognized and the methods and instruments for optical and microscopical study have been developed and brought within the reach of all mineralogical observers. New means of observation have not only increased our knowledge of the optical constants of many species, but have developed new views in regard to the molecular structure of crystals. In Chemical Mineralogy, also, there has been rapid progress; on the theoretical side, in the way of explaining the composition of complex species and groups of species; again on the analytical side, and perhaps even more by the development of the synthetic processes. The last mentioned methods, in the hands of skillful chemists, have resulted in the reproduction in the laboratory of most of the prominent mineral species, as the feldspars, quartz, the pyroxenes and chrysolites, amphibole, corundum, etc.; thus throwing much light upon the composition of species and their formation in nature. The work in this field is almost all of recent date.

It is not strange, then, that this volume should contain more than half more matter than the former edition; indeed, it has only been with a rigid system of abbreviation and condensation, aided by an increase of one-fifth in the size of the page, that it has been kept down to this limit.

The broad and solid foundation laid in the previous edition has made it possible to undertake here a greater degree of thoroughness and completeness than was possible before. The careful work on the history of mineral species, shown in the tracing out to the original source of their many names, was so well and fully done that it stands now essentially as it did in 1868. In other words, the list of synonyms, with references to the first authority, has been adopted entire from the 5th Edition. Such additions, however, as the period has served to introduce have been made, and also there have been added many common names of important species used in the other prominent languages besides English, German, and French. This last feature it is hoped will add much to the general usefulness of the work.

The crystallographic portion of the subject has called for more than a mere revision. Here it has been the attempt, in the first place, to trace back to the original observer the fundamental angles for each species,—not always an easy task,—then the axes have been recalculated from them, and finally the important angles for all common forms have been calculated from these axes. In view of the too common practice of copying angles calculated by another without noting the source from which they have been taken, it is fair to state that every angle here given has been calculated anew for this work without exception; further, where there has been no other independent means of verification at hand, the angles have in most cases been calculated a second time independently. In this way, it is hoped that a fair degree of accuracy has been attained, although the author is keenly aware of the many ways in which errors can creep in, particularly in the case of a work which has so slowly and with so many interruptions approached completion, and where the progress of the science has made new calculations and new lists of forms so often necessary.

The lists of forms have been made up as completely as possible from the original authorities, but doubtful forms and those that seem to be merely of a vicinal character are usually separated from the main list. The forms are denoted by letters in all cases, and the symbols are given on both the systems of Miller and Naumann, though the preference is given to the former, which should, indeed, finally supplant the others. In the hexagonal and rhombohedral systems, the commonly adopted symbols of Miller-Bravais are employed, instead of the rhombohedral symbols of Miller.

References to the authors are given freely; and it is intended that these, with the others relating to the history of the names, and further those in connection with the lists of analyses, shall present a fairly complete literature, in compact form, for each species. Where, in the case of common species, the literature is very voluminous and has been carefully worked up by some author, this source of minuter detail is also indicated.

Of the figures, about 1400 in number, all but very few of those in the body of the work have been made anew. A large part, particularly those illustrating American species, have been drawn from original data, and where figures are taken from other authors—as is done freely—it is intended in all cases to give the source; in these cases, too, they have in large part been redrawn to insure uniformity of projection.

The habits of the crystals, methods of twinning, and the physical characters, especially those on the optical side, have been carefully rewritten and in general are given with much fullness. In regard to the optical constants, however, the object has been rather to give standard determinations than to overload the book with a multitude of measurements of all grades of accuracy.

In regard to the matter of classification, chemical formulas, and related points, reference may be made to the explanation given in the Introduction for the principles adopted. It may be stated, however, that it has been the plan to develop as clearly as possible the successive groups of species and the characters belonging to them.

In the lists of analyses, the plan has been to give all that are useful for a complete understanding of the composition of each species. This means all reliable analyses in the case of the rare species or those of complex composition. In many cases, however, particularly when rare elements are involved, the old analyses have been largly superseded, in consequence of the more accurate results of new chemical methods; for them, therefore, the reader is referred to the former edition. Still again, in the case of many common species where the analyses have developed almost indefinitely (e.g., feldspars, pyroxene, garnet, etc.), the aim has been to select recent analyses and those that best represent the composition; references are often given to other sources where additional analyses may be found. Analyses which are of purely technical character, as, for example, those showing the amount of impurity in iron ores, do not fall within the scope of this work.

The clear development of the varieties of a species in their proper relation to each other and to the main species, which was one of the excellent features of the last edition, has been carried through as far as possible in the same way. In regard to the line between varieties and species, no law can be laid down and individual opinions must differ. The author believes, however, that while a small percentage of a foreign element does not give the variety the place of a species, still the two extremes of a series, between which many gradations exist, it is well to regard as distinct,—e.g., Tetrahedrite and Tennantite,—and this principle has been followed throughout. At the same time, the description is given in such a form as to show as clearly as possible their mutual dependence. The Garnets are made subspecies, like the forms of common monoclinic Pyroxene and Amphibole, but they have much claim to be regarded as distinct.

The line between well defined species and those which are placed in a subordinate position, until further investigated, must also be more or less arbitrarily drawn. Many so-called species, which have long been so regarded, are here deprived of that rank, and probably more might fairly have received the same treatment. Of the multitude of new names recently introduced, but few comparatively are based upon complete, satisfactory investigations. Certainly now that the means of mechanical purification of material for analysis by heavy solutions are so convenient and accurate, and still more since microscopic examination is so well understood, there is little excuse for loading the science down with names based on descriptions faulty and incomplete. A new name for a well characterized variety, announced as such, may be useful; a new name for what may with reasonable certainty be regarded as a new species, even if at the time the material is too scanty to allow of analysis, may be an advantage. But names hastily given to imperfectly described "species," based often upon an imperfect analysis of material of more than doubtful purity, are a serious hindrance to science.

The subject of the general occurrence and association of the species has been considerably developed. It has not been attempted to give an exhaustive statement of localities, however. To have done this would have been to have doubled the size of the volume. The localities are given with much fullness for this country and are to be supplemented by the Catalogue of American Localities at the end of the volume, which, thanks to the assistance of a number of gentlemen, has been made much more complete and accurate than heretofore. For foreign localities, the list is brief but is intended to include those that are most important and typical. The parts of the admirable new Mineralogy of Hintze leave little in this direction to be desired.

All crystallographic and physical data, analyses, etc., have either been taken direct from the original authority or have been verified from it. References given mean, therefore, authors actually consulted; this is distinctly stated, for the practice of quoting at second hand while giving the original reference is as common as it is bad in its results. In the few cases where the original authority has not been accessible this is often given in brackets [ ], while the actual source follows. The only limitation to the above statement concerns the literature connected with the synonyms, where the references are reproduced for the most part from the previous edition, with only such verification as the most important have called for. Other points in regard to the methods followed will be found explained in full in the Introduction.

In the spelling of foreign geographical names the author has attempted to follow a system, chiefly that laid down not long since by the Royal Geographical Society of London, in which, briefly, the consonants have the same value as in English, while the vowels have the Continental (Italian) sounds. The transliteration of Russian names has been the most difficult part of the matter, and here the author most gratefully acknowledges his indebtedness to Mr. J. Sumner Smith of the Yale University Library, whose valuable advice has been always freely given and except in one or two particulars uniformly followed. That a reform is needed in this direction is most obvious, for it is little creditable to the English language that it alone should have no independence, but should follow now a French, now a German method according to the source from which the word has been absorbed—probably both methods more or less at variance with its own usage. The subject is a difficult one, however, and it is doubtful whether a system, satisfactory in all respects, can be devised. Reference may be made here to a paper on the subject in Nature (Feb. 27, 1890) which throws much light upon the subject.

The literature of the science has been freely drawn upon, especially that of the past twenty-five years. No better acknowledgment is needed to the many faithful workers, who have made the science what it is to-day, than the frequent references to their names which are to be found on almost every page of this work: to mention them individually seems quite unnecessary.

The published works of many authors have been also used freely—among these no one has been more useful than the Mineralogy of Brooke and Miller (1852) as revised, on the crystallographic side, by Prof. W. H. Miller. From this admirable volume many hints have been taken. The Russian Mineralogy of Koksharov, the Atlas of Schrauf, the Crystallography of Sadebeck, and many others have been used constantly. The Index of Goldschmidt has been useful in the verification of lists of forms, though these were made out (up to date) before the first part appeared in 1886. On the optical side, use has been made particularly of Des Cloizeaux's

Mineralogy and his other extensive memoirs, also the recent work of Lévy and Lacroix; but many other authors have also yielded valuable material.

In the chemical part of the subject, Rammelsberg's Mineralchemie has been, as before, of great value, while the Tables of Groth have given many suggestions as to the formulas and chemical relations of the species; the papers of Tschermak and Clarke have also been very useful.

In the great labor involved in the preparation of this work, the author has had the assistance of many gentlemen to whom his thanks are returned even if they are not mentioned by name. First of all, his acknowledgments are due to Prof. James D. Dana, the author of this System of Mineralogy from 1837 to 1868, and to whom all its chief points of excellence are due. His encouragement and advice have always been ready, but unfortunately ill health interrupted his plan of following it in detail as it was passing through the press. To Prof. G. J. Brush also the author is indebted for many friendly words of counsel. One of the most valuable features of the last edition was the full account of the blowpipe and allied characters of species, prepared by him, and this has been reproduced here almost without change. Prof. Penfield has stood in still closer connection with the work; much of the proof has passed under his eye, and, besides many suggestions on minor points, he has supplied from his own observations and work much original matter not yet published. Numerous analyses, figures of crystals, etc. (especially under amphibole and pyroxene), have been given by him from a memoir on the minerals of Northern New York, soon to be published as a Bulletin of the U. S. Geological Survey. The permission to use this matter in advance the author owes to the courtesy of Major Powell, Director of the Survey.

To Dr. Genth of Philadelphia, ever active in the investigation of American minerals, the author's thanks are due for new matter supplied from his unpublished notes, for corrections to the former edition, and still more for assistance in regard to the mineral localities in Pennsylvania and North Carolina. Prof. F. W. Clarke has also been most friendly in like directions; while for the difficult subject of American localities, a number of gentlemen have made valuable contributions whose names are mentioned in full on p. 1053. To Prof. F. A. Gooch of New Haven, Dr. W. F. Hillebrand of Washington, Dr. G. H. Williams of Baltimore, Prof. J. C. Branner of Little Rock, Arkansas, Dr. E. O. Leech of the U. S. Mint, Mr. H. S. Durden of San Francisco, Mr. G. Chr. Hoffmann of Ottawa, and other gentlemen the author is also indebted.

Among the Mineralogists abroad, to whom the author owes especial acknowledgment, he would mention Prof. W. J. Lewis of Cambridge, England, Mr. L. Fletcher of the British Museum, Professors Paul Groth of Munich and G. Tschermak of Vienna, whose advice at the beginning of the work was most valuable, as also the aid that they have given since then. Mr. Thomas Davies of the British Museum kindly furnished a list of minor errors that had before escaped notice in the 5th Edition, and these it is hoped have not been perpetuated here. To Prof. A. Des Cloizeaux, W. C. Brögger of Stockholm, N. von Koksharov of St. Petersburg, and others, the author would also express his indebtedness. Through the kindness of Prof. Brögger, advance sheets of his noble work on the minerals of the augite- and nephelite-syenite of Southern Norway were received in time to be freely used.

In two directions the author has been able to make use of clerical assistance. First, in the calculations of angles from the accepted axes, for in general only the recalculation when necessary for the sake of verification has been assumed by the author. Here Miss Charlotte C. Barnum of New Haven, from 1885 to 1887, and Prof. H. H. White of Neligh, Nebraska, from 1886 to the end, have rendered most valuable aid. Second, in the drawing of crystals, the author has been most efficiently aided by Mr. E. F. Ayres, also by Mr. L. V. Pirsson, and further by Prof. E. H. Barbour, Dr. E. O. Hovey, Dr. F. W. Mar, and Messrs. J. Stanley-Brown, O. C. Farrington, E. W. Goodenough, F. D. Leffingwell, John Leverett, Edward Cramer, and others.

Finally, the author takes pleasure in expressing his appreciation of the liberal support of the publishers, Messrs. John Wiley & Sons, and also of the patient care with which the printers and engravers have carried through a work of more than usual labor and vexation.

In conclusion, the author would express the hope that he may be informed of errors, great or small, noted by those using the book, in order that they may be corrected in future printings from the stereotype plates. It is intended to keep the work up to date, by the publication of appendixes at not very long intervals.

EDWARD SALISBURY DANA.

NEW HAVEN, CONN., *January* 1, 1892.

# EXTRACTS FROM THE PREFACES OF THE FORMER EDITIONS OF THIS WORK BY JAMES D. DANA.

## FROM THE PREFACE TO THE FIRST EDITION (1837).

* * * * * The classification of the mineral species, which is here adopted, is strictly a *Natural* Arrangement. The superiority of this method is exhibited in the body of the work, and in connection with the remarks on Chemical Classifications, in Appendix B. Although founded by Mohs on the external characters of minerals, it exhibits, in a considerable degree, the chemical relations of the species; and those who are accustomed to prefer a chemical arrangement will probably perceive that, in addition to such qualities as appear to recommend the chemical method, it possesses other advantages not less important.

The changes which have been made in the nomenclature of minerals appear to be demanded by the state of the science. The present names, excepting those proposed by Mohs, are utterly devoid of system, unless we may consider such the addition of the syllable *ite* to words of various languages; and even this glimmering of system has been capriciously infringed by a French mineralogist of much celebrity—they seldom designate any quality or character peculiar to the mineral; neither do they exhibit any of the general relations of the species, by which the mind may, at a glance, discover their natural associations, and be assisted in obtaining a comprehensive view of the science. On the contrary, they are wholly independent, and often worse than unmeaning, appellatives, and are only tolerable in a very unadvanced state of the science. As a necessary consequence of this looseness of nomenclature, most of the species are embarrassed with a large number of synonyms, a fertile source of confusion and difficulty.

As a remedy for this undesirable state of things, a system of nomenclature, constructed on the plan so advantageously pursued in Botany and Zoology, was proposed by the author in the fourth volume of the Annals of the New York Lyceum. The necessity for something of the kind is very apparent, and the author trusts that it will not be considered a needless innovation. * * * * *

## FROM THE PREFACE TO THE SECOND EDITION* (1844).

The natural system adopted in this treatise has received such modifications in the present edition as were demanded by the advanced state of the science; and the systematic nomenclature has required some corresponding changes.

Besides the natural classification, another, placing the minerals under the principal element in their composition, has been given in Part VII; and various improvements on the usual chemical methods have been introduced, which may render it acceptable to those that prefer that mode of arrangement. * * * * *

## FROM THE PREFACE TO THE THIRD EDITION (1850).

This treatise, in the present edition, has undergone so various and extensive alterations that few of its original features will be recognized. The science of Mineralogy has made rapid progress in the past six years; chemistry has opened to us a better knowledge of the nature and

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* This edition, failing to find a publisher in New York, was printed at the expense of the author.

relations of compounds; and philosophy has thrown new light on the principles of classification. To change is always seeming fickleness. But not to change with the advance of science is worse; it is persistence in error; and, therefore, notwithstanding the former adoption of what has been called the Natural History System, and the pledge to its support given by the author in supplying it with a Latin nomenclature, the whole system, its classes, orders, genera, and Latin names, have been rejected; and even the trace of it which the synonymy might perhaps rightly bear has been discarded. The system has subserved its purpose in giving precision to the science, and displaying many of the natural groupings which chemistry was slow to recognize. But there are errors in its very foundation, which make it false to nature in its most essential points; and, in view of the character of these errors, we are willing it should be considered a relic of the past.

Yet science is far from being ready with an acceptable substitute. Most *chemical* systems have been more artificial than the "natural" system; and doubts now hang over some of the principles of chemistry that are widest in their influence on classification. In view of the difficulties on either side, it was a point long questioned, whether to venture upon a classification that might be deemed most accordant with truth among the many doubts that surround the subject; or to adopt one less strict to science, that might serve the convenience of the student for easy reference, and for the study of mineralogy in its economical bearings, while, at the same time, it should exhibit many natural relations, and inculcate no false affiliations or distinctions of species. The latter alternative has been adopted;—the classification is offered simply as a convenient arrangement, and not an exhibition of the true affinities of species in the highest sense of the term. Among the Silicates, however, it will be perceived that the groupings in the main are natural groupings; and, throughout the work, special care has been taken to inculcate, as far as possible, the true relations of species, both by remarks, and by an exhibition of them in tables. * * * * *

## FROM THE PREFACE TO THE FOURTH EDITION (1854).

In the Preface to the last edition of this treatise, the classification of minerals then adopted was announced as only a temporary expedient. The system of Mohs, valuable in its day, had subserved its end; and in throwing off its shackles for the more consistent principles flowing from recent views in chemistry, the many difficulties in the way of perfecting a new classification led the author to an arrangement which should "serve the convenience of the student without pretending to strict science."

A classification on chemical principles was however proposed in the latter part of the volume, in which the Berzelian method was coupled with crystallography in a manner calculated to display the relations of species in composition as well as form, and prominently "exhibit the various cases of isomorphism and pleomorphism among minerals." The progress of science has afforded the means of giving greater precision and simplicity to this arrangement, until now it seems entitled to become the authorized method of a System of Mineralogy. Whether regarded from a physical or chemical point of view, the groupings appear in general to be a faithful exhibition of the true affinities of the species.

The mind uneducated in science may revolt at seeing a metallic mineral, as galena, side by side with one of unmetallic luster, as blende; and some systems, in accordance with this prejudice, place these species in separate orders. Like the jeweler, without as good reason, the same works have the diamond and sapphire in a common group. But it is one of the sublime lessons taught in the very portals of chemistry, that nature rests no grand distinctions on luster, hardness, or color, which are mere externals, and this truth should be acknowledged by the mineralogist rather than defied. Others, while recognizing the close relations of the carbonates of lime, iron, zinc, and manganese (calcite, spathic iron, smithsonite, and dialogite), or of the silicates of lime, iron, manganese (wollastonite, augite, rhodonite), are somewhat startled by finding silicate of zinc, or silicate of copper, among the silicates of the earths, or of other oxyds. But the distinction of "useful" and "useless," or of "ores" and "stones," although bearing on "economy," is not science. * * * * *

## FROM THE PREFACE TO THE FIFTH EDITION (1868).

The large size of this volume on Descriptive Mineralogy, exceeding by one-half the corresponding part of the preceding edition, is not without good reason.

In the first place, the long interval of fourteen years has elapsed since the last edition was published, and during this period the science has made great progress. Chemical researches have been carried forward in connection with almost every species, and analyses have been largely multiplied; and it is the plan of the work to be complete in this department, so far as to include all analyses. Crystallographic investigations also have been numerous and important. Moreover, the number of species has been much enlarged, and every part of the science has had accessions of facts.

In addition, a new feature has been given the work, in the systematic recognition and description of the *varieties* of species. The first edition of this treatise, that of 1837, was written in the spirit of the school of Mohs. The multitudes of subdivisions into subspecies, varieties, and subvarieties, based largely on unimportant characters, which had encumbered the science through the earlier years of this century, and were nearly smothering the species, were thrown almost out of sight by Mohs, in his philosophic purpose to give prominence and precision to the idea of the species. Much rubbish was cleared away, and the science elevated thereby; but much that was necessary to a full comprehension of minerals in their diversified states was lost sight of. In the present edition an endeavor is made to give varieties their true place; and to insure greater exactness with regard to them, the original locality of each is stated with the description.

Further, the work has received another new feature in its historical synonymy. A list of synonyms has hitherto been mainly an index to works or papers on the species, and often without any regard to the original describer or description. Hausmann's admirable Handbuch (1847) is partly an exception. Leonhard's "Oryktognosie" (1821, 1826), following the method of Reuss of the opening century, contains a full catalogue of references to publications on each species; but it fails of half its value because the references have no connection in any way with the synonymy. In most recent works, an author who has merely adopted a name is often quoted as if the original authority. The present work is no longer open to this criticism. As now issued, the first author and first place of publication of each species, and of each name it has borne, and of the names of all its varieties, are stated in chronological order, with the dates of all publications cited; and, besides, remarks are added in the text when the subject is one of special interest. The facts and conclusions have been derived in almost all cases from the study of the original works themselves; and this treatise has become thereby, to some extent, an account of ancient as well as modern minerals. These historical researches added a third to the labor of preparing the edition for the press, thereby delaying the publication of the work about a year. But such studies are endless, especially when they relate to past centuries, and the work, however long continued, must be incomplete. * * *

* * * In these and other ways the volume has unavoidably become enlarged. Not a page, and scarcely a paragraph, of the preceding edition remains unaltered, and full five-sixths of the volume have been printed from manuscript copy. I may here add that, notwithstanding the impaired state of my health, this manuscript—the paragraphs on the pyrognostic characters excepted—was almost solely in the handwriting of the author, or in that of a copyist from it. Neither the consultation of original authorities, the drawing of conclusions, nor the putting of the results on paper, has been delegated to another. And being now but half-way between the fifties and sixties, it is my hope that the future will afford another opportunity for similar work.

* * * In classification, the general system remains unaltered. It is based on a comprehensive view of the characters of minerals as species in the inorganic kingdom of nature, the preëminence being given to chemical, the next place to crystallographic, the third to the different physical characters. The author believes (after having tried the so-called natural-history system of Mohs for two editions) that light from no source should be shut out where the relations of species and groups in nature are to be determined. As in the preceding edition, the method avoids almost entirely the distinction, in most cases wrong, founded on the fact of the base in

oxygen ternaries or salts being in the protoxyd state, or in the sesquioxyd, or in both combined, and proceeds on the ground that the basic elements in these and the other different states are mutually replaceable in certain proportions determined by their combining power with oxygen. But while the progress of chemistry and the kindred sciences requires no modification of the general plan of the classification, but gives it new support, it has rendered many minor changes necessary, and some that are of much importance.

The historical inquiries above alluded to were prompted by a desire to place the nomenclature of mineralogy on a permanent basis. They were incident to a search after a reason for choosing one name rather than another from among the number that stand as claimants. Part of the existing diversity is due to national partiality, and much of it to indifference. It has become somewhat common for authors to select the name they like best without reference to authority, or to reject an old for a new one on no other ground than that of their preference. Increasing confusion in nomenclature has consequently attended the recent progress of the science; and in view of this fact the novel expedient has been tried of endeavoring to escape the confusion by adding one more to the number of names. The right method is manifestly that which has proved so successful in the other natural sciences, viz., the recognition, under proper restrictions, of the law of priority; and this method the author has aimed to carry out.

Moreover, it has seemed best that the science should not only have a system of nomenclature, but should also stand by it; that, accordingly, the termination *ine*, which is prominently chemical, should be left to the chemists, and that other miscellaneous endings should, as far as possible, be set aside, or be made to conform to the system. With this in view, changes have been made in accordance with the principles explained in the course of the remarks beyond on Nomenclature. * * *

# TABLE OF CONTENTS.

# INTRODUCTION.

In the Description of Species the following order is observed:

**1. Name,** followed by synonyms in historical order with author, original reference, and date; also in many cases the common names in the forms peculiar to the French, German, Swedish, Italian and Spanish. See further on the subject of nomenclature, p. xl.

**2. Crystalline Form and Structure,** including (*a*) system of crystallization; (*b*) axial ratio and angular elements* with authority; (*c*) list of observed forms; (*d*) methods of twinning, general habit of crystals, and such details in regard to the character of individual faces as are of value, particularly in the orientation of the crystals. Also (*e*) general structure of crystalline, massive or amorphous varieties, imitative forms, and so on.

**3. Physical Characters.**—A. Those relating to COHESION, including (*a*) cleavage and parting; (*b*) fracture; (*c*) tenacity; (*d*) hardness (H).

B. SPECIFIC GRAVITY, or density referred to water (G).

C. Characters relating to LIGHT, including (*a*) luster; (*b*) color and streak, pleochroism and absorption; (*c*) degree of transparency; (*d*) special optical properties. These last include the positive (+) or negative (−) optical character; the position of the axial plane and bisectrix; the axial angle; dispersion; also the refractive indices, etc.

D. Characters relating to HEAT, ELECTRICITY, MAGNETISM.

E. TASTE and ODOR.

**4. Chemical Composition (Comp.).**—The chemical formula and percentage composition, followed, or sometimes preceded, by a description of the recognized varieties based upon form, structure, composition, etc. Then the analyses (**Anal.**) with references to the original authorities.

**5. Pyrognostic** characters, or those determined by the use of the blowpipe and similar means; also other related chemical characters (**Pyr., etc.**).

**6. Observations (Obs.),** containing a general statement as to method of occurrence, with a more or less detailed list of important localities, associated minerals, etc.

**7. Altered forms (Alt.).**

**8. Artificial** and furnace products (**Artif.**).

**9. References (Ref.).**—A final paragraph gives the references as indicated by number from the preceding description, particularly the crystallographic part. Also references to memoirs of special character in some cases not otherwise mentioned.

In order to aid those who are not thoroughly familiar with Crystallography, Optical

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* In general it is intended to give the values of the axes to within three or four units in the fifth decimal place, in which case the calculated angles should be correct at least within 10″. When the accuracy of the fundamental angles seems to justify it, a greater degree of exactness is employed, so that the calculated angles may be correct to 1″. It is obvious that, unless in very exceptional cases, to give the axes to more than six decimals is merely playing with numbers.

The angular elements, which are intended to correspond to the axes in degree of accuracy, are those of the unit forms in the pinacoid zones, from which calculations may most readily be made. The fundamental angles are also indicated by an asterisk; when this is omitted the axial ratio of the original author (often deduced by method of least squares) is taken as the starting point. The calculated angles are stated in general to the nearest minute, but the half-minute is often retained when the neglected seconds are near 30.

Mineralogy, Chemistry, etc., and to explain the special methods of notation, abbreviations, etc., adopted, some general explanations under these successive heads are given.

For fuller information on many of these points the reader is referred to the author's Text Book of Mineralogy, also to kindred works whose full titles are given in the Bibliography, thus on *Crystallography* and *Physical Mineralogy*, especially to the works of Groth, Mallard, Liebisch, Tschermak, G. H. Williams (Crystallography); also to others mentioned beyond under the special subjects.

## I. CRYSTALLOGRAPHY.

**Systems of Crystallization.**—There are six systems of crystallization, to one of which every crystal may be assigned; these are distinguished by the degree of symmetry characteristic of each, which usually finds expression in the statement of the lengths and mutual inclinations of certain axes assumed for the description of the form. These systems are:

1, ISOMETRIC; 2, TETRAGONAL; 3, HEXAGONAL and RHOMBOHEDRAL; 4, ORTHORHOMBIC; 5, MONOCLINIC; 6, TRICLINIC.

Other names which are or have been in common use are: for Isometric, cubic, regular; for Tetragonal, quadratic, dimetric; for Orthorhombic, rhombic, trimetric; for Monoclinic, monosymmetric or oblique; for Triclinic, asymmetric, doubly oblique, or anorthic.

Some general explanations applicable to all systems follow.

**Planes and Symbols.**—The position of a plane is fixed by its intercepts on the crystallographic axes, and is defined by its *symbol* which expresses the ratio of these intercepts to certain assumed *unit lengths* of the axes.

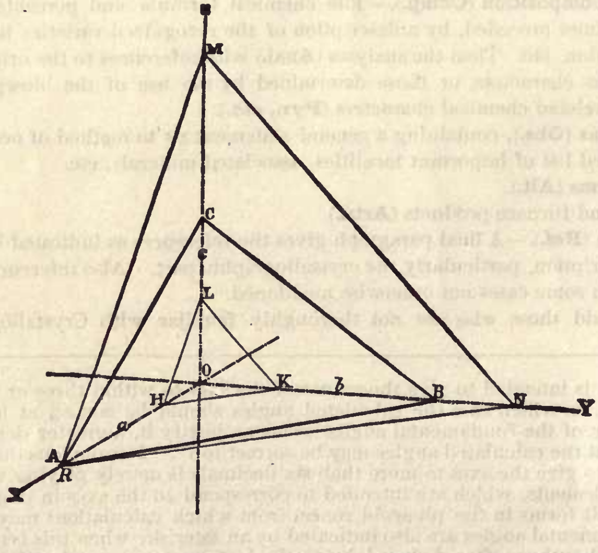
Thus, Fig. 1, let OA, OB, OC be taken as the unit lengths of the axes, and be represented by the letters $a$, $b$, $c$; the position of a plane RNM is fixed by its intercepts OR, ON, OM. If OR $= 1a$, OB $= \frac{4}{3}b$, OM $= 2c$, the ratio of the intercepts to the unit axes may be written for this plane:

$$1. \qquad 1a : \tfrac{4}{3}b : 2c.$$

For the plane HKL parallel to and hence crystallographically identical with RNM, the ratio is

$$2. \qquad \frac{a}{4} : \frac{b}{3} : \frac{c}{2}.$$

1.



It is found, in general, that if the lengths of the axes for any one plane be taken as the units, the ratio of those of every other plane on the same crystal (written as in 2) can be expressed by rational numbers and usually the whole numbers from 1 to 6 (or by 0).

The two forms

$$\begin{array}{ccc} 1. & & 2. \\ 1a : \tfrac{4}{3}b : 2c & \text{and} & \dfrac{a}{4} : \dfrac{b}{3} : \dfrac{c}{2} \end{array}$$

are identical, since the *ratio* of the axes is all that is important, not their absolute length. They further illustrate the symbols after the two common methods in use, those of Naumann and of Miller.

With Naumann the expression is always written in such a form that the multiple of one of the lateral axes (usually $a$) is unity (1) and the symbol,* written in the inverse order and omitting the axes, after Naumann's method, is then

$$2 : \tfrac{4}{3} : 1, \quad \text{or simply} \quad 2\text{-}\tfrac{4}{3}.$$

Similarly for other planes, whose intercepts written in the two methods are, respectively,

$$\begin{array}{cc} 1. & 2. \\ 1a : 1b : 2c & \dfrac{a}{2} : \dfrac{b}{2} : \dfrac{c}{1} \\ 1a : 2b : 1c & \dfrac{a}{2} : \dfrac{b}{1} : \dfrac{c}{2} \end{array}$$

the symbols are again, after Naumann, dropping the unity when it belongs to a lateral axis,

$$2 : 1 : 1, \quad \text{or simply} \quad 2.$$

$$1 : 2 : 1, \quad \text{“} \quad \text{“} \quad 1\text{-}2.$$

With Miller the expression is always taken in the equivalent form, 2 above, where the numerators are the unit lengths of the axes and the denominators are whole numbers; these three integers form then the *symbol* of the plane—that is, in the three examples given above, 432, 221, and 212.

The general symbol is *hkl*, corresponding to the full expression for any plane

$$\frac{a}{h} : \frac{b}{k} : \frac{c}{l}.$$

It will be seen that the symbols of Miller are essentially the reciprocals of those of Naumann. The minus signs, indicating intercepts of the negative lengths of the axes, are placed over the numbers to which they belong. The symbols employed in the hexagonal system are explained on a later page.

Naumann's symbols are further modified by writing the sign for infinity $\infty$ (in this book replaced by the initial letter *i*), and the omission of 1. Further, the lateral axes and the numbers referring to them are distinguished, for example in the orthorhombic system, where $\bar{b} > \breve{a}$, by a long and short mark.

Thus, for example :

| | | Naumann | | | Miller |
|---|---|---|---|---|---|
| $\breve{a} : 2\bar{b} : 2\grave{c}$ | becomes | $2\text{-}\bar{2}$ | or | $2P\bar{2}$ | 211 |
| $\breve{a} : 1\bar{b} : 2\grave{c}$ | “ | 2 | or | $2P$ | 221 |
| $\breve{a} : \infty\bar{b} : 2\grave{c}$ | “ | $2\text{-}\bar{i}$ | or | $2P\bar{\infty}$ | 201 |
| $\breve{a} : 1\bar{b} : \infty c$ | “ | *I* | or | $\infty P$ | 110 |
| $\breve{a} : 2b : \infty c$ | “ | $i\text{-}\bar{2}$ | or | $\infty P\bar{2}$ | 210 |

Some other modifications are mentioned in their proper place. It must be remembered that in Naumann's symbols, as stated above, the natural order is reversed and the first number (or infinity sign) refers always to the *vertical axis*.

Other systems of symbols, besides the two explained, have also been or still are in use, as those of Weiss, of Mohs and Haidinger, and of Hausmann, Lévy, Goldschmidt, and others. Of these the symbols of Weiss are essentially those already given (under 1, above) which abbreviated (and inverted in order) were adopted by Naumann. The symbols of Lévy are extensively

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* Strictly Naumann's method makes this $2P\tfrac{4}{3}$, and in the other cases below $2P$, $P2$—that is, an initial $P$ is inserted after the number referring to the vertical axis in all but the isometric system, where the letter $O$ takes its place.

used by the French school of mineralogists. A very full explanation of all the different systems, as of that recently devised by himself, is given in Goldschmidt's Index (1886–1891). Transformation equations (for the important cases, in concise form) are given by Groth (Phys. Kryst.), Mallard (Crist., vol. 1), Liebisch (Kryst.), and others.

*A form* includes all the similar planes comprised in one general symbol. Thus if the three axes are unequal but at right angles (orthorhombic system) there are eight similar planes included in the general symbol *hkl* (or *m-n*) according as the axes are plus or minus, that is the form includes

| | | | |
|---|---|---|---|
| $hkl$ | $\bar{h}kl$ | $\bar{h}\bar{k}l$ | $h\bar{k}l$ |
| $hk\bar{l}$ | $\bar{h}k\bar{l}$ | $\bar{h}\bar{k}\bar{l}$ | $h\bar{k}\bar{l}$ |

For the form (211):

| | | | |
|---|---|---|---|
| $211$ | $\bar{2}11$ | $\bar{2}\bar{1}1$ | $2\bar{1}1$ |
| $21\bar{1}$ | $\bar{2}1\bar{1}$ | $\bar{2}\bar{1}\bar{1}$ | $2\bar{1}\bar{1}$ |

If, however, the axes *a* and *b* are equal (tetragonal system) the plane *hkl* and *khl* (or *a* : *na* : *mc* and *na* : *a* : *mc*) are similar and the form includes 16 planes; further, in the isometric system, where the axes (*a*) are all equal, a form may include 48 planes, while in the triclinic system it can include only 2 planes. This is further explained later under the different systems.

The *Law of Holohedrism* requires that *all* the planes of a given form should be present, that is all having the same general position with reference to the axes.

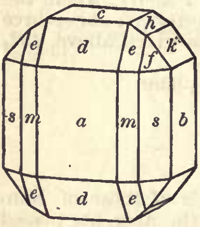
This law finds exceptions in:

*Hemihedrism*, where only half of the planes are present, but half selected according to a definite law; and in

*Tetartohedrism*, where only one-fourth of the possible similar planes are present.

A full explanation of these subjects is impossible in this place, but they are treated as fully as is practicable under the different systems.

2.



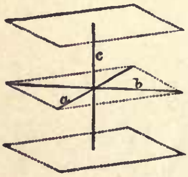
Some technical terms applied in the description of crystals require explanation.

*Pinacoid planes*, in general, are those which are parallel to two of the axes. These are designated in this work by the same letters as the axes at whose extremity they lie. Thus, fig. 2, *a*, *b*, *c* are the pinacoids having (in the orthorhombic system) the symbols:

| | Miller | Naumann | |
|---|---|---|---|
| *a* | 100 | *i*-ī | $\infty P\bar{\infty}$ |
| *b* | 010 | *i*-ĭ | $\infty P\breve{\infty}$ |
| *c* | 001 | *O* | $0P$ |

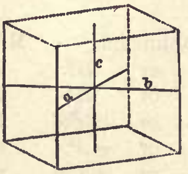
A *Prism* is a form whose planes are parallel to the vertical axis and intersect both the horizontal axes, if at the unit lengths it becomes the *unit prism* (having the symbol *I*) and in this work uniformly denoted by the letter *m*. In the several systems some additional terms, describing the different prisms, are introduced.

3.



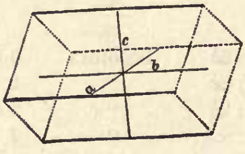
Basal Pinacoid.
(001, *O*)

4.



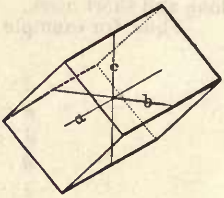
Prism.
(110, *I*)
(*hk*0, *i-n*)

5.



(101, 1-ī)
(*h*0*l*, *m*-ī)

6.



(011, 1-ĭ)
(0*kl*, *m*-ĭ)

Domes.

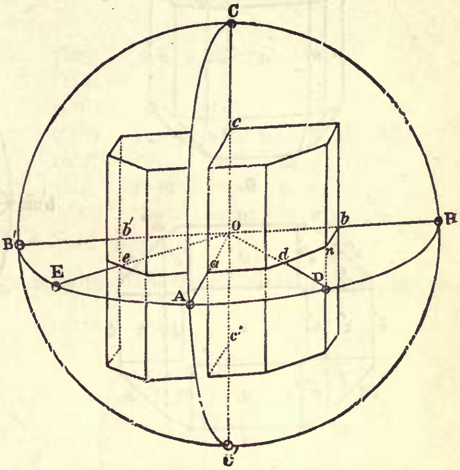
*Domes* are forms whose planes are parallel to one only of the lateral axes. They are specially named (macrodomes, clinodomes, etc.) in the different systems according to which axis they are parallel.

*Pyramids* are forms whose faces intersect the three axes; if the lateral axes at their unit lengths they are *unit pyramids*. In fig. 2, above, *a*, *b*, *c* are pinacoids ; *m* (110, *I*) and *s* (120, *i*-2̆) are prisms ; *d* (101, 1-ī) is a macrodome ; *h* (011, 1-ĭ) and *k* (021, 2-ĭ) are brachydomes, and *e* (111, 1), *f* (121, 2-2̆) are pyramids; cf. also figs. 3, 4, 5, 6.

*A zone* is a series of planes with mutually parallel intersections, since their parameters have all a constant ratio for two of the axes. The line through the center of the crystals to which the planes are parallel is the *zone-axis*. Familiar examples of zones, in part shown in fig. 2, are those of the prisms, $hk0$, of the domes, $h0l$ or $0kl$; also pyramids, as of the unit series $hhl$ (as 112, 111, 221) where $h = k$; or of any other zone as 211, 421, etc., where $h = 2k$; also 212, 111, 121, 131, where $h = l$, etc.

*Spherical Projection* —If the center of a crystal, that is, the point of intersection of the three axes, be taken as the center of a sphere, and normals be drawn from it to the successive planes of the crystals, the points, where they meet the surface of the sphere, will be the poles of the respective planes. For example, in f. 7 the common center of the crystal and sphere is at O, the normal to the plane $b$ meets the surface of the sphere at B, of $b'$ at B', of $d$ and $e$ at D and E respectively, and so on. These poles evidently determine the position of the plane in each case.

7.



After Brezina.

It is obvious that the pole of the plane $b'$ ($0\bar{1}0$) opposite $b$ (010) will be at the opposite extremity of the diameter of the sphere, and so in general, (120) and ($1\bar{2}0$), etc. It is seen also that all the poles, or normal points, of planes in the same *zone*, that is, planes whose intersection-lines are parallel, are in the same great circle, for instance the planes $b$ (010), $d$ (110), $a$ (100), $e$ ($1\bar{1}0$), and so on.

It is customary in the use of the sphere to regard it as projected upon a horizontal plane, usually that normal to the prismatic zone, so that, as in f. 10, the prismatic planes lie in the circumference of the circle, and the other planes within it. The eye being supposed to be situated at the opposite extremity of the diameter of the sphere normal to this plane, the great circles then appear either as arcs of circles, or as straight lines, i.e., diameters.

It will be further obvious from f. 7 that the arc BD, between the poles of $b$ and $d$, measures an angle at the center (BOD), which is the supplement of the actual interior angle $bnd$ between the two planes.

In the construction of the spherical projection, it must be noted that the poles on the circumference are fixed directly by the angles measured by a protractor, while the positions of 101 on the zone-circle 100, 001, $\bar{1}00$ and of 011 on 010, 001, $0\bar{1}0$ are fixed by the fact that the distances to them from the center of the circle (here 001) are proportional to the *tangents of half the angles* of 001 ∧ 101 and 001 ∧ 011, and this holds true in general. Furthermore, it must be noticed that the pole 111 is situated at the intersection of the zone-circles 001 and 110, 100 and 011, 010 and 101; so in general $hkl$ at the intersection of 001 and $hk0$, 100 and $0kl$, 010 and $h0l$.

*Horizontal Projections.*—In addition to the usual perspective figures of crystals, projections usually on the basal plane (or more generally the plane normal to the prismatic zone) are freely used, and in these the successive planes are indicated by accents, passing around in the direction of the axes $a$, $b$, $c$, that is counter-clockwise. Thus compare the figures below, 8 and 9 and the spherical projection, f. 10. These methods are modified somewhat to meet the demands of the different systems.

*Angles between Planes.*—The angles given in this work are always the *normal angles*, that is the angles between the poles or normals to the planes, measured on the arc of a great circle joining the poles as shown on the spherical projection (f. 7, 10). These normal angles are the supplements of the actual interfacial angles, as has just been explained.

Furthermore, by reference to the projection, f. 10, it will be seen that the angle 100 ∧ 110, or (f. 9) *am*, is (in the orthorhombic system) half the angle 110 ∧ $\bar{1}10$ (*mm‴*). Similarly 010 ∧ 120 (*bs*) is half the angle 120 ∧ $\bar{1}20$ (*ss'*); again, 100 ∧ 111 (*ae*) is the complement of half the angle 111 ∧ $\bar{1}11$ (*ee'*), and 010 ∧ 111 (*be*) the complement of half the angle 111 ∧ $1\bar{1}1$ (*ee‴*).

Further:

100 ∧ 010 (*ab*) = 100 ∧ 110 (*am*) + 110 ∧ 120 (*ms*) + 120 ∧ 010 (*sb*)

Also:

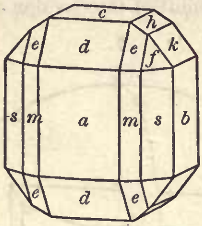
101 ∧ 010 (*db*) = 101 ∧ 111 (*de*) + 111 ∧ 121 (*ef*) + 121 ∧ 010 (*fb*).

Here, as throughout this work, the sign ∧ is used to designate the angle between two faces, usually designated by letters.

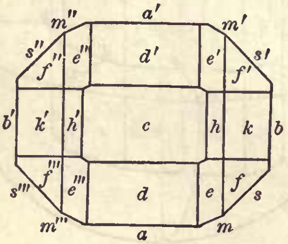
*Methods of Calculation.*—In general the angles between the poles can be calculated by the methods of spherical trigonometry from the triangles as shown in the sphere of projec [illegible] 10

—which for the most part are right-angled. Certain fundamental relations connect the axes with the elemental angles of the projection; the most important of these are given under the individual systems. For the formulas necessary in certain cases, reference must be made to works on crystallography.

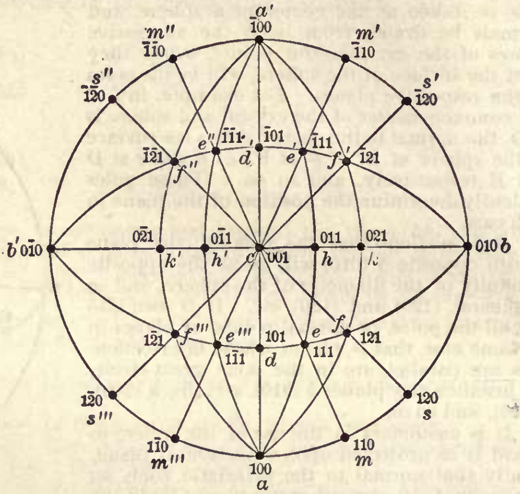
8.



9.



10.



The only relation which need be introduced here is the *tangent principle*, applicable to any zone between a pinacoid plane and a plane, 90° from this, in a zone with the other two pinacoids. The relation and its application to such zones will be evident from the following simple examples:

$$\frac{\tan\,(001 \wedge h0l)}{\tan\,(001 \wedge 101)} = \frac{h}{l}, \qquad \frac{\tan\,(001 \wedge 0kl)}{\tan\,(001 \wedge 011)} = \frac{k}{l},$$

$$\frac{\tan\,(010 \wedge hk0)}{\tan\,(010 \wedge 1\bar{1}0)} = \frac{h}{k}, \text{ or } \frac{\tan\,(100 \wedge hk0)}{\tan\,(100 \wedge 1\bar{1}0)} = \frac{k}{h}.$$

Also

$$\frac{\tan\,(001 \wedge hhl)}{\tan\,(001 \wedge 111)} = \frac{h}{l} \text{ or more generally } \frac{\tan\,(001 \wedge hhl)}{\tan\,(001 \wedge ppr)} = \frac{h}{l} \times \frac{r}{p}, \text{ etc.}$$

*Order of Forms.*—In the lists of forms under each species, the following order is followed:

1. Pinacoids, 100, 010, 001;
2. Prisms, commencing with the form ($hk0$) nearest 100;
3. Domes, commencing with the forms ($h0l$ and $0kl$) nearest to 001;
4. Pyramids of the unit series in a like order;
5. Other pyramids arranged in vertical zones, e.g. from 001 to 210, etc., the zones being taken in the same order as that adopted above for the prisms. In the monoclinic system, the orthopyramids are given before the clinopyramids.

*Twin Crystals.*—A twin crystal is one in which one part is in reversed position with reference to the other, as if, in general, it had been revolved through 180° about a certain axis. This axis of revolution is the *twinning axis*, and the plane normal to it is the *twinning-plane;* either the twinning-axis must be a definite crystallographic line, or the twinning-plane a possible plane (usually a common one)—except in the inclined system both statements must hold true.

The plane common to the two crystals or parts of crystals in a simple *contact-twin* is the *composition-face;* it is usually the same as the twinning-plane, but may be normal to it. In a *penetration-twin* the parts may be united very irregularly.

Twinning may be repeated, giving rise to three-fold, four-fold, etc., compound crystals, called trillings, fourlings, fivelings, etc. This is common where the angle between the axes of the crystals in the twinning position is more or less closely an aliquot part of 180°; five-rayed, six-rayed, etc., star-shaped twins may result (cf. marcasite (p. 95), chrysoberyl (p. 229), rutile (pp. 237, 238).

Polysynthetic twinning is repeated twinning in the form of thin lamellæ alternately in reversed position with reference to each other; this usually produces fine lines or striations upon the bounding surfaces; cf. the triclinic feldspars, p. 326 *et seq.*

In twins the faces of the reversed part are denoted by a letter with a subscript line.

## 1. ISOMETRIC SYSTEM.

In the Isometric System there are three equal axes at right angles to each other. It is characterized (in the holohedral forms) by three principal planes of symmetry, all equal. The lines in which these planes of symmetry intersect are the crystallographic axes. There are also six auxiliary diagonal planes of symmetry, equal among themselves.

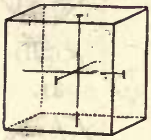
There are seven *holohedral* types of form in this system, that is seven in which *all* the similar planes comprehended by each general symbol are present. They are, in order of simplicity, with their symbols:

| | | | | |
|---|---|---|---|---|
| 1. Cube | (100) | *i-i* | ∞*O*∞ | *a* |
| 2. Octahedron | (111) | 1 | *O* | *o* |
| 3. Dodecahedron | (110) | *i* | ∞*O* | *d* |
| 4. Tetrahexahedron | (*hk*0) | *i-n* | ∞*On* | as *e* (210, *i*-2) |
| 5. Trigonal Trisoctahedron | (*hhl*) | *m* | *mO* | as *p* (221, 2) |
| 6. Tetragonal Trisoctahedron, or Trapezohedron | (*hll*) | *m-m* | *mOm* | as *n* (211, 2-2) |
| 7. Hexoctahedron | (*hkl*) | *m-n* | *mOn* | as *s* (321, 3-$\frac{3}{2}$) |

In the above $h > k > l$.

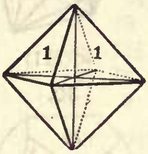
These forms are shown in the following figures with the symbols after both Miller and Naumann.

**11.**



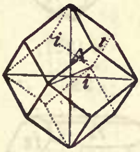
*a* (100, *i-i*)

**12.**



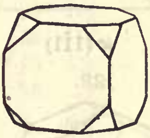
*o* (111, 1)

**13.**



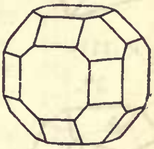
*d* (110, *i*)

**14.**



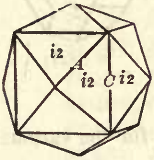
*a*, *o*

**15.**



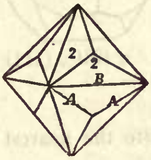
*a*, *o*, *d*

**16.**



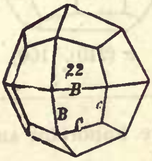
*e* (210, *i*-2)

**17.**



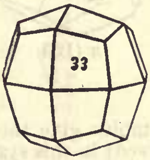
*p* (221, 2)

**18.**



*n* (211, 2-2)

**19.**



*m* (311, 3-3)

**20.**

*s* (321, 3-$\frac{3}{2}$)

The following letters are uniformly used in this work to designate the most commonly occurring forms, viz. (chiefly after Miller):

Cube *a*. Octahedron *o*. Dodecahedron *d*.

Tetrahexahedrons: $e = 210$, $i$-2; $f = 310$, $i$-3; $g = 320$, $i$-$\frac{3}{2}$; $h = 410$, $i$-4.

Tetrahexahedrons: $k = 520$, $i$-$\frac{5}{2}$; $l = 530$, $i$-$\frac{5}{3}$, $\vartheta = 430$, $i$-$\frac{4}{3}$.

Trigonal trisoctahedrons: $p = 221$, 2; $q = 331$, 3; $r = 332$, $\frac{3}{2}$; $\rho = 441$, 4.

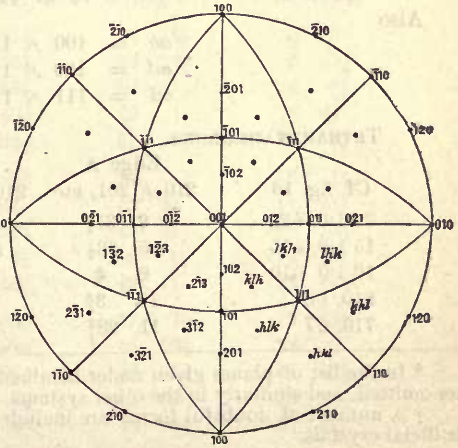
Tetragonal trisoctahedrons: $m = 311$, 3-3; $n = 211$, 2-2; $\beta = 322$, $\frac{3}{2}$-$\frac{3}{2}$.

Hexoctahedrons: $s = 321$, 3-$\frac{3}{2}$; $t = 421$, 4-2.

For other forms letters are used indiscriminately. The spherical projection, f. 21, shows the distribution of some of the forms of this system.

It will be noted that the planes of the hexoctahedron *s* (f. 20) in the right upper octant are, in order (counter-clockwise): 321, 231, 132, 123, 213, 312. Similarly for the trisoctahedron *p* (f. 17), 221, 122, 212; for *n* (f. 18), 211, 121, 112.

**21.**



The HEMIHEDRAL forms are those in which only *half* the normal number of planes are present. The common types are:

A. *Tetrahedral* or *Inclined hemihedrons.* Tetrahedron κ (111) or ½ (1), f. 22, 23.* Hemi-trigonal trisoctahedron κ (*hhl*) or ½ (*m*), f. 24, and hemi-tetragonal trisoctahedron κ (*hll*) or ½ (*m-m*). f. 25; hemi-hexoctahedron (hexatetrahedron) κ (*hkl*) or ½ (*m-n*), f. 26. Also

B. The *Pyritohedral* or *Parallel hemihedrons.* Pyritohedron π (*hk*0) or ½ (*i-n*), f. 27-30, and Diploid π (*hkl*) or ½ (*m-n*), f. 31.

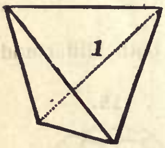
There are also certain gyroidal or plagihedral hemihedrons (e.g., sylvite), and further tetartohedral forms which need not be explained here.

In general, hemihedrons may be plus or minus, according to which set of planes is present, thus:

The *plus* tetrahedron has the planes 111, $\bar{1}\bar{1}1$, $1\bar{1}\bar{1}$, $\bar{1}1\bar{1}$.
The *minus* " " " " $\bar{1}11$, $1\bar{1}1$, $11\bar{1}$, $\bar{1}\bar{1}\bar{1}$.

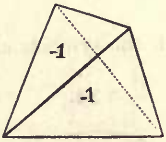
These are, in the majority of cases, represented by the same letters on the figures, but the minus or inverse form is indicated by a subscript accent, thus *o* (111, + 1) and $o_,$ ($1\bar{1}1$, − 1), and similarly of the other + and − hemihedral forms in this system.

22.



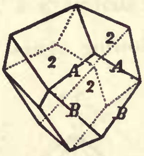
κ (111)

23.



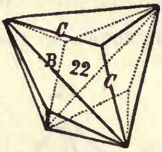
κ ($1\bar{1}1$)

24.



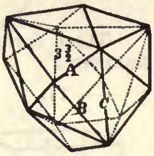
κ (221)

25.



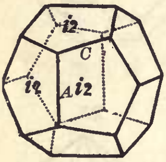
κ (211)

26.



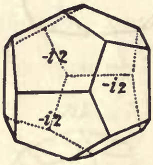
κ (321)

27.



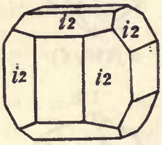
π (210)

28.



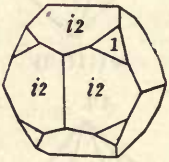
π (120)

29.



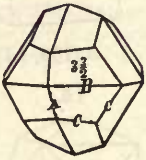
π (210), (100)

30.



π (210), (111)

31.



π (321)

The following tables give the more important angles (to the nearest 15″) for the various forms thus far observed† in this system.

Interfacial angles for the

| Cube | Octahedron | Dodecahedron |
|---|---|---|
| 100 ∧ 010 | *oo'* = 111 ∧ $\bar{1}$11 | *dd'* = 110 ∧ 101 |
| 90° 0′ 0″ | 70° 31′ 44″ | 60° 0′ 0″ |

Also

*ao* = 100 ∧ 111 = 54° 44′ 8″
*ad* = 100 ∧ 110 = 45° 0′ 0″
*od* = 111 ∧ 110 = 35° 15′ 52″

TETRAHEXAHEDRONS.

| | Edge A | Edge C | Angle on | Angle on |
|---|---|---|---|---|
| Cf. fig. 16 | 210 ∧ 201, etc | 210 ∧ 120, etc. | *a* (100, *i-i*) | *o* (111, 1) |
| 32·1·0, *i*-32 | 2° 31¾′ | 86° 25¼′ | 1° 47½′ | 53° 28¾′ |
| 15·1·0, *i*-15 | 5 23½ | 82 22⅓ | 3 48¾ | 52 5¼ |
| 10·1·0, *i*-10 | 8 4 | 78 34¾ | 5 42½ | 50 48½ |
| 810, *i*-8 | 10 3¾ | 75 45 | 7 7½ | 49 52⅛ |
| 710, *i*-7 | 11 28¾ | 73 44⅛ | 8 7¾ | 49 13 |

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* In the list of planes given under hemihedral species, these hemihedral signs κ and π, etc., are omitted, and similarly in the other systems.

† A number of doubtful forms are included in the lists, also some forms known only on artificial crystals.

**Tetrahexahedrons**—*Continued.*

| Cf. fig. 16 | Edge A<br>210 ∧ 201, etc. | Edge C<br>210 ∧ 120, etc. | Angle on<br>*a* (100, *i-i*) | Angle on<br>*o* (111, 1) |
|---|---|---|---|---|
| 610, $i$-6 | 13° 21′ | 71° 4½′ | 9° 27¾′ | 48° 21¾′ |
| 17·3·0, $i$-$\frac{17}{3}$ | 14 6¾ | 69 59 | 10 0⅓ | 48 1 |
| 510, $i$-5 | 15 56⅓ | 67 23 | 11 18½ | 47 12¼ |
| 920, $i$-$\frac{9}{2}$ | 17 39 | 64 56½ | 12 31¾ | 46 27¾ |
| 13·3·0, $i$-$\frac{13}{3}$ | 18 17¾ | 64 0⅔ | 12 59⅔ | 46 10½ |
| 410, $i$-4 | 19 45 | 61 55¾ | 14 2¼ | 45 33¾ |
| 11·3·0, $i$-$\frac{11}{3}$ | 21 26¾ | 59 29⅓ | 15 15⅓ | 44 51¼ |
| 10·3·0, $i$-$\frac{10}{3}$ | 23 26¾ | 56 36⅓ | 16 42 | 44 2¼ |
| 310, $i$-3 | 25 50½ | 53 87¾ | 18 26 | 43 5¼ |
| 520, $i$-$\frac{5}{2}$ | 30 27 | 46 23¾ | 21 48 | 41 22 |
| 12·5·0, $i$-$\frac{12}{5}$ | 31 33¾ | 44 45½ | 22 37¼ | 40 58½ |
| 730, $i$-$\frac{7}{3}$ | 32 20¾ | 43 36¼ | 23 12 | 40 42¼ |
| 940, $i$-$\frac{9}{4}$ | 33 22¾ | 42 4½ | 23 57¾ | 40 21½ |
| 210, $i$-2 | 36 52¼ | 36 52¼ | 26 34 | 39 14 |
| 950, $i$-$\frac{9}{5}$ | 40 10 | 31 53½ | 29 3¼ | 38 16⅓ |
| 740, $i$-$\frac{7}{4}$ | 41 4½ | 30 30½ | 29 44¾ | 38 1½ |
| 530, $i$-$\frac{5}{3}$ | 42 40 | 28 4¼ | 30 57¾ | 37 37 |
| 320, $i$-$\frac{3}{2}$ | 46 11¼ | 22 37¼ | 33 41½ | 36 48½ |
| 750, $i$-$\frac{7}{5}$ | 48 32 | 18 55½ | 35 32¼ | 36 21½ |
| 11·8·0, $i$-$\frac{11}{8}$ | 49 9 | 17 56⅔ | 36 1⅔ | 36 14⅔ |
| 430, $i$-$\frac{4}{3}$ | 50 12½ | 16 15½ | 36 52¼ | 36 4¼ |
| 970, $i$-$\frac{9}{7}$ | 51 27½ | 14 15 | 37 52½ | 35 53 |
| 540, $i$-$\frac{5}{4}$ | 52 25¾ | 12 40¾ | 38 39½ | 35 45⅓ |
| 870, $i$-$\frac{8}{7}$ | 55 30¼ | 7 37⅔ | 41 11¼ | 35 26½ |
| 14·13·0, $i$-$\frac{14}{13}$ | 57 31¼ | 4 14½ | 42 52¾ | 35 19¼ |
| 11·10·0, $i$-$\frac{11}{10}$ | 56 48¼ | 5 27¼ | 42 16½ | 35 21¼ |
| 20·19·0, $i$-$\frac{20}{19}$ | 58 17½ | 2 56¼ | 43 31¾ | 35 17½ |
| 41·40·0, $i$-$\frac{41}{40}$ | 59 10¾ | 1 24¾ | 44 17½ | 35 16¼ |
| 64·63·0. $i$-$\frac{64}{63}$ | 59 28¾ | 0 54¼ | 44 33 | 35 16 |
| 86·85·0, $i$-$\frac{86}{85}$ | 59 36¾ | 0 40¼ | 44 40 | 35 16 |

**Trigonal Trisoctahedrons.**

| Cf. fig. 17 | Edge A<br>221 ∧ 212; etc. | Edge B<br>221 ∧ 22$\bar{1}$, etc. | Angle on<br>*a* (100, *i-i*) | Angle on<br>*o* (111, 1) |
|---|---|---|---|---|
| 65·65·64, $\frac{65}{64}$ | 0° 43½′ | 69° 41½′ | 54° 31¾′ | 0° 25′ |
| 10·10·9, $\frac{10}{9}$ | 4 50 | 64 56⅔ | 53 22⅔. | 2 47⅓ |
| 776, $\frac{7}{6}$ | 7 0¼ | 62 26⅓ | 52 47½ | 4 2⅔ |
| 554, $\frac{5}{4}$ | 9 59¼ | 58 59½ | 52 1 | 5 46 |
| 443, $\frac{4}{3}$ | 12 40¾ | 55 52½ | 51 20½ | 7 19½ |
| 332, $\frac{3}{2}$ | 17 20½ | 50 28¾ | 50 14¼ | 10 1½ |
| 885, $\frac{8}{5}$ | 19 45 | 47 41 | 49 42 | 11 25¼ |
| 553, $\frac{5}{3}$ | 21 13¼ | 45 58¾ | 49 23¼ | 12 16½ |
| 774, $\frac{7}{4}$ | 22 55¼ | 44 0¼ | 49 2 | 13 15¾ |
| 221, 2 | 27 16 | 38 56½ | 48 11 | 15 47½ |
| 552, $\frac{5}{2}$ | 33 33½ | 31 35¼ | 47 7½ | 19 28¼ |
| 331, 3 | 37 51¾ | 26 31½ | 46 30½ | 22 0 |
| 772, $\frac{7}{2}$ | 40 59 | 22 50⅔ | 46 7½ | 23 50½ |
| 441, 4 | 43 20½ | 20 2¾ | 45 52 | 25 14½ |
| 551, 5 | 46 39¾ | 16 6 | 45 33¾ | 27 13 |

TRIGONAL TRISOCTAHEDRONS—*Continued.*

| Cf. fig. 17 | Edge A<br>$221 \wedge 212$, etc. | Edge B<br>$221 \wedge 22\bar{1}$, etc. | Angle on<br>*a* (100, *i-i*) | Angle on<br>*o* (111, 1) |
|---|---|---|---|---|
| 661, 6 | 48° 53¼′ | 13° 26½′ | 45° 23½′ | 28° 32½′ |
| 771, 7 | 50 28¾ | 11 32¼ | 45 17¼ | 29 29¾ |
| 881, 8 | 51 40¼ | 10 6¼ | 45 13¼ | 30 12¾ |
| 11 11·1, 11 | 53 57 | 7 21¼ | 45 7 | 31 35¼ |
| 27·27·1, 27 | 57 32½ | 3 0 | 45 1½ | 33 45¾ |
| 40·40·1, 40 | 58 20½ | 2 1⅜ | 45 0½ | 34 15 |

TETRAGONAL TRISOCTAHEDRONS OR TRAPEZOHEDRONS.

| Cf. fig. 18 | Edge B<br>$211 \wedge 2\bar{1}1$, etc. | Edge C<br>$211 \wedge 121$, etc. | Angle on<br>*a* (100, *i-i*) | Angle on<br>*o* (111, 1) |
|---|---|---|---|---|
| 40·1·1, 40-40 | 2° 51¾′ | 87° 6′ | 2° 1½′ | 52° 42¾′ |
| 36·1·1, 36-36 | 3 10¾ | 86 46½ | 2 15 | 52 29¼ |
| 16·1·1, 16-16 | 7 8¼ | 82 39 | 5 3 | 49 41 |
| 15·1·1, 15-15 | 7 36¾ | 82 9 | 5 23¼ | 49 21 |
| 12·1·1, 12-12 | 9 29¾ | 80 8½ | 6 43¼ | 48 0¾ |
| 11·1·1, 11-11 | 10 20¾ | 79 13¼ | 7 19½ | 47 24½ |
| 10·1·1, 10-10 | 11 22 | 78 7¼ | 8 3 | 46 41¼ |
| 911, 9-9 | 12 36¼ | 76 46 | 8 55¾ | 45 48¼ |
| 811. 8-8 | 14 8½ | 75 4½ | 10 1½ | 44 42¾ |
| 15·2·2, $\frac{15}{2}$-$\frac{15}{2}$ | 15 3½ | 74 3½ | 10 40¾ | 44 3½ |
| 711. 7-7 | 16 6 | 72 53¾ | 11 25¼ | 43 18¾ |
| 611, 6-6 | 18 40¼ | 69 59¾ | 13 15¾ | 41 28¼ |
| 511, 5-5 | 22 11½ | 65 57½ | 15 47½ | 38 56½ |
| 411, 4-4 | 27 16 | 60 0 | 19 28¼ | 35 15¾ |
| 833, $\frac{8}{3}$-$\frac{8}{3}$ | 38 41¾ | 45 57¾ | 27 56¼ | 26 47¾ |
| 722, $\frac{7}{2}$-$\frac{7}{2}$ | 30 43¼ | 55 50¾ | 22 0 | 32 44 |
| 311, 3-3 | 35 5¾ | 50 28¾ | 25 14¼ | 29 29¾ |
| 522, $\frac{5}{2}$-$\frac{5}{2}$ | 40 45 | 43 20½ | 29 29¾ | 25 14¼ |
| 944, $\frac{9}{4}$-$\frac{9}{4}$ | 44 12½ | 38 51¼ | 32 9 | 22 35 |
| 11·5·5, $\frac{11}{5}$-$\frac{11}{5}$ | 44 57½ | 37 51¾ | 32 44 | 22 0 |
| 211, 2-2 | 48 11½ | 33 33½ | 35 15¾ | 19 28¼ |
| 955, $\frac{9}{5}$-$\frac{9}{5}$ | 51 48½ | 28 36¾ | 38 9¼ | 16 34¾ |
| 744, $\frac{7}{4}$-$\frac{7}{4}$ | 52 46½ | 27 16 | 38 56½ | 15 47½ |
| 533, $\frac{5}{3}$-$\frac{5}{3}$ | 54 27 | 24 54½ | 40 19 | 14 25¼ |
| 322, $\frac{3}{2}$-$\frac{3}{2}$ | 58 2 | 19 45 | 43 18¾ | 11 25¼ |
| 433, $\frac{4}{3}$-$\frac{4}{3}$ | 61 55¾ | 13 55¾ | 46 41¼ | 8 3 |
| 655, $\frac{6}{5}$-$\frac{6}{5}$ | 65 15¼ | 8 44¾ | 49 41 | 5 3 |

HEXOCTAHEDRONS.

| Cf. fig. 20 | Edge A<br>$321 \wedge 312$, etc. | Edge B<br>$321 \wedge 32\bar{1}$, etc. | Edge C<br>$321 \wedge 231$, etc. | Angle on<br>*a* (100, *i-i*) | Angle on<br>*o* (111, 1) |
|---|---|---|---|---|---|
| 25·6·2, $\frac{25}{2}$-$\frac{25}{6}$ | 12° 35¾′ | 8° 53¾′ | 62° 47¾′ | 14° 11¾′ | 42° 22′ |
| 12·3·2, 6-4 | 6 28¼ | 18 22¼ | 61 3 | 16 43½ | 38 26 |
| 821, 8-4 | 9 46 | 13 49¾ | 61 25¾ | 15 37 | 40 8 |
| 21·7·5, $\frac{21}{5}$-3 | 7 8¾ | 25 27½ | 51 43½ | 22 16½ | 32 54½ |
| 832, 4-$\frac{8}{3}$ | 9 14¾ | 26 21 | 47 31¼ | 24 15¾ | 31 12¼ |
| 10·4·3, $\frac{10}{3}$-$\frac{5}{2}$ | 7 15 | 31 7¾ | 44 36¼ | 26 34 | 28 36¾ |
| 521, 5-$\frac{5}{2}$ | 14 50 | 21 2¼ | 45 34½ | 24 5¾ | 32 30¾ |
| 15·6·2, $\frac{15}{2}$-$\frac{5}{2}$ | 20 0⅜ | 14 6¾ | 46 1½ | 22 51¾ | 35 20½ |
| 732, $\frac{7}{2}$-$\frac{7}{3}$ | 10 18¼ | 29 25¾ | 42 6¼ | 27 15 | 28 22¼ |
| 731, 7-$\frac{7}{3}$ | 21 13¼ | 14 57¾ | 43 12¾ | 24 18¾ | 34 13¾ |

HEXOCTAHEDRONS—*Continued.*

| Cf. fig. 20 | Edge A 321 ∧ 312, etc. | Edge B 321 ∧ 32$\bar{1}$, etc. | Edge C 321 ∧ 231, etc. | Angle on *a* (100, *i-i*) | Angle on *o* (111, 1) |
|---|---|---|---|---|---|
| 16·7·4, $4\text{-}\frac{16}{7}$ | 13° 36′ | 25° 48′ | 41° 36¾′ | 26° 44½′ | 29° 32′ |
| 942, $\frac{9}{2}\text{-}\frac{9}{4}$ | 16 10¾ | 22 57½ | 41 11¾ | 26 25½ | 30 29¼ |
| 11·5·3, $\frac{11}{3}\text{-}\frac{11}{5}$ | 13 2¾ | 27 53¼ | 39 51 | 27 55¾ | 28 13½ |
| 845, $\frac{8}{5}\text{-}2$ | 7 54¾ | 58 24¾ | 32 2¾ | 38 40½ | 16 41¾ |
| 10·5·3, $\frac{10}{3}\text{-}2$ | 14 2 | 30 2½ | 35 34 | 30 14¾ | 26 8 |
| 421, 4-2 | 17 45¼ | 25 12½ | 35 57 | 29 12¼ | 28 6½ |
| 24·12·5, $\frac{24}{5}\text{-}2$ | 20 53¾ | 21 6⅔ | 36 13½ | 28 26½ | 29 51½ |
| 11·6·1, $11\text{-}\frac{11}{6}$ | 32 40¼ | 9 7½ | 32 40¼ | 28 56½ | 34 14 |
| 13·7·5, $\frac{13}{5}\text{-}\frac{13}{7}$ | 10 24½ | 37 25 | 31 35¼ | 33 29½ | 22 11½ |
| 18·10·5, $\frac{18}{5}\text{-}\frac{9}{5}$ | 19 12½ | 27 17¾ | 30 58 | 31 50¾ | 25 57¼ |
| 18·10·1, $18\text{-}\frac{9}{5}$ | 35 57¾ | 5 33¾ | 31 51¼ | 29 10½ | 35 41½ |
| 12·7·5, $\frac{12}{5}\text{-}\frac{12}{7}$ | 10 59½ | 39 35¼ | 27 42½ | 35 38 | 20 12¼ |
| 531, $5\text{-}\frac{5}{3}$ | 27 39½ | 19 27¾ | 27 39½ | 32 18¾ | 28 33¾ |
| 853, $\frac{8}{3}\text{-}\frac{8}{5}$ | 16 25½ | 35 17 | 24 44¾ | 36 5¼ | 21 4¼ |
| 643, $2\text{-}\frac{3}{2}$ | 10 23⅓ | 45 10⅔ | 20 51¾ | 39 48⅓ | 16 3½ |
| 321, $3\text{-}\frac{3}{2}$ | 21 47¼ | 31 0¼ | 21 47¼ | 36 42 | 22 12½ |
| 10·7·3, $\frac{10}{3}\text{-}\frac{10}{7}$ | 26 0½ | 27 37 | 19 26 | 37 17½ | 23 16⅓ |
| 20·14·3, $\frac{20}{3}\text{-}\frac{10}{7}$ | 36 52¼ | 14 0¾ | 19 52 | 35 36 | 29 43 |
| 751, $7\text{-}\frac{7}{5}$ | 38 7½ | 13 15¾ | 18 47¾ | 36 4¼ | 29 55½ |
| 971, $9\text{-}\frac{9}{7}$ | 43 31 | 10 1⅓ | 14 11¾ | 38 9¼ | 30 57½ |
| 432, $2\text{-}\frac{4}{3}$ | 15 5½ | 43 36¼ | 15 5½ | 42 1¾ | 15 13½ |
| 431, $4\text{-}\frac{4}{3}$ | 32 12¼ | 22 37¼ | 15 56½ | 38 19¾ | 25 4 |
| 543, $\frac{5}{3}\text{-}\frac{5}{4}$ | 11 28⅔ | 50 12½ | 11 28⅔ | 45 0 | 11 32¼ |
| 541, $5\text{-}\frac{5}{4}$ | 38 12¾ | 17 45¼ | 12 31¾ | 39 30½ | 27 1 |
| 654, $\frac{3}{2}\text{-}\frac{6}{5}$ | 9 14¾ | 54 14¼ | 9 14¾ | 46 51¾ | 9 16½ |
| 651, $6\text{-}\frac{6}{5}$ | 42 6¼ | 14 35½ | 10 18¼ | 40 21½ | 28 22¼ |
| 13·11·9, $\frac{13}{9}\text{-}\frac{13}{11}$ | 8 25⅓ | 55 42¾ | 8 25⅓ | 47 33 | 8 26⅔ |
| 875, $\frac{8}{5}\text{-}\frac{8}{7}$ | 13 49¾ | 50 22¾ | 6 54 | 47 4¾ | 10 35¾ |
| 986, $\frac{3}{2}\text{-}\frac{9}{8}$ | 12 4 | 52 58¼ | 6 1½ | 48 0¾ | 9 14½ |
| 64·63·1, $64\text{-}\frac{64}{63}$ | 58 26¼ | 1 16½ | 0 54 | 44 33¼ | 34 36¾ |

Further, the angles for the hemihedral forms* are as follows:

For the tetrahedron *oo′* (111 ∧ $\bar{1}\bar{1}$1) = 109° 28′ 16″, *oo,* (111 ∧ 1$\bar{1}$1) = 70° 31′ 44″.

### Inclined Hemihedrons.

HEMI-TRIGONAL TRISOCTAHEDRONS.

| Cf. fig. 24 | Edge A 221 ∧ 212, etc. | Edge B 221 ∧ 1$\bar{2}\bar{2}$, etc. | Angle on *a* (100, *i-i*) | Angle on *o* (111, 1) |
|---|---|---|---|---|
| 554 | 9° 59¼′ | 103° 8¼′ | 52° 1′ | 5° 46′ |
| 332 | 17 20½ | 97 50¼ | 50 14¼ | 10 1½ |
| 885 | 19 45 | 96 0¼ | 49 42 | 11 25⅛ |
| 553 | 21 13¼ | 94 51⅜ | 49 23¼ | 12 16½ |
| 774 | 22 55¼ | 93 31¼ | 49 2 | 13 15¾ |
| 221 | 27 16 | 90 0 | 48 11½ | 15 47½ |
| 552 | 33 33½ | 84 41 | 47 7½ | 19 28⅛ |
| 331 | 37 51¾ | 80 55 | 46 30½ | 22 0 |
| 661 | 48 53¼ | 70 48⅛ | 45 23½ | 28 32½ |
| 15·15·2 | 51 7 | 68 41⅓ | 45 15¼ | 29 52⅔ |
| 881 | 51 40¼ | 68 9⅓ | 45 13⅓ | 30 12¾ |

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* No distinction is made between the + and − forms; the angles are the same obviously except for the pyritohedrons and diploids, where the angle between a given + form (e.g., 210, 321) and 100 is the same as that for the corresponding − form (120, 231) and 010. The symbols after Naumann (many of them given in the table above) are omitted here.

### HEMI-TETRAGONAL TRISOCTAHEDRONS.

| Cf. fig. 25 | Edge B<br>211 ∧ 21̄1̄, etc. | Edge C<br>211 ∧ 121, etc. | Angle on<br>*a* (100, *i-i*) | Angle on<br>*o* (111, 1) |
|---|---|---|---|---|
| 13·1·1 | 12° 25′ | 80° 55′ | 6° 12½′ | 48° 31½ |
| 12·1·1 | 13 26½ | 80 8½ | 6 43¼ | 48 0¾ |
| 17·2·2 | 18 53½ | 75 58¼ | 9 26¾ | 45 17¼ |
| 13·2·2 | 24 33 | 71 33¼ | 12 16½ | 42 27¾ |
| 611 | 26 31½ | 69 59¾ | 13 15¾ | 41 28½ |
| 511 | 31 35¼ | 65 57½ | 15 47½ | 38 56½ |
| 411 | 38 56½ | 60 0 | 19 28¼ | 35 15¾ |
| 722 | 44 0¼ | 55 50¾ | 22 0 | 32 44 |
| 311 | 50 28¾ | 50 28¾ | 25 14¼ | 29 29¾ |
| 833 | 55 52½ | 45 57¾ | 27 56⅛ | 26 47¾ |
| 522 | 58 59½ | 43 20½ | 29 29¾ | 25 14¼ |
| 733 | 62 26¼ | 40 25¾ | 31 13¼ | 23 31 |
| 944 | 64 18 | 50 25¼ | 32 9 | 22 35 |
| 211 | 70 31¾ | 33 33½ | 35 15¾ | 19 28¼ |
| 17·9·9 | 73 38⅔ | 30 53¾ | 36 49⅛ | 17 54¾ |
| 955 | 76 18¾ | 28 36¾ | 38 9¼ | 16 34¾ |
| 744 | 77 53 | 27 16 | 25 50½ | 15 47½ |
| 322 | 86 37¾ | 19 45 | 43 18¾ | 11 25¼ |

### HEMI-HEXOCTAHEDRONS.

| Cf. fig. 26 | Edge A<br>321 ∧ 312, etc. | Edge B<br>321 ∧ 31̄2̄, etc. | Edge C<br>321 ∧ 231, etc. | Angle on<br>*a* (100, *i-i*) | Angle on<br>*o* (111, 1) |
|---|---|---|---|---|---|
| 521 | 14° 50′ | 45° 34½′ | 45° 34½′ | 24° 5¾′ | 32° 30¾′ |
| 631 | 24 4¼ | 49 17¾ | 36 27¼ | 27 47½ | 31 39 |
| 12·7·5 | 10 59½ | 70 9½ | 27 42½ | 35 38 | 20 12¼ |
| 531 | 27 39⅔ | 57 7⅓ | 27 39⅔ | 32 18⅔ | 28 33⅔ |
| 321 | 21 47¼ | 69 4½ | 21 47¼ | 36 42 | 22 12½ |
| 753 | 17 51⅔ | 76 46 | 17 51⅔ | 39 47⅔ | 18 5¼ |
| 15·11·7 | 16 21¾ | 79 38⅔ | 16 21¾ | 40 41 | 16 32¼ |
| 432 | 15 5½ | 82 4⅛ | 15 5½ | 42 1¾ | 15 13½ |
| 431 | 32 12¼ | 67 22¾ | 15 56½ | 38 19¾ | 25 4 |
| 861 | 41 11⅔ | 59 0¾ | 16 10¾ | 37 14¾ | 30 30⅔ |
| 975 | 13 2¾ | 85 55¾ | 13 2¾ | 43 42¼ | 13 8 |
| 11·10·1 | 50 34¼ | 62 56¼ | 5 26½ | 42 25 | 31 31 |

## Parallel Hemihedrons.

### PYRITOHEDRONS.

| Cf. figs. 27–30 | Edge A<br>210 ∧ 21̄0, etc. | Edge C<br>210 ∧ 102, etc. | Angle on<br>*a* (100, *i-i*) | Angle on<br>*o* (111, 1) |
|---|---|---|---|---|
| 10·1·0 | 11° 25′ | 84° 19′ | 5° 42¾′ | 50° 48½′ |
| 910 | 14 20¾ | 83 42 | 6 20½ | 50 23¼ |
| 810 | 14 15 | 82 55¾ | 7 7½ | 49 52¼ |
| 710 | 16 15½ | 81 57¼ | 8 7¾ | 49 13 |
| 610 | 18 55½ | 80 40 | 9 27¾ | 48 21¾ |
| 510 | 22 37¼ | 78 54¾ | 11 18⅜ | 47 12⅓ |
| 920 | 25 3½ | 77 46½ | 12 31¾ | 46 27¾ |
| 410 | 28 4¼ | 76 23½ | 14 2¼ | 45 33¾ |
| 720 | 31 53½ | 74 41 | 15 56¾ | 44 27½ |
| 10·3·0 | 33 24 | 74 1½ | 16 42 | 44 2¼ |

PYRITOHEDRONS—*Continued.*

| Cf. figs. 27–30 | Edge A<br>210 ∧ 2$\bar{1}$0, etc. | Edge C<br>210 ∧ 102, etc. | Angle on<br>*a* (100, *i-i*) | Angle on<br>*o* (111, 1) |
|---|---|---|---|---|
| 310 | 36° 52¼′ | 72° 32½′ | 18° 26′ | 43° 5¼′ |
| 11·4·0 | 39 58 | 71 16 | 19 59 | 42 16¾ |
| 520 | 43 36¼ | 69 49¾ | 21 48 | 41 22 |
| 940 | 47 55½ | 68 12¾ | 23 57¾ | 40 21¼ |
| 210 | 53 7¾ | 66 25¼ | 26 34 | 39 14 |
| 19·14·0 | 72 46 | 64 28⅛ | 36 23 | 36 10 |
| 12·7·0 | 60 30¾ | 64 12 | 30 15½ | 37 51 |
| 740 | 59 29½ | 64 29 | 29 44¾ | 38 1½ |
| 530 | 61 55¾ | 63 49¼ | 30 57¾ | 37 37 |
| 320 | 67 22¾ | 62 30¾ | 33 41½ | 36 48½ |
| 750 | 71 4½ | 61 46¼ | 35 32¼ | 36 21¼ |
| 430 | 73 44½ | 61 19 | 36 52¼ | 36 4¼ |
| 540 | 77 19¼ | 60 48¼ | 38 39½ | 35 45½ |
| 11·9·0 | 78 34¾ | 60 39¼ | 39 17¼ | 35 39¾ |
| 650 | 79 36¾ | 60 32½ | 39 48¼ | 35 35¾ |
| 760 | 81 12¼ | 60 23¼ | 40 36 | 35 30¼ |
| 15·13·0 | 81 49¾ | 60 20 | 40 54¾ | 35 28¼ |
| 870 | 82 22¼ | 60 17½ | 41 11¼ | 35 26½ |
| 980 | 83 16 | 60 13¾ | 41 38 | 35 24¼ |
| 10·9·0 | 83 58½ | 60 11 | 41 59¼ | 35 22½ |
| 11·10·0 | 84 32¾ | 60 9 | 42 16½ | 35 21½ |

DIPLOIDS.

| Cf. fig. 31 | Edge A<br>321 ∧ 3$\bar{2}$1, etc. | Edge B<br>321 ∧ 32$\bar{1}$, etc. | Edge C<br>321 ∧ 132, etc. | Angle on<br>*a* (100, *i-i*) | Angle on<br>*o* (111, 1) |
|---|---|---|---|---|---|
| 721 | 31° 35¼′ | 15° 38½′ | 64° 47½′ | 17° 43′ | 38° 13′ |
| 932 | 36 3 | 23 48½ | 57 8½ | 21 50 | 33 31¼ |
| 16·6·3 | 40 28 | 19 55 | 57 26¼ | 22 44¾ | 33 42 |
| 15·6·5 | 41 33¾ | 34 23½ | 47 0¾ | 27 30¼ | 27 25½ |
| 831 | 40 49¼ | 13 21 | 61 46¼ | 21 34 | 36 21¼ |
| 942 | 46 54½ | 22 57½ | 52 7¾ | 26 25½ | 30 29¼ |
| 11·5·2 | 48 11½ | 18 47¾ | 54 33 | 26 5 | 31 57 |
| 12·6·5 | 49 33 | 40 52¾ | 37 47½ | 33 3½ | 21 57½ |
| 632 | 50 45¼ | 33 12¼ | 42 43 | 31 0¼ | 24 52¼ |
| 421 | 51 45¼ | 25 12½ | 48 11½ | 29 12¼ | 28 6½ |
| 841 | 52 46½ | 12 45½ | 57 5¾ | 27 16 | 33 29½ |
| 10·5·1 | 52 54¼ | 10 13¼ | 58 56⅘ | 27 1 | 34 37 |
| 12·6·1 | 52 58¼ | 8 31½ | 60 11 | 26 52¾ | 35 22½ |
| 13·7·3 | 55 22¼ | 22 58¼ | 48 18¼ | 30 21¾ | 28 11½ |
| 742 | 57 34¼ | 27 51¾ | 43 33¾ | 32 34½ | 25 22¼ |
| 532 | 58 14½ | 37 51¾ | 35 20 | 35 47¾ | 20 30¾ |
| 531 | 60 56½ | 19 27¾ | 19 27¾ | 32 18¾ | 28 33¾ |
| 10·6·1 | 61 40½ | 9 48¼ | 56 18½ | 31 18¾ | 33 0¾ |
| 851 | 63 36¾ | 12 6 | 53 55¼ | 32 30¾ | 31 34 |
| 22·14·7 | 62 28 | 30 3¼ | 39 48½ | 35 25¾ | 23 9 |
| 962 | 66 6¾ | 20 57 | 46 2 | 35 58¾ | 26 50½ |
| 321 | 64 37½ | 31 0¼ | 38 12¼ | 36 42 | 22 12½ |
| 643 | 61 36¾ | 45 10⅜ | 27 43 | 39 48⅛ | 16 3½ |
| 13·9·6 | 64 18¼ | 41 33¾ | 29 28 | 39 45¾ | 17 4¾ |
| 751 | 70 31¾ | 13 15¾ | 51 11¼ | 36 4¼ | 29 55½ |

Diploids—*Continued.*

| Cf. fig. 31 | Edge A<br>321 ∧ 3$\bar{2}$1, etc. | Edge B<br>321 ∧ 32$\bar{1}$, etc. | Edge C<br>321 ∧ 132, etc. | Angle on<br>*a* (100, *i-i*) | Angle on<br>*o* (111, 1) |
|---|---|---|---|---|---|
| 432 | 67° 42½′ | 43° 36¼′ | 26° 17½′ | 42° 1¾′ | 15° 13½′ |
| 431 | 72 4¾ | 22 37¼ | 43 3 | 38 19¾ | 25 4 |
| 14·11·10 | 65 11¼ | 58 38½ | 14 20¾ | 46 43 | 8 17¼ |
| 10·8·7 | 66 28¾ | 57 19¼ | 14 43¾ | 46 45 | 8 30¾ |
| 543 | 68 54 | 50 12½ | 19 57 | 45 0 | 11 32¼ |

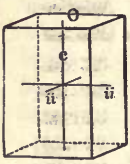
## 2. TETRAGONAL SYSTEM.

In the Tetragonal System there are three axes at right angles to each other; two of these are equal (*a*); the third, the vertical axis (*ċ*), is longer or shorter. The system is characterized by three axial planes of symmetry, two of which are equal to each other; there are also two other auxiliary planes inclined 45° to the other pair.

The holohedral forms in this system are:

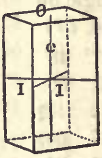
| | | | | |
|---|---|---|---|---|
| 1. Basal plane | (001) | *O* | 0*P* | *c* |
| 2. Diametral prism, or prism of second series | (100) | *i-i* | ∞*P*∞ | *a* |
| 3. Unit prism, or prism of first series | (110) | *I* | ∞*P* | *m* |
| 4. Ditetragonal prism | (*hk*0) | *i-n* | ∞*Pn* | as (210, *i*-2) |
| 5. Pyramids of diametral or second series | (*h*0*l*) | *m-i* | *mP*∞ | as *e* (101, 1-*i*), (201, 2-*i*), etc. |
| 6. Unit pyramids | (*hhl*) | *m* | *mP* | as (111, 1), (221, 2), etc. |
| 7. Ditetragonal pyramids or zirconoids | (*hkl*) | *m-n* | *mPn* | as (211, 2-2), (321, 3-$\frac{3}{2}$), etc. |

32.



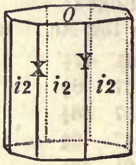
(001), (100)

33.



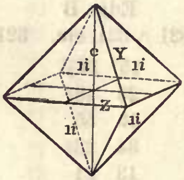
(001), (110)

34.



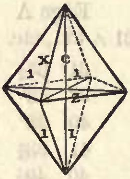
(001), (210)

35.



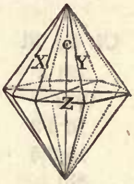
(101)

36.



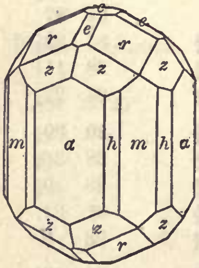
(111)

37

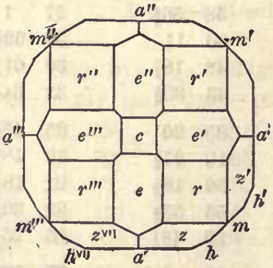


(*hkl*)

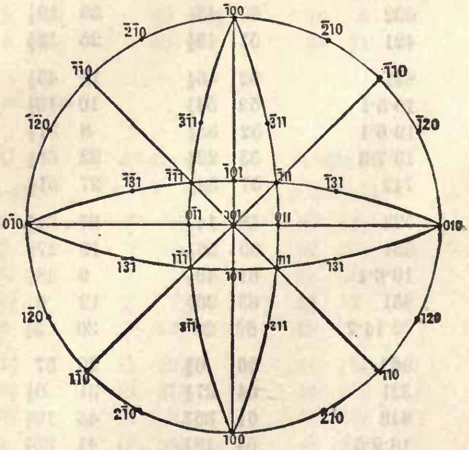
38.



39.



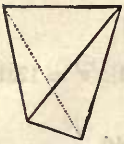
40.



In figs. 38, 39, *c* = (001), *a* = (100), *m* = (110), *h* = (210), *e* = (101), *r* = (111), *z* = (311).

These forms are shown in f. 32–37, and in combination in f. 38, of which f. 39, 40 are projections.

41.



π (111)

The *hemihedral* forms are:

A. *Sphenoidal* or inclined, represented by the sphenoid, or hemi-unit pyramid, f. 41, analogous to the tetrahedron (f. 22) and the tetragonal scalenohedron. Cf. figs. on pp. 80, 81, under chalcopyrite.

B. *Pyramidal,* including the half-form of the ditetragonal prism and pyramid or square prism and pyramid of the *third series.* Cf. figs. 3, 6, 7 under scheelite, p. 986, and f. 4–6, under wulfenite, p. 990.

The following table gives the important angles for the observed ditetragonal prisms, which are the same for all species. The angle of the edge X (f. 34) is twice the angle on *a* (100), and of the edge Y, twice the angle on *m* (110).

| | Angle on *a* (100, *i-i*) | Angle on *m* (110, *I*) | | Angle on *a* (100, *i-i*) | Angle on *m* (110, *I*) |
|---|---|---|---|---|---|
| 810, *i*-8 | 7° 7½′ | 37° 52½′ | 530, $i\text{-}\frac{5}{3}$ | 30° 57¾′ | 14° 2¼′ |
| 710, *i*-7 | 8° 7¾′ | 36° 52¼′ | 320, $i\text{-}\frac{3}{2}$ | 33° 41¼′ | 11° 18¾′ |
| 920, $i\text{-}\frac{9}{2}$ | 12° 31¾′ | 32° 28¼′ | 750, $i\text{-}\frac{7}{5}$ | 35° 32¼′ | 9° 27¾′ |
| 410, *i*-4 | 14° 2¼′ | 30° 57¾′ | 430, $i\text{-}\frac{4}{3}$ | 36° 52¼′ | 8° 7¾′ |
| 310, *i*-3 | 18° 26′ | 26° 34′ | 540, $i\text{-}\frac{5}{4}$ | 38° 39½′ | 6° 20½′ |
| 940, $i\text{-}\frac{9}{4}$ | 23° 57¾′ | 21° 2¼′ | 650, $i\text{-}\frac{6}{5}$ | 39° 48¼′ | 5° 11¾′ |
| 210, *i*-2 | 26° 34′ | 18° 26′ | 870, $i\text{-}\frac{8}{7}$ | 41° 11¼′ | 3° 48¾′ |
| 740, $i\text{-}\frac{7}{4}$ | 29° 44¾′ | 15° 15¼′ | 14·13·0, $i\text{-}\frac{14}{13}$ | 42° 52¾′ | 2° 7¼′ |

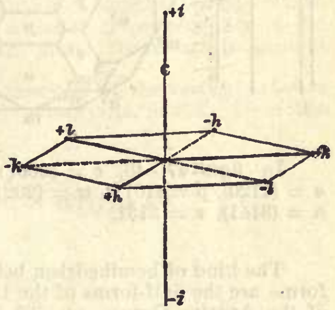
The vertical axis $\dot{c}$ can be obtained from the fundamental equations:

$$\tan (001 \wedge 101) = \dot{c} \quad \text{or} \quad \tan (001 \wedge 111) \, . \, \tfrac{1}{2}\sqrt{2} = \dot{c}.$$

### 3. HEXAGONAL SYSTEM.

The Hexagonal System includes (1) the HEXAGONAL SYSTEM proper, and (2) the RHOMBOHEDRAL DIVISION. In this work all the forms are referred to four axes, three equal axes (*a*) inclined at angles of 60° in a common horizontal plane and a fourth vertical axis ($\dot{c}$) at right angles to them and either longer or shorter.

42.



1. In the HEXAGONAL SYSTEM proper, there are 4 axial planes of symmetry, 3 equal planes intersecting at 60°, and a fourth unequal normal to them; also 3 auxiliary planes diagonal to the first set.

The general symbol for hexagonal forms is:

| 1. Weiss-Naumann | 2. Miller-Bravais |
|---|---|
| $pa : na : a : m\dot{c}$ | $hk\bar{l}i$ |

These symbols correspond to the symbols 1 and 2, already explained on p. xv. It is to be added that here $p = \frac{n}{n-1}$, in the first form, and $h + k - l = 0$ in the second. Special examples of these symbols are given in the list of forms below belonging to the hexagonal system. Note also that in the general symbol $hk\bar{l}i$, $h < k < l$; for example $(12\bar{3}1)$; this corresponds to the axes as shown in f. 42, and the spherical projection, f. 49. In stating the form (which includes 12 planes), it is customary to write it $kh\bar{l}i$, that is $(21\bar{3}1)$, and so in other cases.

The holohedral forms of this system are:

| | | | | | |
|---|---|---|---|---|---|
| 1. Basal plane | (0001) | *O* | 0*P* | *c* | |
| 2. Unit prism, or prism of first series | $(10\bar{1}0)$ | *I* | ∞*P* | *m* | |
| 3. Diagonal prism, or prism of second series | $(11\bar{2}0)$ | *i*-2 | ∞*P*2 | *a* | |
| 4. Dihexagonal prism | $(kh\bar{l}0)$ | *i-n* | ∞*Pn* | as $(21\bar{3}0, i\text{-}\frac{3}{2})$ | |
| 5. Unit pyramids, or first series (quartzoids) | $(h0\bar{h}i)$ | *m* | *mP* | as $(10\bar{1}1, 1)$ | or $(20\bar{2}1, 2)$ |
| 6. Diagonal pyramids, or second series | $(h{\cdot}h{\cdot}\overline{2h}{\cdot}i)$ | *m*-2 | *mP*2 | as $(11\bar{2}2, 1\text{-}2)$ | or $(11\bar{2}1, 2\text{-}2)$ |
| 7. Dihexagonal pyramids | $(kh\bar{l}i)$ | *m-n* | *mPn* | as $(21\bar{3}1, 3\text{-}\frac{3}{2})$ | |

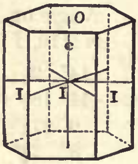
These forms are illustrated by figs. 43–47, also by the projections figs. 48, 49.

It is to be noted that the symbols of the planes of the forms *p* $(10\bar{1}1)$, *s* $(11\bar{2}1)$, taken in order (f. 48, 49), are:

| $p$ | $p'$ | $p''$ | $p'''$ | $p^{iv}$ | $p^{v}$ |
|---|---|---|---|---|---|
| $10\bar{1}1$ | $01\bar{1}1$ | $\bar{1}101$ | $\bar{1}011$ | $0\bar{1}11$ | $1\bar{1}01$ |
| $s$ | $s'$ | $s''$ | $s'''$ | $s^{iv}$ | $s^{v}$ |
| $11\bar{2}1$ | $\bar{1}2\bar{1}1$ | $\bar{2}111$ | $\bar{1}\bar{1}21$ | $1\bar{2}11$ | $2\bar{1}\bar{1}1$ |

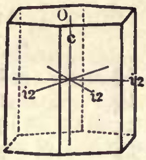
For the forms below, $p^{vi} = 10\bar{1}\bar{1}$, etc., $s^{vi} = 11\bar{2}\bar{1}$, etc. Also for $v\ (2\bar{1}\bar{3}1)$, $v' = 12\bar{3}1$, $v'' = \bar{1}3\bar{2}1$, $v^{xi} = 3\bar{1}\bar{2}1$, etc., cf. f. 49.

43.



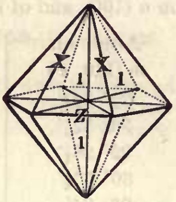
(10$\bar{1}$0)

44.



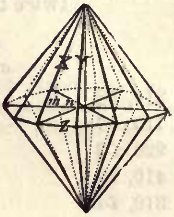
(11$\bar{2}$0)

45.



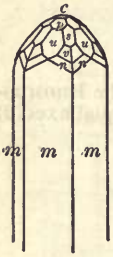
(10$\bar{1}$1)

46.

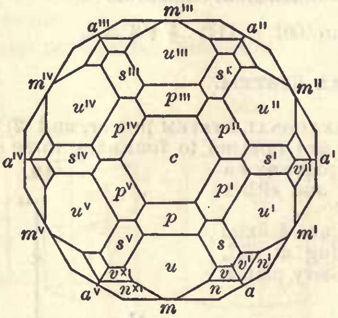


($kh\bar{l}i$)

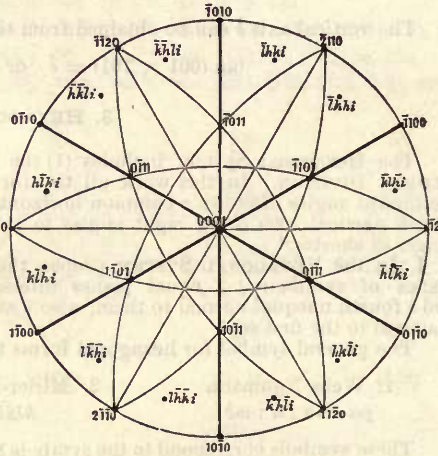
47.



48.



49.



In figs. 47, 48, $c = (0001)$, $m = (10\bar{1}0)$, $a = (11\bar{2}0)$, $p = (10\bar{1}1)$, $u = (20\bar{2}1)$, $s = (11\bar{2}1)$, $n = (31\bar{4}1)$, $v = 21\bar{3}1$.

The kind of hemihedrism belonging to this part of the system is the *pyramidal*, and the special forms are the half-forms of the 12-sided prism and pyramid; which are illustrated by the species of the Apatite Group, pp. 763–773. These half-forms are, respectively, a hexagonal prism, and hexagonal pyramid of the third series; cf. f. 4, p. 763, where the predominating form, $\mu\ (21\bar{3}1)$, is this pyramid.

2. The RHOMBOHEDRAL DIVISION includes forms with only three planes of symmetry intersecting at angles of 120° in the vertical axis. The forms peculiar to it may be regarded as half-forms of the corresponding hexagonal types. They are distinguished as plus and minus, as in similar cases before explained (p. xx). The forms peculiar to the rhombohedral system are the rhombohedron and scalenohedron, figs. 50–53, also f. 54 and the many other figures under calcite, pp. 263, 264, tourmaline, pp. 551, 552, etc.

The symbols for the several planes of the plus unit rhombohedron (f. 50, 54), always denoted by the letter $r$, are:

$$r = 10\bar{1}1 \quad r' = \bar{1}101 \quad r'' = 0\bar{1}11 \quad r''' = 01\bar{1}\bar{1} \quad r^{iv} = \bar{1}01\bar{1} \quad r^{v} = 1\bar{1}0\bar{1}$$

For the scalenohedron in general, which is regarded as a half-form on the same system of the dihexagonal pyramid, Naumann modified his symbols by referring the forms to the rhombohedron having the same lateral edges. His symbols read:

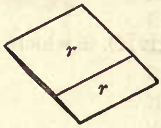
$mRn$, in this book written $m^n$,

where the $m$ and $n$ are connected with the corresponding $m_0$ and $n_0$ of the dihexagonal pyramid by the relations:

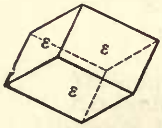
$$m = \frac{m_0(2 - n_0)}{n_0}, \quad n = \frac{n_0}{2 - n_0}, \quad \text{or} \quad m_0 = mn, \quad n_0 = \frac{2n}{n+1}.$$

Thus $\frac{1}{2}(3P\frac{3}{2})$ or $\frac{1}{2}(3\text{-}\frac{3}{2})$ is equivalent to $R^3$ or $1^3$.

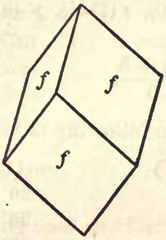
**50.**



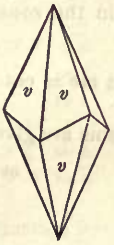
**51.**



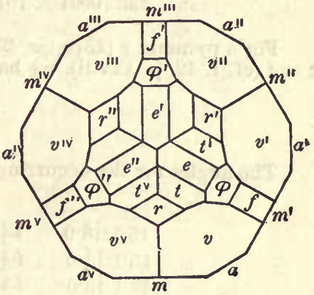
**52.**



**53.**



**54.**



$r = (10\bar{1}1, +R)$, $\epsilon = (01\bar{1}1, -R)$, $(f = 20\bar{2}1, +2R)$, $v = (31\bar{2}1, 1^3)$, also $m = (10\bar{1}0, I)$,
$a = (11\bar{2}0, i\text{-}2)$, $e = (01\bar{1}2, -\frac{1}{2}R)$, $\phi = (05\bar{5}4, -\frac{5}{4}R)$, $t = (21\bar{3}4, \frac{1}{4}^3)$

The hemihedral forms of the Rhombohedral Division, which are *tetartohedral* to the Hexagonal Division, are:

A. Rhombohedral. B. Trapezohedral.

The distinctive form of the rhombohedral-tetartohedral class is the hemi-scalenohedron, or rhombohedron of the third series, illustrated by figs. 4, 5, 9, under phenacite, p. 462. Cf. also figs. under dioptase, p. 464, ilmenite, p. 218, dolomite, p. 272.

The distinctive form of the *trapezohedral* class are the quadrilateral trapezohedron and the unsymmetrical trigonal prism, illustrated by quartz (pp. 184, 185) and cinnabar, p. 66. These forms may be either right- or left-handed, as shown in quartz, where their connection with the phenomena of circular polarization is explained. The plus and minus forms are in general designated by different letters.

There are also *hemimorphic* forms, in which the opposite extremities of the vertical axis are dissimilarly modified, as shown in tourmaline, pp. 551, 552, and pyrargyrite, p. 133. Here the unit prism becomes a trigonal form.

The important mathematical relations in this system are

$$\dot{c} = \tan(0001 \wedge 11\bar{2}2), \qquad \dot{c} = \tan(0001 \wedge 10\bar{1}1)\,.\,\tfrac{1}{2}\sqrt{3}.$$

Also for a hexagonal pyramid

$$\tan\tfrac{1}{2}(10\bar{1}1 \wedge 01\bar{1}1) = \sin\xi\sqrt{\tfrac{1}{3}}, \quad \text{where } \tan\xi = \dot{c},$$

and in general

$$\tan\tfrac{1}{2}(h0\bar{h}l \wedge 0h\bar{h}l) = \sin\xi_{,}\sqrt{\tfrac{1}{3}}, \quad \text{where } \tan\xi_{,} = \frac{h}{l}\dot{c}.$$

For a pyramid of the second series

$$2\sin\tfrac{1}{2}(11\bar{2}2 \wedge \bar{1}2\bar{1}2) = \sin\xi \quad \text{and} \quad \tan\xi = \dot{c}.$$

For a dihexagonal prism, $kh\bar{l}0$ (as, $21\bar{3}0$):

$$\cot(10\bar{1}0 \wedge kh\bar{l}0) = \frac{2k+h}{h}\sqrt{\frac{1}{3}};$$

$$\cot(11\bar{2}0 \wedge kh\bar{l}0) = \frac{k+h}{k-h}\sqrt{3}.$$

The sum of the above angles is equal to 30°.

For a rhombohedron

$$\sin \tfrac{1}{2}(10\bar{1}1 \wedge \bar{1}101) = \sin \alpha \sqrt{\tfrac{3}{4}}, \quad \text{where } \alpha = 0001 \wedge 10\bar{1}1\,;$$

in general

$$\sin \tfrac{1}{2}(h0\bar{h}l \wedge \bar{h}h0l) = \sin \alpha_{,} \sqrt{\tfrac{3}{4}}, \quad \text{where } \alpha_{,} = 0001 \wedge h0\bar{h}l.$$

In the vertical zone of pyramids, rhombohedrons, etc., the tangent principle holds

$$\frac{\tan\,(0001 \wedge h0\bar{h}l)}{\tan\,(0001 \wedge 10\bar{1}1)} = \frac{h}{l}\,; \quad \text{also} \quad \frac{\tan\,(0001 \wedge 11\bar{2}1)}{\tan\,(0001 \wedge 11\bar{2}2)} = 2, \quad \text{etc.}$$

For a pyramid *v* ($kh\bar{l}i$) (as, $21\bar{3}1$) in the zone *m* ($10\bar{1}0$), *s* ($11\bar{2}1$), *p′* ($01\bar{1}1$), *o′* ($\bar{1}2\bar{1}2$), in which $k = i$ (cf. f. 49, p. xxviii), we have:

$$\cot mv = \cot mp' \,.\, \frac{2k+h}{h}.$$

The angles for the occurring prisms are given by the following table:

| | | *m* ($10\bar{1}0$, *I*) | *a* ($11\bar{2}0$, *i*-2) |
|---|---|---|---|
| $15{\cdot}1{\cdot}\bar{16}{\cdot}0$ | *i*-$\frac{16}{15}$ | 3° 12′ | 26° 48′ |
| $13{\cdot}1{\cdot}\bar{14}{\cdot}0$ | *i*-$\frac{14}{13}$ | 3° 40¼′ | 26° 19¾′ |
| $12{\cdot}1{\cdot}\bar{13}{\cdot}0$ | *i*-$\frac{13}{12}$ | 3° 57¾′ | 26° 2¼′ |
| $10{\cdot}1{\cdot}\bar{11}{\cdot}0$ | *i*-$\frac{11}{10}$ | 4° 43′ | 25° 17′ |
| $71\bar{8}0$ | *i*-$\frac{8}{7}$ | 6° 35¼′ | 23° 24¾′ |
| $51\bar{6}0$ | *i*-$\frac{6}{5}$ | 8° 57′ | 21° 3′ |
| $41\bar{5}0$ | *i*-$\frac{5}{4}$ | 10° 53½′ | 19° 6½′ |
| $31\bar{4}0$ | *i*-$\frac{4}{3}$ | 13° 54′ | 16° 6′ |
| $52\bar{7}0$ | *i*-$\frac{7}{5}$ | 16° 6′ | 13° 54′ |
| $21\bar{3}0$ | *i*-$\frac{3}{2}$ | 19° 6½′ | 10° 53½′ |
| $9{\cdot}5{\cdot}\bar{14}{\cdot}0$ | *i*-$\frac{14}{9}$ | 20° 38′ | 9° 22′ |
| $8{\cdot}5{\cdot}\bar{13}{\cdot}0$ | *i*-$\frac{13}{8}$ | 22° 24⅞′ | 7° 35⅛′ |
| $32\bar{5}0$ | *i*-$\frac{5}{3}$ | 23° 24¾′ | 6° 35¼′ |
| $54\bar{9}0$ | *i*-$\frac{9}{5}$ | 26° 19¾′ | 3° 40¼′ |

## THE RHOMBOHEDRAL DIVISION OF MILLER.

The following projection (fig. 55) is added in order to show the relation of the forms in the Hexagonal and Rhombohedral Systems as referred by Miller to three equal oblique axes parallel to the faces of the fundamental rhombohedron. The forms are as follows

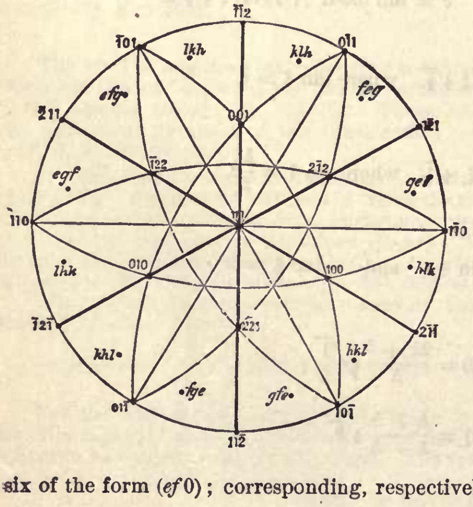
The planes having the indices 100, 001, 010 are those of the (plus) fundamental rhombohedron, while the plane 111 is the base. The planes 221, 121, 122 are those of the minus fundamental rhombohedron; with the planes 100, 010, 001 they form the unit hexagonal pyramid.

The hexagonal unit prism, $I = (10\bar{1}0)$, has the symbols: $11\bar{2}$, $2\bar{1}\bar{1}$, $1\bar{2}1$, $\bar{1}\bar{1}2$, $\bar{2}11$, $\bar{1}2\bar{1}$. The second, or diagonal hexagonal prism, $i\text{-}2 = (11\bar{2}0)$, has the symbols: $10\bar{1}$, $1\bar{1}0$, $0\bar{1}1$, $\bar{1}01$, $\bar{1}10$, $01\bar{1}$

The dihexagonal pyramid embraces, like the simple hexagonal pyramid, two forms (*hkl*) and (*efg*); the symbol (*hkl*) hence belongs to the plus scalenohedron, and (*efg*) to the minus. In this as in other cases it is true that $e = -h + 2k + 2l$, $f = 2h - k + 2l$, $g = 2h + 2k - l$.

The dihexagonal prism includes the six planes of the form (*hk*0), and the remaining six of the form (*ef*0); corresponding, respectively, to the pyramids (*hkl*) and (*efg*).

55.



### 4. ORTHORHOMBIC SYSTEM.

In the Orthorhombic System, there are three unequal axes at right angles to each other. These axes are the brachydiagonal $\breve{a}$, macrodiagonal $\bar{b}$, and vertical $\dot{c}$; in stating the axial ratio, $b$ is always made equal to unity. There are three planes of symmetry, which intersect in these axes, but which are all different. The types of forms in this system are:

| | | | | | |
|---|---|---|---|---|---|
| Macropinacoid | (100) | | $i$-$\bar{\imath}$ | $\infty P\bar{\infty}$ | $a$ |
| Brachypinacoid | (010) | | $i$-$\breve{\imath}$ | $\infty P\breve{\infty}$ | $b$ |
| Basal plane | (001) | | $O$ | $0P$ | $c$ |
| Unit prism | (110) | | $I$ | $mP$ | $m$ |
| Macroprism | ($hk0$) | $h > k$ | $i$-$\bar{n}$ | $\infty P\bar{n}$ | as (210, $i$-$\bar{2}$) |
| Brachyprism | ($kh0$) | $h > k$ | $i$-$\breve{n}$ | $\infty P\breve{n}$ | as (120, $i$-$\breve{2}$) |
| Macrodomes | ($h0l$) | | $m$-$\bar{\imath}$ | $mP\bar{\infty}$ | as (201, 2-$\bar{\imath}$) |
| Brachydomes | ($0kl$) | | $m$-$\breve{\imath}$ | $mP\breve{\infty}$ | as (021, 2-$\breve{\imath}$) |
| Unit pyramids | (111) | | 1 | $m$ | as (111, 1) |
| Macropyramids | ($hkl$) | $h > k$ | $m$-$\bar{n}$ | $mP\bar{n}$ | as (211, 2-$\bar{2}$) |
| Brachypyramids | ($khl$) | $h > k$ | $m$-$\breve{n}$ | $mP\breve{n}$ | as (121, 2-$\breve{2}$) |

These forms hardly need any further explanation beyond what has been given on pp. xv, xvi.

Hemihedral forms in this system are rare; hemimorphic forms are less so, but not very common, cf. calamine, p. 547, struvite, p. 806.

The axial ratio can be calculated from the simple relations

$$\breve{a} = \tan\,(100 \wedge 110),$$

$$\dot{c} = \tan\,(001 \wedge 011),$$

$$\frac{c}{a} = \tan\,(001 \wedge 101).$$

From the measured angles these elemental angles can be calculated, and *vice versa*, by the solution of spherical triangles on the sphere of projection with the aid of the tangent principle.

### 5. MONOCLINIC SYSTEM.

In the Monoclinic System there are three unequal axes, of which one lateral axis, $\grave{a}$, is inclined to the vertical axis, $\dot{c}$, while the angles between $\dot{c}$ and $\bar{b}$, and $\bar{b}$ and $\grave{a}$ are right angles. There is one plane of symmetry, the plane of the axes $\grave{a}$, $\dot{c}$. In stating the axial ratio, $b$ is always taken as the unit, and, in the majority of cases, $\grave{a}$, the clino-axis, is less than $\bar{b}$, the ortho-axis; this is not necessarily the case, however, hence the long mark used in the symbols is conventional only. The types of forms and the special terms employed are shown by the following list. The occurring types of forms are as follows:

| | | | | |
|---|---|---|---|---|
| Orthopinacoid | (100) | $i$-$\bar{\imath}$ | $\infty P\bar{\infty}$ | $a$ |
| Clinopinacoid | (010) | $i$-$\grave{\imath}$ | $\infty P\grave{\infty}$ | $b$ |
| Basal plane | (001) | $O$ | $0P$ | $c$ |
| Unit prism | (110) | $I$ | $\infty P$ | $m$ |
| Ortho-prism | ($hk0$) | $i$-$\bar{n}$ | $\infty P\bar{n}$ | as (210, $i$-$\bar{2}$) |
| Clino-prism | ($kh0$) | $i$-$\grave{n}$ | $\infty P\grave{n}$ | as (120, $i$-$\grave{2}$) |
| Orthodomes | $h0l$<br>$\bar{h}0l$ | $-\,m$-$\bar{\imath}$<br>$m$-$\bar{\imath}$ | $-\,mP\bar{\infty}$<br>$mP\bar{\infty}$ | as (101, $-$ 1-$\bar{\imath}$)<br>as ($\bar{1}$01, 1-$\bar{\imath}$) |
| Clinodomes | $0kl$ | $m$-$\grave{\imath}$ | $-\,mP\grave{\infty}$ | as (011, 1-$\grave{\imath}$) |
| Unit pyramids | $hhl$<br>$\bar{h}hl$ | $-\ m$<br>$m$ | $-\ mP$<br>$mP$ | as (111, $-$ 1)<br>as ($\bar{1}$11, 1) |
| Ortho-pyramids | $hkl$<br>$\bar{h}kl$ | $-\,m$-$\bar{n}$<br>$m$-$\bar{n}$ | $-\ mP\bar{n}$<br>$mP\bar{n}$ | as (211, $-$ 2-2)<br>as ($\bar{2}$11, 2-2) |
| Clino-pyramids | $khl$<br>$\bar{k}hl$ | $-\,m$-$\grave{n}$<br>$m$-$\grave{n}$ | $-\ mP\grave{n}$<br>$mPn$ | as (121, $-$ 2-2)<br>($\bar{1}$21, 2-2) |

Some of these forms are illustrated by the figures of gypsum with the spherical projection, given on p. xxxvi; also by the monoclinic species through the body of the work.

The relations connecting axial and angular elements are as follows:

$$\grave{a} = \frac{\tan (100 \wedge 110)}{\sin \beta} \quad \text{or} \quad \tan (100 \wedge 110) = \grave{a} \,.\, \sin \beta ; \qquad (1.)$$

$$\dot{c} = \frac{\tan (001 \wedge 011)}{\sin \beta} \quad \text{or} \quad \tan (001 \wedge 011) = \dot{c} \,.\, \sin \beta ; \qquad (2.)$$

$$\dot{c} = \frac{\grave{a} \,.\, \tan (001 \wedge 101)}{\sin \beta - \cos \beta \,.\, \tan (001 \wedge 101)} \quad \text{or} \quad \tan (001 \wedge 101) = \frac{\dot{c} \,.\, \sin \beta}{\grave{a} + \dot{c} \,.\, \cos \beta}, \qquad (3a.)$$

or

$$\dot{c} = \frac{\grave{a} \,.\, \tan (001 \wedge \bar{1}01)}{\sin \beta + \cos \beta \,.\, \tan (001 \wedge \bar{1}01)} \quad \text{or} \quad \tan (001 \wedge \bar{1}01) = \frac{\dot{c} \sin \beta}{\grave{a} - \dot{c} \,.\, \cos \beta}. \qquad (3b.)$$

These relations may be made more general by writing in the several cases—

in (1) $hk0$ for 110 and $\frac{k}{h}\grave{a}$ for $\grave{a}$;

(2) $0kl$ for 011 and $\frac{k}{l}\dot{c}$ for $\dot{c}$;

(3) $h0l$ for 100 and $\frac{h}{l}\dot{c}$ for $\dot{c}$.

Also

$$\frac{\dot{c}}{a} = \frac{\sin (001 \wedge 101)}{\sin (100 \wedge 101)} = \frac{\sin (001 \wedge \bar{1}01)}{\sin (100 \wedge \bar{1}01)},$$

and more generally

$$\frac{h}{k} \,.\, \frac{\dot{c}}{a} = \frac{\sin (001 \wedge h0l)}{\sin (100 \wedge h0l)} = \frac{\sin (001 \wedge \bar{h}0l)}{\sin (100 \wedge \bar{h}0l)}.$$

Note also that

$$\tan \phi = \grave{a} \quad \text{and} \quad \tan \zeta = \dot{c} ;$$

where $\phi$ is the angle (f. 63, p. xxxvi) between the zone-circles (001, 100) and (001, 110); also $\zeta$ the angle between (100, 001) and (100, 011).

## VI. TRICLINIC SYSTEM.

In the Triclinic System there are three unequal axes and their intersections are all oblique; there is no plane of symmetry, hence the system is often called the *Asymmetric* system. Only two planes belong to any given form, hence the prisms are hemi-prisms, the pyramids tetarto-pyramids, etc. The axes are designated $a$, $b$, $\dot{c}$, in which $a$ is usually the brachydiagonal axis (then written $\breve{a}$) and $b$ the macrodiagonal ($\bar{b}$); in some cases, however, $a$ is the longer and $b$ the shorter lateral axis. The axial angles are:

$\alpha$ between the axes $b$ and $\dot{c}$.
$\beta$ " " " $a$ and $\dot{c}$.
$\gamma$ " " " $a$ and $b$.

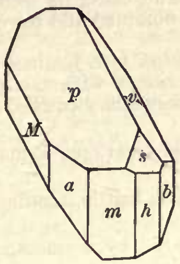
The symbols of Naumann are hence analogous to those of the orthorhombic system, but the different planes are distinguished by accents; thus:

| 111 | $\bar{1}11$ | $\bar{1}\bar{1}1$ | $1\bar{1}1$ |
|---|---|---|---|
| 1' | ,1 | 1, | '1 |

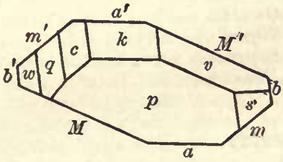
Also 110 = *I*, $1\bar{1}0$ = '*I*, 101 = '1-ī', $\bar{1}01$ = ,1-ī,, 011 = 1-ĭ', $0\bar{1}1$ = '1-ĭ, etc.

For illustrations of these cases, cf. figs. 56–58 of chalcanthite, also many other triclinic species in the body of the work.

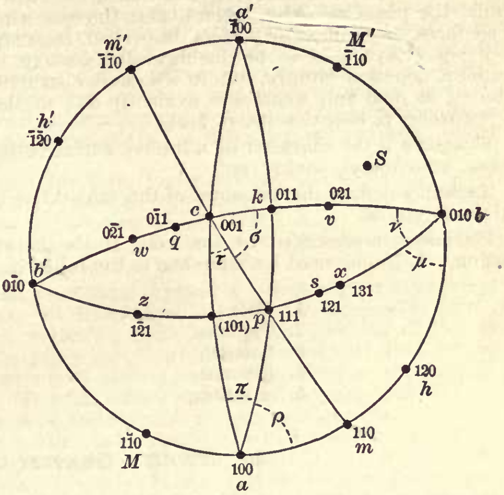
56.



57.



58.



In the figs., *a* = (100, *i-ĭ*), *b* = (010, *i-ĭ*), *c* = (001, *O*), *m* = (110, *I'*), *h* (120, *i-2'*), *M* (1$\bar{1}$0, *'I*); *k* (011, 1-*ĭ'*), *v* (021, 2-*ĭ'*), *q* (0$\bar{1}$1, '1-*ĭ*), *w* (0$\bar{2}$1, '2-*ĭ*), *p* (111, 1'), *s* (121, 2-$\breve{2}$'), *z* (1$\bar{2}$1, '2-$\breve{2}$).

In the spherical projection, the spherical angles of the triangle 100, 010, 001 are the supplements of the axial angles, viz.: the angle at 100 (A) = 180 – $\alpha$, at 010 (B) = 180° – $\beta$, at 001 (C) = 180° – $\gamma$.

These angles A, B, C can be calculated from the angles between the planes 100 ∧ 001, 100 ∧ 010, 001 ∧ 010, in the spherical triangle named and *vice versa*. Furthermore, cf, f. 58.

$$\frac{\sin\,\tau}{\sin\,\sigma} = \frac{\sin\,\tau'}{\sin\,\sigma'} = \frac{a}{b},$$

$$\frac{\sin\,\nu}{\sin\,\mu} = \frac{\sin\,\nu'}{\sin\,\mu'} = \frac{\dot{c}}{a},$$

$$\frac{\sin\,\pi}{\sin\,\rho} = \frac{\sin\,\pi'}{\sin\,\rho'} = \frac{\dot{c}}{b}.$$

Here A = $\pi + \rho$, B = $\nu + \mu$, C = $\tau + \sigma$; 180° – A = $\pi' + \rho'$ (in adjacent quadrant), etc.

These relations become general for any plane *hkl*, where $\tau_x$ $\sigma_x$ are the corresponding angles and we have

$$\frac{\sin\,\tau_x}{\sin\,\sigma_x} = \frac{a}{\frac{h}{k}b}, \quad \text{etc.}$$

For other mathematical relations, reference must be made to works on Crystallography.

## II. PHYSICAL MINERALOGY.

In general the physical characters of crystallized minerals conform to the symmetry of the system to which the crystals belong. That is, the cleavage must be alike in all directions which are crystallographically similar in a given species, etc.

The following are brief explanations in regard to the successive physical characters

### A. CHARACTERS DEPENDING UPON COHESION.

**Cleavage** is the natural fracture of a crystallized mineral yielding more or less smooth surfaces; it is due to minimum cohesion. The cleavage is characterized, first according to direction, as cubic, octahedral, dodecahedral, also basal, prismatic, etc.; in general $\parallel x$, or parallel the plane $x$. Also, second, as to the ease with which it is obtained and the character of the surfaces, as eminent or perfect, imperfect, interrupted, etc.

From cleavage is to be distinguished *parting*, or the separation into laminæ, due not to minimum cohesion simply, but to a lamellar structure often connected with the presence of twinning laminæ and sometimes evidently due to the action of secondary causes, as pressure (cf. pyroxene, p. 354, titanite, p. 713).

**Fracture** is the character of a broken surface other than that of cleavage; it may be even, uneven, conchoidal, hackly, etc.

**Tenacity** defines the character of the mineral as to whether it is brittle, sectile, malleable, flexible, or elastic.

**Hardness**, represented by the letter H., is the resistance offered by a smooth surface to abrasion. It is measured by reference to the following scale of Mohs:

1. *Talc.*
2. *Gypsum.*
3. *Calcite.*
4. *Fluorite.*
5. *Apatite.*
6. *Feldspar.*
7. *Quartz.*
8. *Topaz.*
9. *Sapphire.*
10. *Diamond.*

### B. SPECIFIC GRAVITY OR DENSITY.

**Specific Gravity**, represented by the letter G., is the density compared with that of water, strictly speaking, with water at 4° C. (39·2° F.). Practically a determination of specific gravity need not take into account the temperature unless a very high degree of accuracy is called for, e.g., when it is to be accurate to a unit in the third decimal place. Inasmuch as the material available is seldom faultless, the unavoidable error of experiment is usually greater than the limit of accuracy noted, and hence temperature may be neglected.

The specific gravity of a mineral varies with variation in composition, sometimes widely (cf the garnets, pyroxene, etc.). When the composition is constant, however, the specific gravity carefully taken on material free from mechanical admixture is nearly constant. Hence the wide variation often given is usually due to faulty observation or to poor material. In the descriptions of species which follow, a large number of determinations are quoted, particularly with the tables of analyses.

### C. CHARACTERS DEPENDING UPON LIGHT.

(*a*) **Luster.**—A. The KINDS OF LUSTER are:
1. *Metallic:* the luster of metals; if imperfect it is called *sub-metallic.*
2. *Adamantine:* the luster of the diamond.
3. *Vitreous:* the luster of broken glass.
4. *Resinous:* luster of the yellow resins.
5. *Greasy:* as that of elæolite.
6. *Pearly:* like pearl.
7. *Silky:* like silk; it is the result of a fibrous structure.

B. The DEGREES OF INTENSITY are:
1. *Splendent.*
2. *Shining.*
3. *Glistening.*
4. *Glimmering.*

[When there is a total absence of luster, a mineral is characterized as *dull.*]

(*b*) **Color.**—Usually the color by reflected light is given, sometimes also by transmitted light. The special terms employed need no explanation.

The *streak* is the color of the fine powder when scratched by the knife or, better, rubbed upon a surface of unglazed porcelain. The streak is of most importance in the case of minerals containing the heavy metals. It is usually omitted in the description of species when it is uncolored.

*Pleochroism,* or the difference in color shown by many crystals for light transmitted in different directions through them, is a special case of color-absorption, but is more conveniently treated as a special optical property, see beyond, p. xxxvii.

(*c*) **Diaphaneity,** or degree of transparency.—Minerals may be *transparent, sub-transparent* or *semi-transparent, translucent, subtranslucent, opaque.*

(*d*) **Special Optical Properties.**—ISOTROPIC CRYSTALS.—Transparent isometric crystals and amorphous substances (e.g., glass) are *isotropic* with respect to light. They have a single index of refraction, represented by the letter $n$, and further defined according to the color, as $n_y$ or $n_r$, etc.

Crystals of all the other systems are *anisotropic*.

*Optical Anomalies.*—The term optical anomalies is applied to the optical phenomena exhibited in polarized light, particularly by many crystals of the isometric system, which are so far abnormal or anomalous in that they do not conform to the external crystallographic form. Here belongs the double refraction of boracite, of most garnet, also analcite, etc.; further, the biaxial character of much beryl, apophyllite, etc. This is a subject to which much attention has been given of late years, particularly since the publication of the classical paper by Mallard (1876). Details in regard to it, with references to the literature, will be found under the species named and many others.

In this connection it may be noted that the term *pseudo-symmetry* (also pseudo-isometric, etc.) is used, first of crystals belonging to one system but approximating in angle closely to one of higher symmetry; thus biotite is said to be pseudo-rhombohedral. Also, second, to crystals which gain an apparent symmetry of higher grade than that actually belonging to them by twinning; thus aragonite is said to be pseudo-hexagonal by twinning.

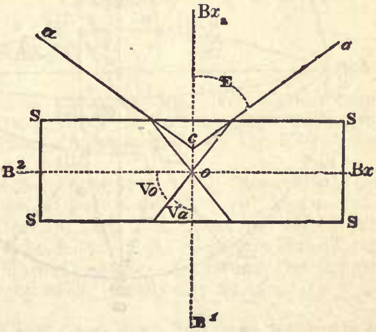
UNIAXIAL CRYSTALS.—Tetragonal and hexagonal crystals are *uniaxial*, or have one axis of optical symmetry in which direction a ray of transmitted light suffers no double refraction. This optic axis coincides with the vertical crystallographic axis in the position of the crystals ordinarily taken and here followed. Further, they have two indices of refraction, that corresponding to the ordinary ray (represented by $\omega$) whose vibrations are transverse to the vertical axis ($\perp \dot{c}$), and that of the extraordinary ray ($\epsilon$) with vibrations parallel to this axis ($\parallel \dot{c}$). The character of the crystal is optically positive (+) or negative (−) according as $\omega < \epsilon$, or $\omega > \epsilon$. The double refraction is strong or weak according as to whether the difference $\omega - \epsilon$ (or $\epsilon - \omega$) is relatively large or small. For example, it is strong in calcite, where $\omega - \epsilon = 0{\cdot}172$, but very weak in apophyllite, where $\epsilon - \omega = 0{\cdot}002$. Crystals of these systems may be *dichroic*, according to the kind and degree of absorption in the two axial directions $\perp \dot{c}$ and $\parallel \dot{c}$, cf. tourmaline, p. 553.

Crystals belonging to the trapezohedral (tetartohedral) section of the rhombohedral division of the hexagonal system show circular polarization, and are right- or left-handed according as they rotate the plane of polarization of a ray of light passing from the observer through the crystal to his right or left. The amount of rotation for a section of unit thickness (e.g., 1 mm.) varies with the wave-length; cf. quartz, p. 186.

BIAXIAL CRYSTALS.—Crystals of the orthorhombic, monoclinic, and triclinic systems are *biaxial* and have three axes of elasticity, or three directions at right angles to each other, in which the elasticity of the light ether has its minimum $\mathfrak{c}$, maximum $\mathfrak{a}$, and mean value $\mathfrak{b}$. They have also three indices of refraction for a given wave-length, $\alpha, \beta, \gamma$, for rays whose vibrations are parallel to the axes $\mathfrak{a}$, $\mathfrak{b}$, $\mathfrak{c}$, respectively; here $\alpha < \beta < \gamma$.

The plane of the greatest and least axes of elasticity is the *optic axial plane* (usually contracted *Ax. pl.*), since it contains the optic axes or the two directions of no double refraction. The angles between the optic axes are bisected by the axes $\mathfrak{a}$ and $\mathfrak{c}$. The axis bisecting the acute angle is the *acute bisectrix*, $Bx_a$ or simply the bisectrix, the other is the *obtuse bisectrix*, $Bx_o$. The crystal is optically positive (+) or negative (−) according to whether $Bx_a$ is the axis of least elasticity ($\mathfrak{c}$) or greatest elasticity ($\mathfrak{a}$). The double refraction is strong or weak according as to whether the difference of the refractive indices $\gamma - \alpha$ is relatively large or small; for example it is strong in epidote with $\gamma - \alpha = 0{\cdot}055$; but weak in zoisite with $\gamma - \alpha = 0{\cdot}006$.

59.



The angle of the optic axes is designated (cf. f. 59) as follows:

2V = real or interior angle of the optic axes;
2E = apparent angle " " " " in air;
2H = " " " " " " measured in oil or some other medium of high refractive power.*

The distinction between the acute and obtuse axial angle is designated by $2V_a$, $2V_o$, etc., and the angles for the different colors, usually red, yellow, and green or blue, are written $2V_{a.r}$, $2V_{a.y}$, $2V_{a.gr}$, etc.

In *Orthorhombic* crystals the axes of elasticity coincide with the crystallographic axes, or axes of symmetry; accordingly the axial plane is parallel to one of the pinacoids ($\parallel a$, $\parallel b$, or $\parallel c$),

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*It is often convenient to designate this angle by 2K when measured in a solution of mercuric iodide in potassium iodide (G. = 3·117, $n_y = 1{\cdot}7176$, Gdt.); also by 2G when measured in the glass of the Adams-Schneider polariscope.

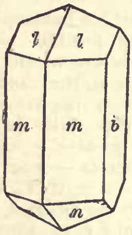
and the bisectrix is normal to one of these planes (Bx ⊥ $c$, etc.). Since, however, the refractive indices may vary for rays of different wave-length, the axial angle may be larger for red than for blue rays or vice versa, and this dispersion is characterized as $\rho > v$ or $\rho < v$.

In *Monoclinic* crystals one axis of elasticity coincides with the orthodiagonal axis, $\bar{b}$, and the others lie in the plane of symmetry (parallel to the pinacoid $b$ (010, *i-ĭ*) ) normal to it. Hence the axial plane may be ∥ $b$ or ⊥ $b$; if the latter, its position must be further defined according to the angle that it makes either with the normals to the planes $a$ or $c$, or more conveniently with the vertical axis, $\dot{c}$.

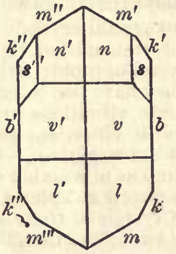
Three cases are possible:

1. Axial plane parallel to the plane of symmetry (Ax. pl. ∥ $b$); the position of the bisectrices is usually indicated by reference to the vertical axis, and the angle formed is called + or − according as the bisectrix ($Bx_a$) falls in front of or behind $\dot{c}$ (the middle point in the sphere of projection, f. 63), that is, is situated in the obtuse or acute axial angle.

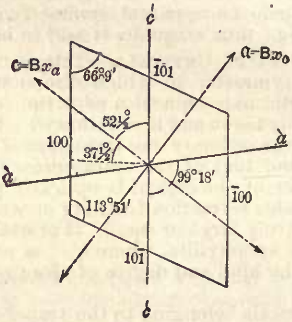
60.



61.

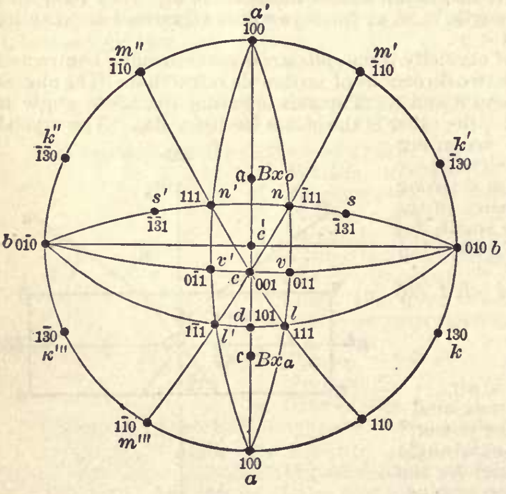


62.



For example, gypsum (f. 60–63) is optically positive, hence the axis of elasticity, 𝔠, is the acute bisectrix, $Bx_a$. Further (f. 62, 63), the position of $Bx_a$ is defined (Des Cloizeaux) by the angle, $Bx_a \wedge \dot{c} = +52\frac{1}{2}°$. But since the axial angle $\beta$ or $ac$ (001 ∧ 100) = 80° 42′, it is also true that the normal angles between 𝔠 or 𝔞 and the planes $c$, $a$ are as follows:

63.



$$\mathfrak{c}c = +43°\ 12',$$
$$\mathfrak{a}c = +37°\ 30',$$
and $$\mathfrak{c}a = -46°\ 48'$$

With varying positions of the axes 𝔞 and 𝔠 (the bisectrices) the axial planes for different colors may be more or less inclined to one another in the plane of symmetry, and this *dispersion of the bisectrices* is hence called *inclined dispersion.*

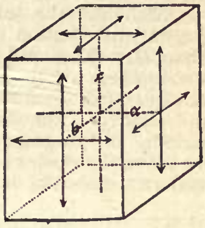
2. If the axial plane and the obtuse bisectrix are normal to the plane of symmetry (Ax. pl. and $Bx_o$ ⊥ $b$), then the position of the axial plane is further defined by that of the acute bisectrix in the plane of symmetry, which is written in the form just explained ($Bx_a \wedge \dot{c} = \pm$). The dispersion of the bisectrices possible in this case is called *horizontal*, in consequence of the relative position of the axial planes to each other.

3. If the axial plane and the acute bisectrix are normal to the plane of symmetry (Ax. pl. and $Bx_a$ ⊥ $b$) the position of the axial plane is further defined by that of the obtuse bisectrix ($Bx_o$) ± with reference to the vertical axis. The dispersion of the bisectrices for different colors which may be present in this case is called *crossed.*

In the *Triclinic System* there is no necessary relation between the assumed crystallographic axes and the axes of elasticity. Hence also the dispersion may be, for example, both horizontal and inclined. Cf. f. 58, p. xxxiii, of chalcanthite (see also p. 944), where $S$ represents approximately the position of $Bx_a$, or in other words is the pole or normal to the plane at right angles to the acute bisectrix.

**Pleochroism and Absorption.**—Biaxial crystals, having three axes of elasticity, may show different degrees or kinds of absorption in different directions, usually assumed as those of the axes of elasticity. The degree of absorption is designated as $\mathfrak{a} > \mathfrak{b} > \mathfrak{c}$, etc. Further, according to the kind of selective absorption, the crystal may be dichroic or trichroic (or better, in general, pleochroic), in which cases the colors corresponding to the vibrations parallel to the axes of elasticity are usually given (cf. f. 64). It has been shown, however, that the axes of absorption do not necessarily coincide with the axes of elasticity (cf. epidote, p. 518).

64.



The optical characters of mineral species are given very fully in the Mineralogy (vol. 1, 1862, and 2, part I, 1874) and in certain prominent memoirs of Des Cloizeaux (see Bibliography); the results of earlier investigations are also given by Grailich, Lang, Schrauf, and others; further, later by Rosenbusch (Mikr. Phys.), Lévy-Lacroix (Min. Roches), etc.

### D. CHARACTERS RELATING TO HEAT.

Here belong: the fusibility, defined, however, under the pyrognostic characters (p. xl); the thermal conductivity, and the position of the thermic axes (also the effect of heat in changing the crystallographic and optical constants); further, the specific heat.

These subjects are briefly treated under the different species, and references to many important memoirs are given. Recent determinations of the specific heat have been made by Joly (Proc. Roy. Soc., **41**, 250, 1887), also by Öberg, Öfv. Ak. Stockh., **42**, No. 8, 43, 1885.

### E. CHARACTERS RELATING TO MAGNETISM AND ELECTRICITY.

A few minerals are strongly magnetic and sometimes show polarity, e.g., magnetite, pyrrhotite, iron-platinum. Many species are diamagnetic, and the diamagnetic constant, also the magnetic rotatory power, have been determined in a few cases, e.g., calcite.

The electrical properties include (1) the power of becoming strongly electrified by friction, e.g., amber, p. 1002; (2) pyroelectricity, or the state of electric potential (+ and −) developed in crystallographically dissimilar parts of a crystal (non-conductor) by change of temperature, also by pressure (piezo-electricity), or by direct radiation (actino-electricity), cf. tourmaline, p. 553, calamine, p. 547, quartz, p. 186. Also (3) thermo-electricity, or the electromotive force established in some metallic minerals when they form an electric circuit with another conductor and one point of junction is changed in temperature, cf. pyrite, p. 85. Further, the electrical conductivity or resistance to the passage of an electrical current, and other points.

For the most part, these characters coming under the heads of Heat, Electricity, Magnetism are so far special that they are treated very briefly—if at all—in this work under the individual species; references are given, however, to many important papers. Further, the student is referred to the works on Physical Mineralogy by Groth, Mallard, Liebisch, already mentioned. Special investigations in pyroelectricity have been made by Hankel (Abh. Sächs. Ges. Wiss., also, Wied. Ann.) and by others. A recent paper on thermo-electricity is given by Bäckström, Öfv. Ak. Stockh., **45**, 553, 1888; also one on the production of electrical potential by the action of light by Elster and Geitel in Wied. Ann., **44**, 722, 1891.

## III. CHEMICAL MINERALOGY.

**Chemical Composition (Comp.) and General Scheme of Classification.**—The classification adopted in this work, as in the preceding edition, follows, first the chemical composition, and second crystallographic and other physical characters which indicate more or less clearly the relations of individual species.

The general outline of the chief chemical divisions is given on p. 1. As seen there, the elements are placed first; then compounds in which the acidic part is taken by sulphur and the allied elements, selenium, tellurium, also by arsenic, antimony, bismuth; these include in part simple Sulphides, Selenides, etc., and after them, the Sulpho-salts. Next come the Haloids, or compounds of the metals with chlorine, bromine, iodine, fluorine; after these follow the oxygen compounds; first the Oxides and then the various Oxygen-salts; finally the Salts of Organic Acids and Hydrocarbon compounds.

Among the Oxygen-salts, the Carbonates are placed first (thus deviating from the order in the last edition), and after them the Silicates and Titanates, which last are closely connected with the Niobates and Tantalates. Then follow the Phosphates, Arsenates, etc. After them are placed the Borates, and next the Uranates (the latter might properly be placed after the Tungstates); then come the large class of Sulphates with the allied Chromates and Tellurates, and finally the less closely related Tungstates and Molybdates.

In order to understand the relations of these chief classes, as still more their further subdivision, down finally to the many *isomorphous groups*—groups of species having analogous composition and closely similar form—the fundamental relations and grouping of the elements must be understood, especially as developed of recent years and shown in the so-called Periodic Law.

Although the subject can be only briefly touched upon, it will be useful to give here the general distribution of the elements into Groups and Series, as presented in the Principles of Chemistry (Engl. Ed., 1891) of D. Mendeléeff, to whom is due more than any one else the development of the Periodic Law. A few remarks are added on the grouping of the elements as illustrated by mineral compounds; artificial compounds show these relations still more fully and clearly. For the thorough explanation of this subject, more particularly as regards the periodic or progressive relation between the atomic weights and various properties of the elements, the reader is referred to the work above mentioned or to one of the many other excellent modern text-books of chemistry.

| Groups . . . . . | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|
| Series 1 . . . . . | H | — | — | $RH_4$ | $RH_3$ | $RH_2$ | RH | Hydrogen Compounds |
| " 2 . . . . . | Li | Be | B | C | N | O | F | |
| " 3 . . . . . | Na | Mg | Al | Si | P | S | Cl | |
| " 4 . . . . . | K | Ca | Sc | Ti | V | Cr | Mn | Fe Co Ni Cu |
| " 5 . . . . . | (Cu) | Zn | Ga | Ge | As | Se | Br | |
| " 6 . . . . . | Rb | Sr | Y | Zr | Nb | Mo | — | Ru Rh Pd Ag |
| " 7 . . . . . | Ag | Cd | In | Sn | Sb | Te | I | |
| " 8 . . . . . | Cs | Ba | La | Ce | Di? | — | — | |
| " 9 . . . . . | — | — | — | — | — | — | — | |
| " 10 . . . . . | — | — | Yt | — | Ta | W | — | Os Ir Pt Au |
| " 11 . . . . . | Au | Hg | Tl | Pb | Bi | — | — | |
| " 12 . . . . . | — | — | — | Th | — | U | — | |
| | $R_2O$ | $R_2O_2$ | $R_2O_3$ | $R_2O_4$ | $R_2O_5$ | $R_2O_6$ | $R_2O_7$ | Higher Oxides |
| | | RO | | $RO_2$ | | $RO_3$ | | $RO_4$ |

The relations of some of the elements of the first group are exhibited by the isomorphism of NaCl, KCl, AgCl (p. 152); or again of $LiMnPO_4$ and $NaMnPO_4$, etc. (p. 756). In the second group, reference may be made to the isomorphism of the carbonates (p. 261) and sulphates (p. 894) of calcium, barium and strontium; while among the sulphides, ZnS, CdS, and HgS are doubly related (pp. 59, 66). In the third group, we find boron and aluminium often replacing one another among silicates. In the fourth group, the relations of silicon and titanium are shown in the many titano-silicates, while the compounds $TiO_2$, $SnO_2$, $PbO_2$ (and $MnO_2$), also $ZrSiO_4$ and $ThSiO_4$, have closely similar form (pp. 233, 234). In the fifth group, many compounds of arsenic, antimony, and bismuth are isomorphous among metallic compounds while the relations of phosphorus, vanadium, arsenic, also antimony, are shown among the phosphates, vanadates, arsenates, and antimonates; again note the mutual relations of the niobates and tantalates (p. 725),

In the sixth group, the strongly acidic elements, sulphur, selenium, tellurium, are all closely related, as seen in many sulphides, selenides, tellurides; further, the relations of sulphur and chromium, and similarly both of these to molybdenum and tungsten, are shown among many artificial sulphates, chromates, also molybdates and tungstates.

In the seventh group the relations of the halogens are too well understood to need special remark. In the eighth group, we have Fe, Co, Ni alloyed in meteoric iron, and their phosphates and sulphates (pp. 928, 929) are in several cases closely isomorphous; further the relation of the iron series to that of the platinum series is exhibited in the isomorphism of $FeS_2$, FeAsS, $FeAs_2$, $NiAs_2$, etc., with $PtAs_2$ and probably $RuS_2$ (p. 93).

**Formulas.**—The fact that the formula of a species is always given in two places, first in the tabular classification of each group, and, second, under the description of the species itself, affords an opportunity to vary the form in which it is stated. Thus malachite (pp. 293, 294), a basic cupric carbonate, has strictly the formula $Cu_2(OH)_2CO_3$, which indicates that the affinities of one atom of copper are satisfied by the double hydroxyl group 2(OH), and the other by the group $CO_3$. It is, however, often convenient to think of this as if it were made up of cupric carbonate and cupric hydrate and accordingly the formula (p. 295) is also written $CuCO_3.Cu(OH)_2$. To the latter is added the formula after the old dualistic system, $2CuO.CO_2.H_2O$, and in general the composition of most species is given in this form. It is interesting to note that the last method, generally discarded when the atomic theory was adopted, has ~~come~~ back again, since in the case of complex compounds it presents the composition most clearly before the mind. It is to be noted, however, that the period used in both the above cases (some authors employ a comma) is merely a conventional sign and does not indicate that the different molecular groups separated by it are regarded as present in the substance in that form. When it is intended to express this, a plus sign (+) is employed, as $NaCO_3 + 10H_2O$, or sodium carbonate with ten molecules of water of crystallization.

The formulas given are in general the simple empirical formulas, written, where possible in brief form, so as to suggest the actual nature of the compound. Thus $(CaF)Ca_4(PO_4)_3$ means a salt of orthophosphoric acid $3(H_3PO_4)$ in which the 9 hydrogen atoms are replaced by the 4 calcium atoms with also the univalent group CaF.

That the formula of a mineral does not necessarily express the structure of the molecule is too obvious to need explanation; not only is the atomic grouping often uncertain, but, as has been repeatedly remarked, the composition of the actual molecule, for example, of corundum is doubtless expressed by $nAl_2O_3$, where the factor $n$ is as yet undetermined. The first office of a mineralogical formula, however, is to present to the mind as clearly as possible the composition of the species, and if with that an indication can be given of the molecular structure, that is a decided gain, but complex structural or rational formulas are in a work like the present entirely out of place.

But not only is the actual molecular structure of mineral species in most cases doubtful, but even the simple empirical composition of many species, often common ones, is still unsettled. This is particularly true among the more complex silicates. Analysis has shown in many such cases that no single formula can express the composition, but that a varying basic or acidic character may belong to the same species. In such cases recourse is often had to the theory of isomorphous mixtures which has thrown so much light upon the Feldspar Group (p. 314 *et seq.*), but the extreme or end compounds assumed are often hypothetical, and the correctness of the views which have been proposed needs confirmation. Clarke has shown that the variation in composition within the limits of a single species may be often explained in such cases by regarding the different forms as derivatives of a normal salt in which various atoms or molecular groups may enter. The theory thus advanced, supported by the experimental data which the same author is accumulating, promises to bring useful results.

The *oxygen ratio*, in the case of the silicates, is the ratio of the oxygen atoms belonging to the different groups of basic metals and to the acidic silicon, as seen clearly if the formula is written in the dualistic form. Thus for garnet, whose formula is $Ca_3Al_2Si_3O_{12}$ or $3CaO.Al_2O_3.3SiO_2$, the oxygen ratio for $Ca : Al_2 : Si$ is $3 : 3 : 6 = 1 : 1 : 2$; that is, for bases to silicon 1 : 1. This ratio is the same as the quantivalent ratio, which for garnet, $\overset{II}{R}_3[\overset{VI}{R}_2]\overset{IV}{Si}_3O_{12}$, is:

$$3 \times II : VI : 3 \times IV = 6 : 6 : 12 = 1 : 1 : 2.$$

Although not strictly in accord with modern chemical principles, the oxygen ratio is often a useful way of expressing the general nature of a complex compound.

The following atomic weights have been accepted, and from them the theoretical composition of each species has been calculated:

| | Symbol. | At. Weight. |
|---|---|---|
| Aluminium | Al | 27 |
| Antimony (*Stibium*) | Sb | 120 |
| Arsenic | As | 74·9 |
| Barium | Ba | 137 |
| Beryllium | Be (or Gl) | 9·1 |
| Bismuth | Bi | 207·5 |
| Boron | B | 10·9 |
| Bromine | Br | 79·8 |
| Cadmium | Cd | 111·7 |
| Cæsium | Cs | 58·7 |
| Calcium | Ca | 39·9 |
| Carbon | C | 12 |
| Cerium | Ce | 141 |
| Chlorine | Cl | 35·4 |
| Chromium | Cr | 52·5 |
| Cobalt | Co | 58·7 |
| Columbium, see *Niobium* | | |
| Copper (*Cuprum*) | Cu | 63·2 |
| Didymium | Di | 142 |
| Erbium | Er | 166 |
| Fluorine | F | 19·1 |
| Gallium | Ga | 69·9 |
| Germanium | Ge | 73·3 |
| Glucinum, see *Beryllium* | | |
| Gold (*Aurum*) | Au | 196·7 |
| Hydrogen | H | 1 |
| Indium | In | 113·4 |
| Iodine | I | 126·5 |
| Iridium | Ir | 192·5 |
| Iron (*Ferrum*) | Fe | 55·9 |
| Lanthanum | La | 138 |
| Lead (*Plumbum*) | Pb | 206·4 |
| Lithium | Li | 7 |
| Magnesium | Mg | 24 |
| Manganese | Mn | 54·8 |
| Mercury (*Hydrargyrum*) | Hg | 199·8 |

| | Symbol. | At. Weight. | | Symbol. | At. Weight. |
|---|---|---|---|---|---|
| Molybdenum | Mo | 96 | Sodium (*Natrium*) | Na | 23 |
| Nickel | Ni | 58·6 | Strontium | Sr | 87·3 |
| Niobium | Nb | 93·7 | Sulphur | S | 32 |
| Nitrogen | N | 14 | Tantalum | Ta | 182 |
| Osmium | Os | 191 | Tellurium | Te | 125 |
| Oxygen | O | 16 | Thallium | Tl | 203·7 |
| Palladium | Pd | 106·2 | Thorium | Th | 232 |
| Phosphorus | P | 31 | Tin (*Stannum*) | Sn | 117·4 |
| Platinum | Pt | 194·3 | Titanium | Ti | 48 |
| Potassium (*Kalium*) | K | 39 | Tungsten (*Wolframium*) | W | 183·6 |
| Rhodium | Rh | 104·1 | Uranium | U | 240 |
| Rubidium | Rb | 85·2 | Vanadium | V | 51·1 |
| Ruthenium | Ru | 103·5 | Ytterbium | Yt | 172·6 |
| Scandium | Sc | 44 | Yttrium | Y | 89 |
| Selenium | Se | 78·9 | Zinc | Zn | 65·1 |
| Silicon | Si | 28 | Zirconium | Zr | 90·4 |
| Silver (*Argentum*) | Ag | 107·7 | | | |

For a minute discussion of the many analyses and other points involved in Chemical Mineralogy, reference is made to the Mineralchemie of Rammelsberg, also to the works of Doelter and Roth, whose titles are given in the Bibliography following. On the views of Tschermak in case of complex species and groups of species, see the Feldspars (p. 325), Scapolites (p. 466), Micas (p. 612), Chlorites (p. 643); for references to the work of Clarke and his memoirs, see pp. 311, 612, 648 *et seq.* Hunt's recent volumes, noted in the Bibliography, contain his views on the subject of mineral classification, especially as based upon what he calls the coefficient of condensation.

**Pyrognostics (Pyr.).**—The Blowpipe Characters, or *pyrognostics*, include, first, the fusibility, in which the following scale (von Kobell, cf. p. 1034) is employed:

1. Stibnite. 2, Natrolite. 3, Almandite garnet. 4, Green actinolite. 5, Orthoclase. 6, Bronzite.

Further, they include the behavior of the mineral as to flame coloration, on charcoal, in the open and closed tubes (tube closed at one end), etc. Here B.B. means before the blowpipe; O.F. is the oxidizing flame or that which tends to give oxygen to the mineral being heated; R.F. is the reducing flame which tends to rob it of oxygen. It is to be noted that the use of the blowpipe is for the most part an easy method of qualitative chemical analysis.

With the proper blowpipe characters are given also the degree of solubility, behavior with acids, etc. On blowpipe analysis, see further Brush, Determ. Min. (1875), also the excellent works by Plattner, Cornwall, and others (Bibliography).

**Alteration (Alt.).**—Under this head is given brief mention of the changes to which the prominent species are liable, and frequently analyses of the products of alteration. With this is often added a statement as to the species from whose alteration it may result and after which it may accordingly occur as a pseudomorph.

For fuller information on this head the works of Blum and Roth should be consulted.

**Artificial Compounds (Art.).**—This head states some of the results as to the formation of chemical compounds occurring as minerals either in the laboratory or by the furnace. This subject which has been largely developed of recent years, especially by the French chemists, is fully discussed in the works of Fouqué-Lévy, Bourgeois, and Meunier; also earlier, Fuchs and others (see Bibliography).

## IV. NOMENCLATURE.*

1. The termination *ites* or *itis* (the original of *ite*) was used, according to system, among the Greeks, and from them among the Romans, in the names of stones, it being one of the regular Greek suffixes. It was added (as *ite* in these recent times) to the word signifying a *quality*, *constituent*, *use*, or *locality* of the stone.

Some of the examples are : *Hæmatites*, from the red color of the powder; *Chloritis*, from the green color; *Steatites*, from the greasy feel; *Dendritis*, from a resemblance to a tree or branch: *Alabastritis*, for the stone out of which a vase called an *alabastron* was made; *Basanites*, from the word for touchstone; *Siderites*, from the word for iron; *Argyritis*, from the Greek for silver; *Syenitis*, from the *locality*, Syene in Egypt; *Memphitis*, for a marble from Memphis in Egypt.

2. The only modern kind of name not in vogue in Pliny's time is that after persons.

Werner appears to have been the first to introduce personal names into mineralogy. The

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* Reproduced almost entire, and without much change, from the 5th Edition; the principles stated are followed (but not quite rigidly) in this edition. The fact that Prehnite probably antedated Torbernite (cf. 5th Ed., p. xxix) has been pointed out to the author of the present edition by Prof. A. H. Chester of Rutgers College (Feb. 1892).

earliest example was probably *Prehnite* (before called chrysolite), named after Col. Prehn; this name, according to Werner's statement (Bergm. J., **1**, 107, 1890), was given in 1783. About the same time he named *Torbernite,* after Torbern Bergmann, and Witherite after Dr. Withering (ibid., **1**, 103, 1790). The exact date of the former name does not appear; the first mention found is that by Karsten in 1793 (by him written *Torberite*), who states that Werner substituted *Chalcolite* for it; accepting this it must be at least earlier than 1788 (cf. ibid., **2**, 503, 1788). In 1789, Sage protested (J. Phys., **34**, p. 446) against the name Prehnite and the use of personal names in general as trivial. In 1790, Estner, a mineralogist of Vienna, issued a pamphlet against the Werner school, with the title "Freymüthige Gedanken über Herrn Inspector Werner's Verbesserungen in der Mineralogie," etc. (64 pp. 16mo, 1790), in which he makes light of Werner's labors in the science, and under the head of *Prehnite* ridiculed this method of creating a paternity, and providing the childless with children to hand down their names to posterity (p. 25). Such names were, however, too easily made, too pleasant, as a general thing, to give and receive, and withal too free from real objection, to be thus stopped off, and they have since become numerous, even Vienna contributing her full share toward their multiplication.

As a part of the history of mineralogical nomenclature, it may be here added that Werner, when it was proved that his *chalcolite* was an ore of uranium with but little copper, instead of a true ore of copper, dropped the name entirely, and called the mineral simply *Uranglimmer* (Uranium mica); and Karsten, in his reply to Abbé Estner (Berlin, 1793, 80 pp. 12mo), makes out of the necessary rejection of chalcolite an argument against chemical names, and in favor of names after persons, as the latter could never turn out erroneous in signification.

Werner, in an article written in defense of his introduction of this class of names (Bergm. J., **1**, 103, 1790), mentions the case of *Obsidian* (more properly *Obsian*) as a precedent from Pliny, Obsian being, as Pliny states, the reputed discoverer of the substance in Ethiopia. But this is not strictly an example. For Pliny uses *Obsian* not as a substantive, but as an adjective; the mineral was not *Obsian,* but *Obsian glass* or *Obsian stone; vitrum obsianum, lapis obsianus,* and *obsiana* [vitra], occurring in the course of the paragraph. The addition of the termination *ite* to Obsian would, according to mineralogical method, make a name equivalent to Pliny's *lapis obsianus.* Names of persons ending in *an* (as Octavian, Tertullian) were common among the Romans; and this is so far reason for avoiding the termination in names of stones.

Some critics question the existence of the reputed Obsius, and reject Pliny's explanation.

3. The ancient origin of this termination *ite,* its adoption for most of the names in modern mineralogy, its distinctive character and convenient application, make it evidently the true basis for uniformity in the nomenclature of the science.

4. If any other termination in addition is to be used, it should be so only *under system;* that is, it should be made characteristic of a particular natural group of species, and be invariably employed for the names in that group; and its use should not be a matter of choice or fancy with describers of species.

As a matter of fact, several other terminations are in use, but wholly without reference to any such system. The most common of them is *ine;* but it has not been employed for any particular division of minerals, and it could not now be so restricted; it belongs by adoption and long usage to chemistry, and should be left to that science.

5. In order then that the acquired uniformity may be attained, changes should be made in existing names, when it can be done without great inconvenience.

Names like *Quartz, Garnet, Gypsum, Realgar, Orpiment,* with the names of the metals and gems, which are part of general literature, must remain unaltered. *Mica* and *Feldspar,* equally old with Quartz, have become the names of *groups* of minerals, and are no longer applied to particular species. *Fluor* was written *fluorite* last century by Napione. *Blende,* although one of the number that might be allowed to stand among the exceptions, has already given place with some mineralogists to *Sphalerite,* a name proposed by Haidinger (because blende was applied also to other species) in 1845, and signifying *deception,* like Blende. Galena was written *Galenite* by von Kobell some years since. Orthoclase, Loxoclase, Oligoclase might be rightly lengthened to *Orthoclasite,* etc. But the termination *clase* (from the Greek for *fracture*) is peculiar to names of minerals, and the abbreviated form in use may be allowed to stand for species of the Feldspar group. Many other examples will be found by the reader in the pages of this volume.

In the course of the last century, when the science of minerals was taking shape, and progress in chemistry was helping it forward, there was an effort on one side to introduce, under the influence of Linnæus, the double names of Botany and Zoology; and on the other, under the influence of Cronstedt and Bergmann, names expressive of chemical composition, as far as it was ascertained; and the two methods have their advocates even now. But, at the same time, the necessity of single names was recognized by most of the early mineralogists; and in the spirit of the system which had made its appearance among the Greeks and Romans out of the genius of the Greek language, they almost uniformly adopted for the new names the termination *ite.*

Thus we have from Werner the names Torberite, Chalcolite, Graphite, Prehnite, Witherite, Boracite, Augite, Pistacite, Pinite, Aragonite, Apatite, Leucite, Cyanite (Kyanite); and from other sources in the same century, Zeolite, Actinolite, Tremolite, Coccolite, Arendalite, Baikalite, Melanite, Staurolite, Lepidolite, Cryolite, Chiastolite, Collyrite, Agalmatolite, Sommite, Moroxite, Pharmacolite, Strontianite, Delphinite, Titanite, Ceylanite, Gadolinite, Rubellite, Salite, Wernerite, Scapolite, Mellite, etc.

The termination *ine* was also adopted for a few names, as Tourmaline, Olivine, Mascagnine, Serpentine; and *an* in Vesuvian; but the great bulk of the names were systematically terminated in *ite*.

With the opening of the present century (in 1801), Haüy came forward with his great work on Crystallography, and in it he brought out a variety of new names that defy all system, having nothing of the system of the earlier science, and no substitute of his own. Forgetting that the unity of law which he had found in nature should be a feature of scientific language, he gave to his names the following terminations:

*ane*, in Cymophane; *ase*, in Euclase, Idocrase, Anatase, Dioptase; *aste*, in Pleonaste; *age*, in Diallage; *ene*, in Disthene, Sphene; *gene*, in Amphigene; *ide*, in Staurotide; *ime*, in Analcime; *ole*, in Amphibole; *ome*, in Aplome, Harmotome; *ose*, in Orthose; *ote*, in Actinote, Epidote; *yre*, in Dipyre; *ype*, in Mesotype. And the true mineralogical termination *ite* he admitted only in the few following: Axinite, Meionite, Pycnite, Stilbite, Grammatite.

Haüy had commanded so great and so general admiration by his brilliant discoveries in crystallography, and by the benefits which he had thus conferred on mineralogical science, that his names with their innovations were for the most part immediately accepted even beyond the limits of France, although a number of them were substitutes for those of other authors. Some of Werner's names were among the rejected; and a break was thus occasioned between German and French mineralogy, which will not be wholly removed until the rule of priority, properly restricted, shall be allowed to have sway.

The *substitutes* among Haüy's names in the 1st Edition of his Crystallography (1801) are the following:

Amphibole, for *Hornblende* of last century and earlier.

Orthose, for *Feldspar*.

Pyroxene, for *Augite* of Werner, and *Volcanite* of Delamétherie. [Delamétherie was a contemporary of Haüy at Paris, the author in 1792 of an edition of Mongez's *Manuel du Minéralogiste* (after Bergmann's Sciagraphia); in 1797, of an ambitious speculative work entitled *Théorie de la Terre*, the first two volumes of which consisted of a Treatise on Mineralogy; in 1811, 1812, of *Leçons de Minéralogie*, in 2 vols., and for a number of years principal editor of the *Journal de Physique*. He gave offense to Haüy by some of his early publications. Haüy's mineral Euclase is described in full by Delamétherie in the *Journal de Physique* for 1792 (some years in advance of Haüy's description of it), without crediting the name or anything else to Haüy; but five years later, in his *Théorie de la Terre*, he inserts the species with full credit to Haüy.]

Cymophane, for *Chrysoberyl* of Werner.

Idocrase, for *Vesuvian* of Werner.

Pleonaste, for *Ceylanite* of Delamétherie.

Disthene, for *Cyanite* of Werner.

Anatase, for *Octahedrite* of de Saussure, and *Oisanite* of Delamétherie.

Sphene, for *Titanite* of Klaproth.

Nepheline, for *Sommite* of Delamétherie.

Triphane, for *Spodumene* of d'Andrada.

Amphigene, for *Leucite* of Werner.

Actinote, for *Actinolite* of Kirwan, and *Zillerthite* of Delamétherie.

Epidote, for *Thallite* of Delamétherie, *Delphinite* of de Saussure, and *Arendalite* of Karsten.

Axinite, for *Yanolite* of Delamétherie.

Harmotome, for *Andreolite* of Delamétherie.

Grammatite, for *Tremolite* of Pini.

Staurotide, for *Staurolite* of Delamétherie, and *Grenatite* of de Saussure.

And, later, *Paranthine*, for *Scapolite* of d'Andrada, and *Rapidolite* of Abildgaard.

Part of the changes were made with good reason; but others were wholly unnecessary. Haüy was opposed to names from localities, and hence several of the displacements. He objected also to names based on variable characters, and characters not confined to the species. Moreover, as his pupil, Lucas, observes (in giving reasons for rejecting the name *Scapolite* and substituting *Paranthine*), "le vice du mot *lite*, qui s'applique à toutes les pierres, ne pouvoient plus convenir à cette substance du moment où elle seroit reconnue pour un espèce." Haüy's own names are remarkable, in general, for their indefiniteness of signification, which makes them etymologically nearly as good for one mineral as another, and very bad for almost none; as, for example, *Diallage*, which is from the Greek for *difference; Analcime*, from *weakness* in Greek; *Orthose*, from *straight* in Greek; *Epidote*, from *increase* in Greek; *Anatase*, from *erection* in Greek, interpreted by him as equivalent to *length; Idocrase*, from *to see a mixture* in Greek, etc. His name *Pyroxene*, which he defines *hôte ou étranger dans le domaine du feu*, is an unfortunate exception, as often remarked, the mineral being the most common and universal constituent of igneous rocks.

Beudant succeeded Haüy, and had the same want of system in his ideas of nomenclature. Finding occasion to name various mineral species which till then had only chemical names, he adopted Haüy's method of miscellaneous terminations, but indulged in it with less taste and judgment, and with little knowledge of the rules of etymology. In his work we find the termination *ese*, in Apherese, Aphanese, Neoctese, Acerdese, Mimetese; *ise*, in Leberkise, Sperkise, Harkise (only German words Gallicized), Melaconise, Zinconise, Crocoise, Stibiconise, Uraconise; *ose*, in Argyrose, Argyrythrose, Psaturose, Aphthalose, Rhodalose, Siderose, Elasmose, Exanthalose, Cyanose, Melinose, Disomose; *ase*, in Neoptase, Discrase; *ime*, in Ypoleime; *ele*, in Exitele; while names ending in *ine* are greatly multiplied.

In Germany, the tendency has always been to uniformity through the adoption of the termination *ite*. Breithaupt has been somewhat lawless, giving the science his Plinian, Alumian, Sardinian, Asbolan, etc.; his Castor and Pollux; Glaucodot, Homichlin, Orthoclase, Xanthocon, etc.; still, far the larger part of his numerous names are rightly terminated. Haidinger's many names are always right and good.

6. In forming names from the Greek or Latin the termination *ite* is added to the genitive form after dropping the vowel or vowels of the last syllable, and any following letters. Thus, μέλας makes μέλανος (*melanos*) in the genitive, and gives the name *melanite*. The Greek language is the most approved source of names.

7. In compounding Greek words the same elision of the Greek genitive is made for the first word in the compound, provided the second word begins with a vowel; if not, the letter *o* is inserted. Thus, from πῦρ, genitive πυρός (*puros*), and ὀρθός (*orthos*), comes pyrorthite; and from the same and ξένος (*xenos*) comes pyroxene.

8. The liberty is sometimes taken in the case of long compounds to drop a syllable, and when done with judgment it is not objectionable; thus *melacanite* has been accepted in place of *melanoconite*. But *magnoferrite* (as if from the Latin *magnus*, great, and ferrum, *iron*), for a compound of *magnesiă* and iron, or *calcimangite* for one containing lime and *manganese*, are bad.

9. In the transfer of Greek words into Latin or English, the κ (*k*) becomes *c*, and the υ (*u*) becomes *y*.

10. In the formation of the names of minerals, the addition of the termination *ite* to proper names in modern languages (names of places, persons, etc.), or names of characteristic chemical constituents, is allowable; but making this or any other syllable a suffix to *common* words in such languages is barbarous.

11. Names made half of Greek and half of Latin are objectionable; but names that are half of Greek or Latin and half of a modern language are intolerable.

12. *Law of Priority.*—The law of priority has the same claim to recognition in mineralogy as in the other natural sciences. Its purpose is primarily to secure the stability, purity, and perfection of science, and not to insure credit to authors.

13. *Limitations of the Law of Priority.*—The following are cases in which a name having priority may properly be set aside:

*a.* When the name is identical with the accepted name of another mineral of earlier date.

*b.* When it is glaringly false in signification; as when a red mineral is declared in its name to be black; e.g., *Melanochroite* (p. 914).

*c.* When it is put forth without a description.

*d.* When published with a description so incorrect that a recognition of the mineral by means of it is impossible; and in consequence, and because also of the rarity of specimens, the same species is described under another name without the describer's knowledge of the mineral bearing the former name. When, on the contrary, a badly described but well-known old mineral is redescribed correctly, there is no propriety in the new describer changing the old name.

*e.* When the name is based on an uncharacteristic variety of the species, Thus *Sagenite* was properly set aside for *Rutile*.

*f.* When the name is based upon a variety so important that the variety is best left to retain its original name; particularly where this and other varieties of the species, introduced originally as separate species, are afterwards shown by investigation to belong to a common species. Thus, the earlier name *Augite* is properly retained as the name of a variety, and Haüy's later name *Pyroxene* accepted for the group.

*g.* When a name becomes the designation of a group of species: as *Mica*, *Chlorite*.

*h.* When the name is badly formed, or the parts are badly put together: as when the terminal *s* of a Greek word is retained in the derivative; e.g., *aphanese* from ἀφανής; *Melaconise* from the Greek for *black* and κόνις; *Rhodalose* from the Greek for *rose-colored* and ἅλος (*halos*), the genitive of αλς, *salt*. The last word is bad not only in termination but in wanting an *h* before the *a*, and strictly an *o* after the *d*. Also *Siderose* (spathic iron), *Argyrose* (silver glance), *Chalcosine* (copper glance), from, respectively, σίδηρος, ἄργυρος, χαλκός. The ancient Greeks showed us how the derivatives from these words should terminate by writing them *Sideritis*, *Argyritis*, *Chalcitis*.

Ignorance or carelessness should not be allowed to give perpetuity to its blunders under any law of priority.

*i.* When a name is intolerable for the reasons mentioned in §§ 10, 11, as Harkise, from the German Haarkies (hair-pyrites); *Kupaphrite*, from the German *Kupferschaum; Bleinierite*, from the German *Blei-Niere*.

*j.* When a name has been lost sight of and has found no one to assert its claim for a period of more than fifty years; especially if the later name adopted for the species has become intimately incorporated with the structure of the science, or with the nomenclature of rocks. Thus, although *Thallite* and *Delphinite* antedate *Epidote*, it is not for the good of Science that Epidote should be thrown aside. But where a name has not this importance, and is unexceptionable, the law of priority may be allowed to have its course.

*k*. Where the adopted system of nomenclature in the science is not conformed to. In accordance with this last principle, the author, believing that the system demands that the names of species should have as far as possible, as above explained, the common termination *ite*, has changed, accordingly, a number of the names in the course of this volume.

14. It has appeared desirable that the names of rocks should have some difference of form from those of minerals. To secure this end, the author has written the final syllable *ite* of such names with a *y;* thus Diorite, Eurite, Tonalite, etc., are written *Dioryte*, *Euryte*, *Tonalyte*. The *y* is already in the name *Trachyte*. The author has allowed Granite and Syenite to remain as they are ordinarily written, since they are familiar names in common as well as in scientific literature.

See further, on Nomenclature, the excellent Mineral-Namen of von Kobell. A recent discussion of the subject has been given by Dr. H. Hugo A. Francke (Ueber die mineralogische Nomenclatur, 124 pp. 8vo. Berlin, 1890).

The following paragraphs on the history of the Silicates (from 5th Ed., pp. 204–206) are an important addition to the subject of mineral-nomenclature.

*Note on the History of the Silicates.*—In the work of the Swedish mineralogist Wallerius, of 1747, silicates as such are unrecognized, and the only species of those now so called which are described are the gems that passed under the names of *emerald*, *beryl*, *topaz*, *hyacinth*, *chrysolite*, *garnet ; clays* of various kinds and names ; *mica*, *talc*, *serpentine*, *amianthus*, *asbestus*, *feldspar*, and the convenient pocket for various undetermined heavy stones, named *Corneus*—the *Hornbärg* of the Swedish mineralogist, and *Roche de Corne* of his French translator, and which embraced *Skiörl* (*Schörl* of the Germans) as a prominent part of it. Quartz (Kieselsten, or Silex) in its many varieties, with opal, made up a large part of the non-metallic division of the science, occupying 30 pages out of 200. Feldspar is placed in the genus Spatum, as *Spatum pyrimachum* (or scintillating spar) alongside of fluor, Iceland spar, and heavy spar ; and sapphire and the other precious stones are in the group of Gems. All of these species excepting feldspar had special names in Pliny's time; and feldspar is distinctly referred to in Agricola as "Silex ex eo ictu ferri facile ignis elicitur, in cubis aliisque figuris intersectis constans" (p. 314, 1546).

Cronstedt's work of 1758 includes with the preceding the species *Zeolite*, a recent discovery of his own (1756); but adds no others. He shows, however, his acumen in making his group of *Kiesel-Arter* (siliceous minerals) to include not only the varieties of quartz, but also feldspar and the gems above enumerated (and his adding to it the diamond is not surprising). Garnet and schörl are left outside, and make the two species of his *Granat-Arter; Mica* (Glimmer-Arter) and *Asbestus* (Asbest-Arter), with Ler-Arter (clay minerals), are the other independent groups. Transparent tourmalines from Ceylon were among the gems of the day, having been first introduced into Europe in 1707 or before, but they are not distinctly mentioned by Cronstedt or Wallerius.

The group of Schörl increased in its varieties for the next twenty-five years, and after that became prolific in species, and much of the history of mineralogy is involved in its various phases. The following observations make, therefore, an introduction to the synonymy of many minerals beyond.

The *Corneus*, or *Hornbärg*, of Wallerius included a variety of hard, cheap or worthless stones, rather heavy, mostly of dark colors from black to dull green. The name alludes to a resemblance to horn in the aspect of some of the kinds. To *Corneus solidus* belonged the massive, compact, flinty rocks of black and lighter shades; also petrosilex (or *Hälleflinta* of the Swedes, which means *false flint*) of different shades; and massive hornblende ("granulis compactis"), though the name hornblende was, by a mistake of its German use, given by Wallerius to a black zinc-blende alone. His *Corneus fissilis* embraced lamellar forms of hornblende and pyroxene, and some slaty rocks. While *Corneus crystallisatus* was his *Skiörl*, which comprised opaque tourmalines, and other prismatic minerals of black, brown, green, and reddish colors, as hornblende, actinolite, and perhaps pyroxene, and at the head of the list basalt, and basanite or Lydian stone.

Cronstedt's *Skörl* made up his genus *Basaltes*, and was nearly synonymous with the *Corneus crystallisatus* of Wallerius. Its varieties were better defined; and to massive, lamellar, and columnar hornblende, actinolite and pyroxene and crystallized opaque tourmaline were added; and in an appendix to the species, cruciform staurotide. The name *Hornblende* is applied only to the massive variety or rock which Cronstedt made a *bole*, and called *Bolus induratis particulis squamosis ;* it probably covered other similar stones.

J. Hill in his work on Fossils, published in London, and according to the title-page in 1771 (though de Lisle says it was not issued until 1772), says of the "Shirls," that "as to size we see them from that of barley corn up to the Giant's Causeway," and the columns of the latter he calls "Irish Shirl," or "Basaltes Hibernicus." The group contains also macle or chiostolite from Andalusia, besides tourmaline, etc.

In the editions of Wallerius of 1772 and 1778 there is a little advance beyond the first as regards the number and classification of the species. Cronstedt is followed in the position of feldspar, and in the name "Basaltes" for the schörls; and Corneus is restricted to massive, fibrous, and coarse columnar stones, among which stands "hornblende" as *Corneus spathosus*, and "trapp" as *Corneus trapezius*.

At this period de Lisle brought crystallography to bear on the subject. But while making known new distinctions, he did not appreciate their full value, or the precision required for thorough work. As a consequence, the group of Schörls (or Schorls, as he writes the word in his later treatise of 1783) reached its greatest extension, although in a partly divided state. He early pronounced basaltic columns no crystals, and dropped off this excrescence. He showed in 1772 that the gem tourmaline, his *Transparent rhomboidal schorl*, was identical in form with the common black schorl. But still he made the latter a distinct *species*, his *Opaque rhomboidal schorl*, and included in it, along with black or opaque tourmaline, crystals of hornblende, augite, octahedrite from Oisans, rutile (needles in quartz), and, as a white variety, thin twins of albite, whose relation to feldspar he did not perceive; and even hexagonal nephelite from Vesuvius has a passing remark under this head. Axinite, then a novelty from Dauphiny, was made a short lenticular variety of *Transparent rhomboidal schorl*, or tourmaline, its *rhomboidal* planes proving to his eye the relationship. The massive mineral called *Hornblende*, or *Roche de Corne*, referred by Cronstedt to *Bole*, he annexes to Schorl as a massive or semi-crystallized kind, but makes it a separate species, *Schorl argileux*, although apparently appreciating that it was little entitled to the distinction. *Schorl cruciforme* was his last species in the group, and to it were referred both andalusite and staurolite—the latter his *Pierre de croix*, with the prismatic angle of 130° by his measurement; and the former, *Macle basaltique*, with an angle of 95°. The garnets and schorls were placed in a common division, as done by Cronstedt, and garnet was made the first species, with tourmaline the second and "cruciform schorl" the fifth. Garnet included the "white garnet," as it was called, of Vesuvius (leucite), first observed by Ferber in 1772. Besides these Silicates, de Lisle's work has its several groups of Gems, Feldspar, Argillaceous Minerals (embracing mica, asbestus, talc, serpentine), Zeolite, and Quartz. Labradorite, from Labrador (first brought to Europe about 1770), stands as a variety of feldspar, to which it had been referred by Werner; idocrase, of which many figures are given by him (first described and figured by Cappeler in 1722), meionite (hyacintes blanches), from Somma, and harmotome from Andreasberg (his *hyacinte blanche cruciforme*, made calcareous spar by v. Born in 1775, who first mentions and figures it, but a hyacinth-like *siliceous* species by Bergmann in 1780), are placed with zircon as kinds of *hyacinth*.

After de Lisle, as chemistry and crystallography made progress, the disintegration of the great Schorl group went rapidly forward, until the only thing left to it was common tourmaline; and now the name, once so important, has become a mere mineralogical relic. In Werner's system of 1789, as published by Hoffmann (Bergm. J., **1**, 369, 1789), Schörl includes only the species Tourmaline as it now stands. The *Kieselarten*, or Siliceous species (commencing with the diamond still), comprised the different gems; among which stands chrysoberyl (the modern), and, as distinct species, axinite, prehnite, hornblende of various kinds, with feldspar, mica, chlorite, the clays, etc.; while under *Talkarten*, or Magnesian species, there are kyanite, actinolite, with asbestus, talc, serpentine, nephrite, etc.

Silica was first proved to be a chemical constituent of many mineral species by Bergmann; and in his Opuscula (1780) and his Sciagraphia Regni Mineralis (1782) he distinguishes, after analyses by himself (made by fusion with potash, a method of his own), the following minerals as siliceous compounds of alumina, with or without lime or magnesia, namely, topaz, emerald, garnet, schörl (black tourmaline), hornblende, mica, zeolite from Iceland, feldspar, and the clays; and as essentially magnesian silicates, containing lime and a little iron, and little or no alumina, actinolite, asbestus (mountain cork and mountain leather), amianthus, steatite. These were the investigations that commenced the disbanding of the schorls, and before Werner's system of 1789 was published, many other analyses, more or less imperfect, had already been made by Wiegleb, Klaproth, Achard, Heyer, Mayer, Höpfner, Pelletier, and other chemists of the day.

The word *Schörl* of the Germans has been supposed to be derived from the name of a locality of the mineral, *Schorlau* (meaning Schörl-village) in Germany. But Prof. Naumann said (in a letter to J. D. Dana, 1867) that it is more likely that the name is a miner's term of unknown origin, and that the village got its name from the occurrence there of the schörl. Some German mineralogists have pronounced it of Swedish origin, and as first used by Cronstedt. But it occurs in Brückmann's Magnalia Dei, published at Braunschweig in 1727, on page 175, where it is spelt *schirl*. It exists also still earlier, as the author has found, in Ercker's Aula Subterranea, first published in 1595, *shurl* and wolfram being spoken of as among the rejected material in auriferous washings; and again in the yet older work of Gesner, De Rerum Foss, etc., 1565, p. 87, where schurl (misspelt? *schrul*) is given as the German for "Lapilli nigri steriles" of a tin vein, which, "quando cum lapillis plumbi candidi [or tin] coquuntur plumbum consumunt," etc.; again, in Matthesius's Sarepta, 1562, in the 9th "Predigt," where "Schurl" is quite fully described, and also in the next paragraph, "Wolffrumb." The name Schörl (or Schurl) was at that time used quite indefinitely for the *sterile* (or metallurgically worthless) black little stones ("nigri lapilli") accompanying tin ore and gold, especially the former; and, as they were among the refuse of the ore-washings, Adelung suggests that Schörl may have come from the old German word *Schor*, meaning *impurities*, or *refuse*.

## V. BIBLIOGRAPHY.

The following catalogue contains the titles of the independent works and of most of the periodicals which are referred to in the following pages, with their abbreviated forms. Some titles also are added of works consulted but not referred to.

Titles of *Inaugural Dissertations* (chiefly German) are not specially mentioned in the Bibliography, though in most cases the originals have been in the hands of the author. For the benefit of those who have not access to these and to the rarer portion of recent periodical literature in general, it may be noted that full abstracts are usually to be found in the Jahrbuch für Mineralogie (**Jb. Min.**) and particularly (since 1877) in Groth's Zeitschrift (**Zs. Kr.**); further, abstracts of chemical papers are generally given in the Jahresbericht für Chemie (**JB. Ch.**), also in the Journal of the Chemical Society (**J. Ch. Soc.**) and elsewhere. Many more titles could have been introduced of scientific periodicals, particularly of Scientific Societies, but it would only greatly overburden an already long list if they were all included. The explanation of the general system of abbreviations adopted is so full that references will be intelligible even when the periodical in question is not included in the list. In this connection, attention may be called to the excellent Catalogues of scientific periodicals prepared by Scudder* (1879) and by Bolton † (1885).

In the references, the number of the volume is uniformly printed in heavy-faced type (**9**). In the case of periodicals, the number of the series (in the last edition denoted by Roman numerals, I, II, III, etc.) is omitted for the sake of brevity, as not essential, since the *date* is always given. In general it may be mentioned that the addition of the date to a reference much increases its value. The number of the section, e.g. of an Academy, to which the publication belongs is indicated by a number in parentheses following the volume, as *Ber. Ak. Wien*, **50** (1), etc.

The statement made in the Preface is repeated here, that authors quoted have been actually consulted in the original; in a few cases when the original source was not accessible, this is given in brackets, [ ], while the authority used follows.

The abbreviations of the more important words in the abbreviated titles are given after the Bibliography (p. lxi *et seq.*), with also the abbreviations of the names of the States in the United States; and finally the abbreviations of proper names.

### 1. PERIODICALS NOT ISSUED BY SCIENTIFIC SOCIETIES.

**Afh., or Afhandl.** Afhandlingar i Fisik, Kemi och Mineralogie, etc., utgifne af Hisinger & Berzelius. Vol. 1, 1806; 2, '07; 3, '10; 4, '15; 5, 6, '18.

**Am. Ch. J.** American Chemical Journal. Edited by Ira Remsen, Baltimore (Johns Hopkins University). Begun in 1879. One volume annually in 6 numbers. Vol. 1, 1879; 12, 1891. Index, vols. 1-10, 1890.

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* Scientific Serials of all Countries, including the Transactions of Learned Societies, in the Natural, Physical, and Mathematical Sciences, 1633-1876. By Samuel H. Scudder. Cambridge, 1879.

† A Catalogue of Scientific and Technical Periodicals, 1665-1882, by H. Carrington Bolton. Washington, 1885 (Smithsonian Miscellaneous Contributions, 514).

**Am. J. Sc.** American Journal of Science. 1st series of 50 volumes, 8vo; conducted by B. Silliman, 1818–1839; with B. Silliman, Jr., from 1840. Four numbers to vol. 1, and two to subsequent vols. Vol. 1, No. 1, Aug., 1818; No. 2, Jan., '19; No. 3, Mar., '19; No. 4, June, '18; vol. 2, Ap., Nov., '20; 3, Feb., May, '21; 4, Oct., Feb., '21, '22; 5, June, Sept., '22; 6, Jan., May, '23; 7, Nov., Feb., '23, '24; 8, May, Aug., '24; 9, Feb., June, '25; 10, Oct., Feb., '25, '26; 11, June, Oct., '26; 12, 13, Mar., June, Sept., Dec., '27; afterward regularly on the first of April, July, Oct., Jan.; vols. 14, 15, in '28, '28–'29; 24, 25, in '33, '33–'34; 34, 35, in '38, '38–'39; then regularly, Jan., May, July, Oct., 36, 37, in '39; 38, 39, in '40; 48, 49, in '50; 50, Index volume.

2d ser., by the same and James D. Dana, until 1865, after which, by B. Silliman and James D. Dana; from 1851, aided by A. Gray and W. Gibbs, and later by other co-editors. 2 vols. ann.; 1, 2, 1846; 11, 12, '51; 21, 22, '56; 31, 32, '61; 41, 42, '66; whence, 49, 50, 1870. An index to each 10 vols. in vol. 10, 20, 30, etc.

3d ser. from 1871 in monthly numbers, by James D. Dana and B. Silliman until 1875; then by the same and E. S. Dana, and from 1885 by James D. and E. S. Dana. Vol. 1, 2, '71; 11, 12, '76; 21, 22, '81; 31, 32, '86; 41, 42, '91. An index to each 10 volumes issued (sometimes separately) with vol. 10, 20, 30, etc. The title was "American Journal of Science and Arts" until 1880.

**Amer. Geol.** The American Geologist. 8vo, Minneapolis. Vol. 1, 2, '88; 7, 8, '91.

**Amer. Nat.** The American Naturalist. 1 vol. annually. 8vo, Salem, and later Philadelphia. Vol. 1, '68; 25, '91.

**Ann. Ch.** Annales de Chimie. 8vo, Paris, vols. 1–3, 1789; 4–7, '90; 8–11, '91; 12–15, '92; 16–18, '93; 19–24, '97; 25–27, '98; 28–31, '99; then regularly 4 v. ann.; 32–35, 1800; 52–55; '05; 72–75, '10; 92–95, 96, '15. Index to vols. 31 to 60 inclusive. Continued in the Ann. Ch. Phys. (q.v.).

**Ann. Ch. Pharm.** See **Lieb. Ann.**

**Ann. Ch. Phys.** Annales de Chèmie et de Physique; at first by Gay Lussac et Arago. 8vo, Paris; 3 vols. ann.; 1–3, 1816; 16–18, '21; 31–33, '26; 46–48, '31; 61–63, '36; 73–75, '40. Vols. 67–75 made 2d ser., and numbered 1–9. 3d ser., 1–3, '41; 16–18, '46; 31–33, '51; 46–48, '56; 61–63, '61; 67–69, '63. 4th ser., 1–3, 1864; 16–18, '69; 28–30, '73. 5th ser., 1–3, '74; 22–24, '81; 28–30, '83. 6th ser., 1–3, '84; 22–24, '91.

Index 1st ser. to vols. 1–30; 31–60; 61–90. To 2d ser., 1–30; 31–75. To 3d ser., 1–30; 31–69. 4th ser., 1–30. 5th ser., 1–30.

**Ann. Mines.** Annales des Mines. 8vo, Paris. Begun in 1816 as sequel to Journal des Mines; 1 vol. a year until 1825, and subsequently 2 vols. a year. Vol. 1, 1816; 6, '21; 10, 11, '25; 12, 13, '26. 2d ser., 1, 2, '27; 8, last. 3d ser., 1, 2, '32; 19, 20, '41. 4th ser., 1, 2, '42; 19, 20, '51. 5th ser., 1, 2, '52; 19. 20, '61. 6th ser., 1, 2, '62; 19, 20, '71. 7th ser., 1, 2, '72; 19, 20, '81. 8th ser., 1, 2, '82; 19, 20, '91. Indexes to the different series.

**Ann. Mus. d'Hist. Nat.** Annales du Muséum d'histoire naturelle par les Professeurs de cet établissement, MM. Haüy, Fourcroy, Vauquelin, Desfontaines, A. L. de Jussieu, Geoffroy, Lacepède, etc. 4to, Paris; vols. 1–20, 2 a year, 1803–1815.

**Ann. Phil.** Annals of Philosophy. 2 vols. ann., 8vo, London. 1st ser. by Thos. Thomson; vols. 1, 2, 1813: 11, 12, '18; 15, 16, '20. 2d ser., vols. 1, 2, 1821; 11, 12, '26. Then merged in Phil. Mag. (q.v.).

**Arch. Math. Nat.** Archiv for Mathematik og Naturvidenskab, 8vo, Kristiania. Begun in 1876.

**Arch. Sc. phys. nat.** See **Bibl. Univ.**

**B. H. Ztg.** Berg- und hüttenmännische Zeitung. 4to, Leipzig, 1 vol. ann. Begun by Hartmann, and sometimes called Hartmann's Zeitung. Vol. 1, 1842; 4, '45; 9, '50; 14, '55; 19, '60; 24, '65; 29, '70, etc.

**Baumg. Zs.** Zeitschrift f. Physik und Mathematik; edited by Baumgartner and Ettingshausen. 10 vols., 8vo, 1826–1832, Vienna.

**Bergm. J.** Bergmännisches Journal; ed. by A. W. Köhler. 12mo, Freyberg, Sax. 1, 2, 1788; 1, 2, '89; so to '92; 1, 2, '93, by Köhler and Hoffmann. Afterward, Neues Bergm. J., of K. & H.; 1, 1795; 2, '98; 3, 1802; 4, '16. Contains papers by Werner, Hoffmann, Klaproth, and much on mineralogy.

**Berz. JB.** See **JB. Ch.**

**Bibl. Univ.** Bibliothèque Universelle de Genève. Begun in 1816. In 1846, 4th series of 36 vols. commenced, and the scientific part of the Review takes the title, *Archives des Sciences physiques et naturelles.* 5th series commenced in 1858. Vols. 1–3, '58; 31–33, '68; 61–64, '78. New ser., 1, 2, '79; 15, 16, '86.

**Bruce Am. Min. J.** The American Mineralogical Journal; conducted by Archibald Bruce, M.D. Only 1 vol., 8vo. Begun Jan., 1810; No. 1, 62 pp., 1810, and 2, to p. 126, '10; 3, to p. 190, '11; 4, to end, p. 270, '13.

**Can. Nat.** Canadian Naturalist and Geologist. 8vo, Montreal. Vol. 1, 1856; 5, '61; 8, '63; 2d ser., vol. 1, '64; 2, '65; 3, '66; 10, '81–'83, etc.

**Can. J.** Canadian Journal of Industry, Science, and Art. Toronto, Canada. 2d ser., vol. 1, 1856; 5, '60; 10, '65; 11, '66, '67; 15, '76–'78.

**Ch. Gaz.** Chemical Gazette, by W. Francis. 8vo, London. 1 vol, ann. after vol. 1, of 1842 17, '59.

**Ch. News.** Chemical News; edited by W. Crookes. Sm. 4to, London. 2 v. ann.; vols. 1, 2, 1860; 11, 12, '65; 21, 22, '70; 41, 42, '80; 61, 62, '90.

**Crell's Ann.** Chemische Annalen; by L. Crell. 40 vols., 12mo, Helmstadt u. Leipzig. Vols. numbered 1, 2, for each year, from 1784 to 1803 inclusive.

**Dingler J.** Polytechnisches Journal; by J. G. & E. M. Dingler. 3 vols. ann., 8vo, Augsburg. Begun in 1820; vol. 187, in 1868, etc.

**Dublin Q. J. Sc.** Dublin Quarterly Journal of Science; edited by Rev. S. Haughton. 6 vols. 8vo, 1861–'66, Dublin.

**Ed. J. Sc.** Edinburgh Journal of Science; edited by D. Brewster (~~often called~~ Brewster's J.). 8vo, Edinburgh, 2 vols. ann. 1st ser., vol. 1, 1824; 2, 3, '25; 6, 7, '27; 10, '29. 2d ser., vol. 1, 1829; 2, 3, '30; 4, 5, '31; 6, '32. Merged in Phil. Mag.

**Ed. Phil. J.** Edinburgh Philosophical Journal; edited by Brewster and Jameson. 8vo, 2 vols. ann.; vol. 1, 1819; 2, 3, '20; 6, 7, '22; 10, '24; edited by Jameson alone, 11, 1824; 12, 13, '25; 14, '26. Becomes Ed. N. Phil. J. (q.v.).

**Ed. N. Phil. J.** Edinburgh New Philosophical Journal; edited by Prof. Jameson (often called Jameson's Journal. 8vo, 2 vols. ann. 1st ser., vol. 1, 1826; 2, 3, '27; 12, 13, '32; 22, 23, '37; 32, 33, '42; 42, 43, '47; 52, 53, '52; 56, 57, '54. 2d ser., vols. 1, 2, 1855; 11, 12, '60; 19, 20, '64. Here ends.

**Eng. Mng. J.** Engineering and Mining Journal. 4to, published weekly. New York. Begun in 1866. Vols. 51, 52, 1891. Before 1872, Am. Journal of Mining, Milling, etc.

**Erman's Arch.** Archiv für wissenschaftliche Russland. Begun in 1841; 1 vol. ann. Vol. 1, 1841; 11, '51; 21, '61, etc.

**Gehlen's J.** Neues allg. Journal der Chemie; by A. F. Gehlen. 6 vols., Berlin; 1, 1803; 2, 3, '04; 6, '06. 2d ser., under the title Journal für die Chemie und Physik und Mineralogie, 9 vols., Berlin: 1, 2, 1806; 5, 6, '08; 9, '10. Afterward, Schweigger's Journal (q.v.) began at Nuremberg.

**Geol. Mag.** The Geological Magazine, or Monthly Journal of Geology. In monthly numbers. London. Begun in 1864; vol. 10, 1873; Decade II, vol. 1, '74; 10, '83. Decade III, vol. 1, '84; 8, 91. Preceded by The Geologist. 1858–63.

**Gilb. Ann.** Annalen der Physik; conducted by L. W. Gilbert. 8vo, Leipzig, 30 vols.; 1st series, 1799–1808; then 30 vols., 2d ser., 1809–'18; then Annalen d. Phys. und der Physikalischen Chemie, 16 vols., 3d ser., 1819–'23. The vols. of the several series usually counted consecutively; 1, 2, 1799; afterward 3 vols. a year, 3–6, 1800; 13–15, '03; 28–30, '08; 43–5, '13; 58–60, '18; 73–5, '23; 76, '24. Afterward continued as Poggendorff's Annalen, see **Pogg.**

**Giorn. Min.** Giornale di Mineralogia, Cristallografia e Petrografia, diretto dal Dr. F. Sansoni. Milan. Begun in 1890; vol. 2, 1891.

**Groth's Zeitschr.** See **Zs. Kr.**

**Haid., Nat. Abh. Wien.** Naturwissenschaftliche Abhandlungen. von Haidinger. 4to. Vols 1–4, 1847–'51.

**J. Mines,** or **J. d. M.** Journal des Mines. 8vo, Paris. In monthly nos. 2 v. ann.; 1, 2, 1797; 11, 12, 1802; 21, 22, '07; 31, 32, '12; 37, 38, '15. Continued in Annales des Mines (q v.).

**J. de Phys.,** or **J. Phys.** Journal de Physique. 4to, Paris, 2 vols. ann. Edited by Abbé Rozier (and hence called Rozier's J.), for vols. 1-43 (for a time with also Mongez, Jr.); by Delamétherie for vols. 44–84; and afterward by Blainville. Two introductory vols., 1771, 1772; vols. 1, 2, 1773; 11, 12, '78; 22, 23, '83; 32, 33, '88; 42, 43, '93; 44, 45, '94 (French Revolution); 46, 47, '98; 56, 57, 1803; 66, 67, '08; 76, 77, '13; 86, 87, '18; 94, 95, '22; 96, 1823.

**J. Phys.** Journal de Physique. Paris. Begun in 1872. One vol. annually. Vol. 1, 1872; 10, 1881. 2d ser., vol. 1, 1882; 10, 1891. Distinguished from the preceding by the date.

**J. pr. Ch.** Journal für praktische Chemie. 8vo, Leipzig, 3 vols. ann. Preceded by J. f. pr. und ökonomische Chemie, 18 vols. 8vo, 3 vols ann., begun in 1828. Begun in 1834; first edited by Erdmann & Schweigger-Seidel (see Schweigger J.); from 1838 by E. & Marchand; from 1852, by E. & Werther. Vols. 1–3, 1834; 19–21, '40; 34–36, '45; 49–51, '50; 64–66, '55; 79–81, '60; 94–96, '65; 109–111, '70. 2d ser. begun in 1870, vol. 1, 2, '70; 3, 4, '71; 23, 24, '81; 43, 44, '91.

**Arsb.**
**Jahresb.**
**JB. Ch.**
Årsberättelser om framstegen i Kemi och Mineralogi, af Jac. Berzelius. In German, Jahresbericht über die Fortschritte der Chemie und Mineralogie. 8vo; usually designated by the year. Commenced with 1821. Vol. 1, 1821; 11, '31; 21, '41; 30, 1850; the last three vols. by Svanberg. Continued in the Giessen Jahresbericht, issued by Liebig & Kopp, from 1847 to '56; by F. Zamminer, '57; Kopp & Will, '58; and Will alone from '63 on. The first vol. covers the years 1847, '48.

**Jb. Min.** Jahrbuch für Mineralogie, Geognosie, Geologie, und Petrefaktenkunde; edited by K. C. v. Leonhard & H. G. Bronn. 8vo, Heidelberg, 1 vol. ann. 1830–32, 4 Nos. a year; after '32, 6 Nos., and called *Neues Jahrbuch*, etc.

Since 1880 two volumes of three numbers each annually, the abstracts (**Ref.**) with independent paging. Also Beilage Band (**Beil.** or **Beil.-Bd.**), 1, 1881, 7, 1890–91. Index (Allg. Repertorium), 1850–59, 1860–'69, 1870–'79, 1880–'89, 1880–'84, and Beil.-Bd. 1, 2 (1885); 1885–'89, and Beil.-Bd. 3–6 (1891).

**Karst. Arch Min.** Archiv für Mineralogie, Geognosie, Bergbau und Hüttenkunde. 26 vols. 8vo, 1829–1855, Berlin. Edited for vols. 1–10 by C. J. B. Karsten; later by Karsten & v. Dechen.

**Kastn. Arch. Nat.** Archiv für die gesammte Naturlehre ; edited by K. W. G. Kastner. 8vo, Nürnberg. 27 vols., 3 vols. ann., 1824–'35.

**Kell. & Tiedm.** Nordamerikanischer Monatsbericht für Natur- und Heilkunde ; edited by Dr. W. Keller & Dr. H. Tiedemann. 4 vols., 8vo, Philadelphia. Vol. 1, 1850 ; 2, 3, '51 ; 4, '52.

**Lempe's Mag.** Magazin für die Bergbaukunde, by J. F. Lempe. 8vo, Dresden. Vol. 1, 1785; 2, 3. '86; 4, '87; then 1 vol. ann. till 11, '94; 12, '98; 13, '99.

**Lieb. Ann.** Annalen der Chemie und Pharmacie: by Wöhler and Liebig; from vol. 77, by Wöhler, Liebig, and Kopp, and called *new series.* 8vo, Leipzig and Heidelberg. 4 vols. (and later 4 to 6 or 7) ann. Vols. 1–4, 1832; 13–16, '35; 33–36, '40; 53–56, 45; 73–76, '50; 93–96, '55; 113–116, '60; 133–136, '65; 153–156, '70; 191–194, '78; 195–200, '79; 255–260, '90. Supplementband, 1, 1861; 2. '62, '63; 3, '64; 4. '65, '66; 7, '70; 8, '72.

With vol. 173 the title was changed to Liebig's Annalen der Chemie and the reference to the new series was dropped. Index to vols. 1–100, '61; 101–116, '61; 117–164, '74.

**L'Institut.** L'Institut, a weekly journal in small fol., Paris, 1 vol. ann.; begun in 1832.

**Mag. Nat. Helvet.** Magazin für die Naturkunde Helvetiens; herausg. A. Höpfner, Zürich. Begun in 1787.

**Min. Mag.** See p. l.

**Min. Mitth.** Mineralogische Mittheilungen gesammelt von G. Tschermak. Begun in 1871 as Beilage zum Jahrbuche der k. k. geol. Reichsanstalt. Since 1878 published separately (in smaller form) as Mineralogische und Petrographische Mittheilungen. Vol. 1, 1878; 11, 1890. Index, vols. 1–10, 1890. Edited since 1889 by F. Becke.

**Moll's Efem.** Efemeriden der Berg- und Hüttenkunde; edited by C. E. von Moll. 5 vols.; 1, 1805, at München; afterward at Nürnberg, 2, '06; 3, '07; 4, '08; 5, '09. Preceded by v. Moll's Jahrb. f. B. H., Salzburg, 5 vols., 1797–1801; and Annalen id., Salzburg, 3 vols., 1802–'04.

**Naturaleza.** La Naturaleza, Periodico cientifico, Mexico. Begun in 1869; vol. 7, '84–'87. 2d ser., vol. 1, '87–'91.

**Nature.** A weekly illustrated Journal of Science. London. Commenced in Nov. 1869, in weekly numbers. Vol. 1, Nov. '69–April '70; 2, May–Nov. '70; 10, May–Oct. '74; 20, May–Oct. '79; 30, May–Oct. '84; 40, May–Oct. '89; 44, May–Oct. '91.

**Nicholson's J.** Journal of Natural Philosophy, Chemistry, and the Arts; by Wm. Nicholson. London, 1st ser., 5 vols., 4to, vol. 1, 1797; 5, 1801. 2d ser., 36 vols. 8vo, vol. 1, 1802; 36, 1813.

**Nuovo Cimento.** Il nuovo Cimento; giornale di Fisica, di Chimica, etc. Vol. 1–2, 1855–'56. 2d ser., vol. 1, 1869.

**Nyt. Mag.** See p. l.

**Phil. Mag.** Philosophical Magazine. 8vo, London. 1st ser. by Tilloch, 2 or 3 vols. a year; 1, 2, 1798; 3–5, '99; 6–8, 1800; 21–23, '05; 30–32, '08; 33, 34, '09 (thence 2 v. ann.); 35, 36, '10; 45, 46, '15; 55, 56, '20; 65, 66, '25; 67, 68, '26.

2d ser., or Philosophical Magazine and Annals of Philosophy, 2 v. ann.; 1, 2, 1827; 11, '32.

3d ser., London & Edinburgh Phil. Mag.; 1, 1832; 2, 3, '33; 12, 13, '38; 22, 23, '43; 32, 33, '48; 36, 37, '50.

4th ser., L., E. & Dublin Phil. Mag., 1, 2, 1851; 11, 12, '56; 21, 22, '61; 31, 32, '66; 49, 50, '75.

5th ser. with 1876. 1, 2, '76; 11, 12, '81; 21, 22, '86; 31, 32, '91.

**Pogg.** or **Pogg. Ann.** Annalen der Physik und Chemie; edited by J. C. Poggendorff. 8vo, Leipzig, 3 vols. ann. Preceded by Gilbert's Annalen (q.v.). Vols. 1, 2, 1824; 3–5, '25; 11, Index vol ; 18–20, '30; 27–29. '33; 30, Index vol.; 31–33, '34; 34–36, '35; 49–51, '40; 63–66, '45; 79–81, '50; 94–96, '55; 109–111, '60; 124–126, '65; 139–141, '70; 157–159, '76; last vol., 160, '77 Also Ergänzungsbd (Erg.), 1, 2, '48; 3, '53; 4, '54; 5, '71; 6, 7, '76; 8, '78, and Jubelband, 1874. General Index (Sachregister) to the whole series, 1824–1877, issued in 1888

Edited since 1877 by G. Wiedemann and called Wiedemann's Annalen; see **Wied. Ann.**

**Q. J. Sc.** Brandes' Quarterly Journal of Science. 8vo. 2 vols. ann. after 1819. Published by the Royal Institution. Vol. 1, 1816; 2, 3, '17, '17–'18; 4, 5, '18; 6, 7, 8, '19; 9, 10, '20; 19, 20, '25; 27, 28, '29.

**Rec. Gen. Sc.** Records of General Science; by Thos. Thomson. 4 vols., 8vo, Edinburgh. Vols. 1, 2, 1835; 3, 4, '36.

**Revista Minera.** Revista Minera, Periodico cientifico é industrial redactado por una Sociedad de Ingenieros. 2 vols., 8vo, Madrid. Vol. 1, 1850; 2, '51.

**Riv. Min.** Rivista di Mineralogia e Cristallografia Italiana diretta da R. Panebianco. Padua. Begun in 1887. Vol. 1, 1887; 8, 9, 1891.

**Scherer's J.** Allgemeines Journal der Chemie; conducted by A. N. Scherer. 10 vols., Leipzig und Berlin; 1, 1798; 2, 3, 1799; 6, 7, 1801; 10, '03. Continued as Gehlen's Journal (q.v.).

**Schw. J.** or **Schweigg. J.** Journal für Chemie und Physik; conducted by J. S. C. Schweigger. Nürnberg, 8vo. Also under the title Jahrbuch der Chemie und Physik. 3 vols. a year; 1–3, 1811; 16–18, '16; 28–30, '20; afterward issued by Schweigger & Meinecke; then by J.

S. C. Schweigger & Fr. W. Schweigger-Seidel; then by Fr. W. Schweigger-Seidel; 31–33, 1821; 46–48, '26; 61–63, '31; 67–69, '33 The next year began the J. pr. Ch. (q.v.), by Erdmann & Schweigger-Seidel.

**Science.** An illustrated Journal published weekly. Begun Feb. 1883, Cambridge, Mass. Vol. 1, Feb.–June '83; 6, July–Dec. '85, New York.

**Tasch. Min.** Taschenbuch für die gesammte Mineralogie, von C. C. Leonhard. 18 vols., 12mo, Frankfurt a. M., 1 vol. ann. Vol. 1, 1807; 4, '10, 9, '15, ~~14, '20;~~ 18, '24.

**Tschermak's Mitth.** See **Min. Mitth.**

**Wied. Ann.** Annalen der Physik und Chemie herausgegeben von G. Wiedemann, successor to Poggendorff, Annalen (see Pogg. Ann.), begun in 1877; 3 vols. ann. Vol. 1, 2, '77; 3–5, '78; 24–26, '85; 42–44, '91.

Also. connected with this, Beiblätter zu den Annalen der Physik und Chemie, begun in 1877, 1 vol. ann. Vol. 1, '77; 9, '85; 15, '91.

**Zs. Kr.** Zeitschrift für Krystallographie und Mineralogie, herausgegeben von Paul Groth, Leipzig. Begun in 1877; vol. 19 closed in 1891. Index to vols. 1–10, 1886 (Repertorium der mineral. u. kryst. Literatur, 1877–1885).

### 2. TRANSACTIONS, ETC., OF SCIENTIFIC SOCIETIES.

**Abh. Ak. Berlin.** Abhandlungen der königlichen preuss. Akademie der Wissenschaften zu Berlin. 4to, Berlin. Vol. 1 (for 1804–1811) issued in 1815.

**Abhandl. Senck. Ges. Frankfurt.** Abhandlungen von d. Senckenbergischen naturforschenden Gesellschaft zu Frankfurt. Begun in 1854. Vol. 7 in 1868; 16, '90.

**Act. Soc. Fenn.** Acta Societatis scientiarum Fennicæ. Helsingfors, Finland. Begun in 1842; 2–10, '47–'75.

**Ak. H. Stockholm.** K. Vet.-Akademiens Handlingar, Stockholm.

**Ak. H. Stockh., Bihang.** See **Ofv. Ak. Stockh.**

**Amer. Assoc.** Proceedings of the American Association for the Advancement of Science. 8vo. Vol. 1, meeting at Philadelphia in 1848; 2, at Cambridge in '49; 3, at Charleston in '50; 4, at N. Haven, '50; 5, at Cincinnati, '51; 6, at Albany, '52; 7, at Cleveland, '53; 8, at Washington, '54; 9, at Providence, '55; 10, at Albany, '56; 11, at Montreal, '57; 12, at Baltimore, '58; 13, at Springfield, '59; 14, at Newport, '60; 15, at Buffalo, '66; 16, at Burlington, '67; and annually since then, 40, at Washington, '91.

**Ann. Lyc. N. Hist. N. Y.** Annals of the Lyceum of Natural History of New York. Begun in 1824. Followed by the Annals of the New York Academy of Science. Vol. 1, 1879; 2, '82; etc.

**Ann. Mus. Wien.** Annalen des K. K. naturhistorischen Hofmuseums, redigirt von Dr. Franz Ritter von Hauer, Vienna. Begun in 1886; one vol. annually; vol. 6, 1891.

**Ann. Soc. G. Belg.** Annales de la Société géologique de Belgique. Vol. 1, '74–'75; 16, '89.

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**Quenstedt Kryst.** Grundriss der bestimmenden und rechnenden Krystallographie nebst einer historischen Einleitung; by Fr. Aug. Quenstedt. 443 pp., Tübingen. 1873.

**Quenstedt, Min.** Handbuch der Mineralogie; by F. A. Quenstedt. 8vo, Tübingen, 1853. Also 2d ed., ib., 1863; 3d ed., ib., 1877.

**Raimondi, Min. Pérou.** Minéraux du Pérou: Catalogue raisonné d'une collection des principaux types minéraux de la République; by A. Raimondi. Translated from the Spanish by J.-B. H. Martinet. 336 pp. 8vo, Paris, 1878.

**Rashleigh, Brit. Min.** Specimens of British Minerals selected from the cabinet of Philip Rashleigh (descriptions and colored plates). 4to, London. Part 1, 1797; 2, 1802.

**Rep. G. Cal.** Report on the Geology of California; by J. D. Whitney. Large 8vo, San Francisco, 1865.

**Rep. G. Can.** Annual Reports on the Progress of the Geological Survey of Canada; by Sir Wm. E. Logan. Containing reports on mineralogy by T. S. Hunt. 8vo, 1845–'59. In 1863 a General Report for the years 1843–'63. Also Annual Reports for later years with mineralogy by B. J. Harrington and G. Chr. Hoffmann.

**Rep. G. Mass.** Report on the Geology of Massachusetts; by E. Hitchcock. 1st Rep., 1833, 8vo; 2d ed., 1835. 2d Rep., 1841, 4to.

**Rep. G. N. Y.** Reports on the Geological Survey of New York. Annual Reports in 8vo, 1837–'41; final in 4to.

**Rep. Min. N. Y.** Report on the Mineralogy of the State of New York; by L. C. Beck. 4to, 1842.

☞ [The many Geological Reports published both for the general government as also for the different states during recent years cannot be mentioned in detail. See, however, **U. S. G. Surv.**]

**Reuss, Min.** Lehrbuch d. Mineralogie; by F. A. Reuss. 8vo, 1801–05, Leipzig. Divided into parts, and the parts into vols. Pt. 1 and pt. 2, vol. 1, 1801; vol. 2, '02; vol. 3, 4, '03; 3d pt., vol. 1, 2, '05; 4th pt., including Index, '06.

**Rg., Handw.** Handwörterbuch des chemischen Theils der Mineralogie; by C. F. Rammelsberg. 8vo, Berlin, 1841. Supplement 1, '43; 2, '45; 3, '47; 4, '49; 5, '53.

**Rg., Kr. Ch.** Handbuch der krystallographisch-physikalischen Chemie. Abtheilung I: Elemente und anorganische Verbindungen. 615 pp. 8vo, Leipzig, 1881. Abth. II: Organische Verbindungen, 1882.

**Rg., Min.** J. J. Berzelius's neues chemisches Mineralsystem; by id. 8vo, Nürnberg, 1847.

**Rg., Min. Ch. 1860, 1875.** Handb. d. Mineralchemie; by id. 8vo, Leipzig, 1860. Do., 2d ed., part I, 136 pp.; part II, 744 pp., 1875. Ergänzungsheft (**Erg.**), 276 pp., 1886.

**Rio, Min.** Nuevo Sistema Minerale; by A. M. del Rio. Mexico, 1827.

**Rio, Orykt.** Elementos de Oryktognosia, ó del Conocimiento de los Fósiles, dispuestos segun los principios de A. G. Werner; by id. 4to, Mexico, 1795.

**Rio, Tabl. Min.** Tablas mineralogicas por D. L. G. Karsten; by A. M. del Rio. 4to, Mexico, 1804.

**Robinson, Cat.** Catalogue of American Minerals, with their Localities; by S. Robinson. 8vo, Boston, 1825.

**Rose, Reis. Ural.** Reise nach dem Ural, dem Altai, und dem Kaspischen Meere; by Gustav Rose 8vo, Berlin; vol. 1, 1837; 2, '42.

**Rose, Kryst.-Ch. Min.** Das Krystallo-chemischen Mineral-System; by G. Rose. 8vo, Leipzig, 1852.

**Rose Kryst.** Elemente der Krystallographie. See **Rose-Sbk., Kryst.**, also **Sbk. Ang. Kryst.**, and **Websky, Kryst.**

**Rose-Sbk., Kryst.** Gustav Rose's Elemente der Krystallographie, 3d ed., vol. 1, 181 pp., 1873.

**Rosenb., Mass. Gest.** Mikroskopische Physiographie der massigen Gesteine; by H. Rosenbusch. 596 pp. 8vo, Stuttgart, 1877. 2d ed., 877 pp., 1886–87.

**Rosenb., Mikr. Phys.** Mikroskopische Physiographie der petrographisch-wichtigen Mineralien; by H. Rosenbusch. 398 pp. 8vo, Stuttgart, 1873; 2d ed., 664 pp., 1885. Also accompanied by Hülfstabellen zur mikroskopischen Mineralbestimmung, Stuttgart, 1888.

**Rosenbusch-Iddings, Micr. Phys.** English translation and abridgment of the above work. 333 pp., New York, 1888.

**Roth, Ch. G.** Allgemeine und chemische Geologie; by Justus Roth. Vol. 1, Bildung u. Umbildung der Mineralien, etc., 633 pp., Berlin, 1879. 2, Petrographie, 695 pp., 1887.

**Sage, Min.** Élémens de Minéralogie docimastique; by B. G. Sage. 2d ed., 2 vols., 1777. 1st ed. appeared in 1772.

**Sandb., Unt. Erzgänge.** Untersuchungen über Erzgänge von Fridolin Sandberger. 430 pp. 8vo, Wiesbaden, 1882–85.

**Saussure, Voy. Alpes.** Voyages dans les Alpes, par H. B. Saussure. 4 vols. 4to. Vols. 1, 2, 1779, '80; 3, 4, '96.

**Sbk., Ang. Kryst.** Angewandte Krystallographie (Ausbildung der Krystalle, Zwillingsbildung, Krystallotektonik) nebst einem Anhang über Zonenlehre; by Alexander Sadebeck (Rose's Elemente der Krystallographie, II. Band). 284 pp. 8vo, Berlin, 1876.

**Sbk., Kryst.** See **Rose-Sbk.**

**Scacchi, Mem. Min. e Geol.** Memorie mineralogiche e geologiche; by A. Scacchi. 8vo, Napoli, 1841.

**Scacchi, Crist.** Quadri Cristallografici, e Distribuzione sistematica dei minerale; by id. 8vo, Napoli, 1842.

**Scacchi, Mem. G. Campania.** Memorie geologiche sulla Campania; by id. 4to, Napoli, 1849. By the same, Memoria sulla Incendio Vesuviano, 1855. Napoli, 1855. Polisimmetria dei Cristalli. 4to, 1864.

**Scacchi, Contr. Min.** Contribuzioni mineralogiche per servire alla Storia dell' Incendio Vesuviano, del mese di Aprile. 1872. Part I, Naples, 1872; Part II, Naples. 1874.

**Scacchi, Min. Vesuv.** Catalogo dei Minerali Vesuviani. Naples, 1887. Also Catalogo dei Minerali e delle Rocce Vesuviane per servire alla Storia del Vesuvio ed al commercio dei suoi prodotti, 1889 (Att. Accad. Napoli, 4th ser., vol. 1).

**Schrauf, Atlas.** Atlas der Krystall-Formen des Mineralreiches. 4to, vol. 1, A–C., Vienna, 1865–1877. 1 Lief., Tf. i–x, 1865; 2, Tf. xi–xx, 1871; 3, Tf. xxi–xxx, 1872; 4, Tf. xxxi–xl, 1873; 5, xli–l, 1875.

**Schrauf, Edelsteinkunde.** Handbuch der Edelsteinkunde; by Albrecht Schrauf. 252 pp. 8vo, Vienna, 1869.

**Schrauf, Phys. Min.** Lehrbuch der physikalischen Mineralogie. 8vo, vol. 1, 253 pp., 1866; vol. 2, 426 pp., Vienna, 1868.

**Schumacher, Verz.** Versuch eines Verzeichnisses der in den Dänisch-Nordischen Staaten sich findenden einfachen Mineralien. 4to, Copenhagen, 1801.

**Schütz, Nordamer. Foss.** Beschreibung einiger nordamerikanischen Fossilien; by A. G. Schütz, of Freyberg. 16mo, Leipzig, 1791. Contains the first notice of *celestine*, a mineral named by Werner from Schütz's American specimens.

**Sella, Min. Sarda.** Studii sulla Mineralogia Sarda; by Quintino Sella. 4to, Turin, 1856.

**Selle, Min.** Cours de Minéralogie et de Géologie, by Albert de Selle. Vol. 1, Minéralogie, 589 pp. 8vo, Paris, 1878.

**Senft, Min.** Synopsis der Mineralogie und Geognosie; by F. Senft. 1te Abtheilung, Mineralogie, 931 pp. 8vo, Hannover, 1875.

**Shep., Min., 1832–1835, 1844, 1852, 1857.** Treatise on Mineralogy; by C. U. Shepard. 1st part, 1 vol. 12mo. New Haven, 1832; 2d part, 2 vols., New Haven, 1835. Also, 2d ed. (with only the 1st part revised), New Haven, 1844. Also, 3d ed., 8vo, New Haven, No. 1, 1852; No. 2, '57.

**Shep., Min. Conn.** Report on the Geological Survey of Connecticut; by id. 8vo, N. Haven, 1837.

**Sohncke, Kryst.** Entwickelung einer Theorie der Krystallstruktur; by L. Sohncke. 247 pp. 8vo, Leipzig, 1879.

**Steffens, Handb.** Handb. d. Oryktognosie; by H. Steffens. 3 vols. 18mo, Halle; vol. 1, 1811; 2 '15; 3, '19.

**Stromeyer, Unt.** Untersuchungen über die Mischung der Mineralkörper, etc.; by Fr. Stromeyer. 8vo, Göttingen, 1821.

**Tabl. Min.** See **Adam, Tabl. Min.**

**Theophr.** Theophrastus Περί λίθων (on Stones); written about 315 B.C. Only a portion of the whole work is extant, but sufficient to show that the author was precise in his knowledge of minerals and careful in the statement of facts. T. born about 371 B.C., and d. 286 B.C.

**Thomson, Min., 1802, 1836.** Outlines of Mineralogy, Geology, and Mineral Analysis; by T. Thomson. 2 vols. 8vo, London, 1836. A treatise on Mineralogy published also with preceding editions of his Chemistry, the earliest in 1802.

**Traube, Min. Schlesiens.** Die Minerale Schlesiens; by H. Traube. 285 pp. 8vo, Breslau, 1888.

**Tsch., Min.** Lehrbuch der Mineralogie, von Dr. Gustav Tschermak. 589 pp. 8vo, Vienna, 1885. 3d ed., 1888.

**Ullmann, Syst.-tab. Ueb.** Systematisch-tabellarische Uebersicht der min.-einfachen Fossilien; by J. C. Ullmann. Small 4to, Cassel and Marburg, 1814.

**Ulrich, Contr. Min. Vict.** Contributions to the Mineralogy of Victoria; by G. H. F. Ulrich. 32 pp. 8vo, Melbourne, 1870.

**U. S. G. Surv.** United States Geological Survey.

—— **Bull.** Bulletins 1 to 81. 8vo. A catalogue of those previously issued is given with each number.

—— **Ann. Rep.** Annual Reports. 4to. Vol. 1, for 1880–81; 10 for 1888–89.

—— **Mon.** Monographs. 4 to Vols. 1 to 16.

**Vogl's Joach.** Gängverhältnisse und Mineralreichthum Joachimsthals; by J. Fl. Vogl. 8vo, Teplitz, 1857.

**Volger, Studien, etc.** Studien zur Entwicklungsgeschichte der Mineralien; by G. H. O. Volger. 8vo, Zürich, 1854. Other works: Entwickl. der Min. d. Talk-Glimmer Familie, 1855; Arragonit und Kalcit, 1855; Monographie des Borazites, Hannover, 1855; Epidot und Granat, Beobachtungen über das gegenseitige Verhältniss dieser Krystalle, Zürich, 1855; Krystallographie, Stuttgart, 1854.

**Wall.,** or **Wall., Min.** Mineralogia, eller Mineralriket; by J. G. Wallerius. 12mo, Stockholm, 1747.

**Wall., Fr. Trl.** French edition of Wallerius's Min. of 1747. 2 vols. 8vo, Paris, 1753. Published anonymously.

**Wall., Min., 1772, '75.** Systema Mineralogicum. 8vo, Holmiæ, vol. 1, 1772; 2, '75.

**Wall., Min., 1778.** Syst. Min. 2 vols. 8vo, Vienna, 1778.

**Waltersh., Vulk. Gest.** Ueber die vulkanischen Gesteine in Sicilien und Island [Iceland], und ihre submarine Umbildung; by W. Sartorius v. Waltershausen. 8vo, Göttingen, 1853.

**Watts, Dict. Ch.** Dictionary of Chemistry; by H. Watts. 5 vols.; 1 in 1863; with supplements. Two volumes (A—In) of a revised edition have been published, 1888, '89, edited by H. F. Morley and M. M. Pattison Muir.

Also two volumes of a companion-work, Dictionary of Applied Chemistry, edited by T. E. Thorpe, 1890, '91.

**Websky, Kryst.** Anwendung der Linearprojection zum Berechnen der Krystalle; by Martin Websky (Rose's Elemente der Krystallographie, III Band). 377 pp. 8vo, Berlin, 1887.

**Websky, Min. Sp. G.** Die Mineral Species nach den für das specifische Gewicht derselben angenommenen und gefundenen Werthen; by Martin Websky. 170 pp. 4to, Breslau, 1868.

**Weisbach, Synops. Min.** Synopsis Mineralogica, systematische Uebersicht des Mineralreiches; by Albin Weisbach. 78 pp. 8vo, Freiberg, 1875. 2d ed., 1884.

**Wern., Auss. Kennz. Foss.** Von d. äusserlichen Kennzeichen d. Fossilien; by A. G. Werner. 8vo, Leipzig, 1774.

**Wern., Letzt. Min. Syst.** Letztes Mineral-System. 8vo, Freiberg & Wien, 1817. A Catalogue with notes. Werner or his scholars issued, from time to time, a tabular synopsis of his Mineral System revised to the time of publication, on folio sheets, or published them in other works. The earliest after that of Werner's Cronstedt was issued by Hofmann in Bergm. J., 1789, vol. 1, p. 369. Emmerling's Min., vol. 1, 1799, contains the synopsis of 1798, and Ludwig's Min. contains that of 1800 and 1803. Leonhard's Tasch., vol. 3, 261, that of 1809.

**Wern., Min.-Kab. Pabst.** Verzeichniss des Mineralien-Kabinets des Herrn K. E. Pabst von Ohain; by A. G. Werner. 2 vols., Freiberg, 1791, '93.

**Wern., Ueb. Cronst.** Cronstedt's Versuch einer Min. übersetzt und vermehrt von A. G. Werner. Vol. 1, part 1, Leipzig, 1780.

**Westrumb, Kl. Phys.-Ch. Abh.** Kleine physikalisch-chemische Abhandlungen; by J. F. Westrumb. 8vo, Leipzig, vol. 1, 1785; 2, '87; 3, '88; 4, '89; Hannover, 5, 6, '93; 7, '95; 8, '97.

**Whitney, Lake Sup.** Report on the Geology of the Lake Superior Land District; by J. W. Foster and J. D. Whitney. 8vo, Part 1, 1850; 2, '51.

**Whitney, Met. Wealth.** The Metallic Wealth of the United States, described and compared with that of other countries; by J. D. Whitney. 8vo, Philadelphia, 1854.

**Whitney, Miss. Lead Region.** Report of a Geological Survey of the Upper Mississippi Lead Region; by id. (Made by authority of the State of Wisconsin.) 8vo, 1862.

**Whitney, Rep. G. Cal.** See **Rep. G. Cal.**

**Whitney, Berz. Blowpipe.** Berzelius on the Blowpipe; translated by J. D. Whitney. 8vo, Boston, 1845.

**Withering, Trl. Bergm. Sciagr.** Outlines of Mineralogy, trl. from the original of Bergmann; by Wm. Withering. 8vo, 1783. (Reprinted in vol. 2 of Mem. and Tracts of the late Dr. Withering, London, 1822.)

**Wiik, Min.-Kar.** Mineral-Karakteristik: En Handledning vid Bestämmandet af Mineralier och Bergarter; by F. J. Wiik. 218 pp. 12mo, Helsingfors, 1881.

**Williams, Cryst.** Elements of Crystallography for Students of Chemistry, Physics, and Mineralogy; by G. H. Williams. 250 pp. 12mo, New York, 1890.

**Woodward, Foss.** Fossils of all kinds digested into a Method suitable to their mutual Relation and Affinity. 8vo, London, 1728.

**Zepharovich, Min. Lex.** Mineralogisches Lexicon für das Kaiserthum Oesterreich; by V. R. v. Zepharovich. 8vo, Vienna, 1859. Vol. 2, ibid., 1873.

**Zirkel, Mikr. Besch.** Die mikroscopische Beschaffenheit der Mineralien und Gesteine; by Ferdinand Zirkel. 502 pp. 8vo, Leipzig, 1873.
See also **N.-Z., Min.**

The works in the above catalogue which are most important for the study of the history of mineral species are the following, the order cited being that of time:

Theophrastus; Dioscorides; Pliny's Natural History; Agricola's works; Linnæus's Systema Naturæ, 1st ed., 1735; Wallerius's Mineralogy in the original Swedish, 1747 (the first systematic, descriptive work, following in its system of classification mainly the 1st edition of Linnæus, which the author alludes to in his preface, among other Swedish works by Forsius, Hiærne, Bromell, and Swedenborg); Cronstedt's Mineralogy, 1757 (a new chemical system); Linnæus's Systema Naturæ, 10th ed., 1768; Romé de Lisle's Crystallography, 1772, 1783 (the first systematic effort to apply the principles of crystallography to the science); Wallerius's Min. of 1772, 1778 (the system and facts are little changed from the earlier edition); Werner on the External Characters of Minerals, 1774, and his Cronstedt, 1780; Bergmann's Opuscula, 1780, and Sciagraphia, 1782; Hofmann's exposition of Werner's system in the Bergm. J., 1789; Emmerling's Mineralogy, 1793–'97, and 1799–1802; Lenz's Mineralogy, 1794; Klaproth's Beiträge, 1795–1810; Karsten's Tabellen, 1800; Haüy's Treatise on Mineralogy, 1801; Reuss's Mineralogy, 1801–1806; Ludwig's Werner, 1803, 1804; Mohs's Null Kab., 1804; Karsten's Tabellen, 1808; Lucas's Tableau, part 1, 1806 (giving views of Haüy of 1801 to 1806); Brongniart's Mineralogy, 1807; Haüy's Tableau comparatif, 1809; Hausmann's Handbuch, 1813; Hoffmann's Mineralogie, 1811–1817; Ullmann's Uebersicht, 1814; Jameson's Mineralogy, 1816, 1820; Werner's Last Mineral System (Letztes, etc.), 1817; Cleaveland's Mineralogy, 1816, 1822; Berzelius's Nouv. Système, 1819; Leonhard's Handbuch, 1821, 1826; Mohs's Mineralogy, 1822; Haidinger's translation of Mohs, 1825; Breithaupt's Charakteristik, 1820, 1823, 1832; Beudant's Treatise, 1824, 1832; Phillips's Min., 1823, 1837; Glocker's Min., 1831, 1839; Shepard's Min., 1832–'35, and later editions; von Kobell's Grundzüge, 1838; Mohs's Min., 1839; Breithaupt's Min., 1836–1847; Haidinger's Handbuch, 1845; Hausmann's Handbuch, 1847; Dufrénoy's Min., 1844–1847 (also 1856–1859); Glocker's Synopsis, 1847; Brooke & Miller, 1852; Rammelsberg's Handwörterbuch and Supplements, 1841–1853, also his Mineralchemie, 1860, 1875; Hessenberg's Notizen, 1854 to 1873; Koksharov's Mineralogie Russlands, 1854 to 1891; Kenngott's Uebersicht, 1844–1865; Des Cloizeaux's Mineralogy, 1862, 1874; von Kobell's Geschichte, 1864; Naumann's Min. (and Naumann-Zirkel), 1846 to 1885; Tschermak's Min., 1881; Goldschmidt's Index, 1886–'91; Hintze's Min. (1889–'91), five parts only completed, but with greater detail of treatment than has been before attempted. To the above list are to be added the earlier editions of this work by James D. Dana, 1837, 1844, 1850, 1854, 1868.

## VI. ABBREVIATIONS.

### 1. General Abbreviations used in Titles, etc.

| | |
|---|---|
| **Abh.** | Abhandlungen. |
| **Ac.** or **Acad.** | Academy. |
| **Accad.** | Accademie (Ital.). |
| **Ak.** or **Akad.** | Akademie (Germ.). |
| **Am.** or **Amer.** | American. |
| **Ann.** | Annals,<br>Annales,<br>Annalen. |
| **Att.** | Atti (Ital.). |
| **B C.** | British Columbia. |
| **Ber.** | Berichte or<br>Sitzungsberichte. |
| **Bull.** | Bulletin. |
| **Can.** | Canada,<br>Canadian. |
| **Ch.** | Chemistry,<br>Chemical,<br>Chemie,<br>Chimie, etc. |
| **Dan.** | Danish. |
| **Ed.** or **Edinb.** | Edinburgh. |
| **Eng.** | Engineers,<br>Engineering. |
| **Erg.** | Ergänzung. |
| **Fr.** | French. |
| **G.** | Geological, etc. |
| **Germ.** | German. |
| **Ges.** | Gesellschaft. |
| **Inst.** | Institute. |
| **Ital.** | Italian. |
| **J.** | Journal. |
| **Jb.** or **Jahrb.** | Jahrbuch. |
| **JB.** or **Jahresb.** | Jahresbericht. |
| **Mag.** | Magazine. |
| **Mem.** | Memoirs,<br>Mémoires. |
| **Min.** | Mineralogy,<br>Mineralogical,<br>Mineralogische, etc. |
| **Mitth.** | Mittheilungen. |

| | |
|---|---|
| **Mng.** | Mining. |
| **Mon.** | Monograph. |
| **N. A.** | North America |
| **N. S.** | Nova Scotia. |
| **N. S. W.** | New South Wales. |
| **N. Z.** | New Zealand. |
| **Ont.** | Ontario. |
| **Phil.** | Philosophy,<br>Philosophical. |
| **Proc.** | Proceedings. |
| **Q.** | Quarterly |
| **Rend.** | Rendiconti. |
| **Rep.** | Report. |
| **S. A.** | South America. |
| **Sc.** | Science. |
| **Soc.** | Society. |
| **Span.** | Spanish. |
| **Trans.** | Transactions,<br>Transiunti (Ital.). |
| **Vh.** or **Verh.** | Verhandlungen. |
| **Zs.** | Zeitschrift. |
| **Ztg.** | Zeitung. |

## 2. ABBREVIATED NAMES OF THE UNITED STATES (U. S.).

| | |
|---|---|
| **Ala.** | Alabama. |
| **Ark.** | Arkansas. |
| **Cal.** | California. |
| **Col., Colo.** | Colorado. |
| **Ct., Conn.** | Connecticut. |
| **Dak.** | Dakota. |
| **Del.** | Delaware. |
| **Ga.** | Georgia. |
| **Ill.** | Illinois. |
| **Ind.** | Indiana. |
| **Kan.** | Kansas. |
| **Ky.** | Kentucky. |
| **Mass.** | Massachusetts. |
| **Md.** | Maryland. |
| **Me.** | Maine. |
| **Mich.** | Michigan. |
| **Minn.** | Minnesota. |
| **Miss.** | Mississippi. |
| **Mo.** | Missouri. |
| **Mont.** | Montana. |
| **N. Car.** | North Carolina. |
| **N. H., N. Hamp.** | New Hampshire. |
| **N. J.** | New Jersey. |
| **N. Y.** | New York. |
| **O.** | Ohio. |
| **Pa., Penn.** | Pennsylvania. |
| **R. I.** | Rhode Island. |
| **S. Car.** | South Carolina. |
| **Tenn.** | Tennessee. |
| **Va.** | Virginia. |
| **Vt.** | Vermont. |
| **Wisc.** | Wisconsin. |

## 3. ABBREVIATIONS OF PROPER NAMES USED IN REFERENCES TO AUTHORS AND IN TITLES.

| | |
|---|---|
| **Ach.** | A. D'Achiardi, Pisa. |
| **Arz.** | A. Arzruni, Aachen. |
| **Baumh.** | H. Baumhauer, Lüdinghausen. |
| **Bdg.** | C. Bodewig, Cologne. |
| **Bgr.** | W. C. Brögger, Stockholm. |
| **Bkg.** | H. Bücking, Strassburg. |
| **Breith.** | J. F. A. Breithaupt (1791-1873). |
| **Brk.** | H. J. Brooke (1771-1857). |
| **Brz.** | A. Brezina, Vienna. |
| **Btd.** | E. Bertrand, Paris. |
| **E. S. D.** | E. S. Dana, New Haven. |
| **J. D. D.** | J. D. Dana, New Haven. |
| **Dbr.** | H. Dauber (1823-1861). |
| **Dmr.** | A. Damour, Paris. |
| **Dx.** | A. Des Cloizeaux, Paris. |
| **Erem.** | P. von Eremeyev, St. Petersburg (*Germ.* Jérémejew). |
| **Fzl.** | A. Frenzel, Freiberg. |
| **Gdt.** | V. Goldschmidt, Heidelberg. |
| **Grl.** | J. Grailich (1829-1859). |
| **H.** | R. J. Haüy (1743-1822). |
| **Haid.** | W. von Haidinger (1795-1871). |
| **Hausm.** | J. F. L. Hausmann (1782-1859). |
| **Hbg.** | Fr. Hessenberg (1810-1874). |
| **Hkl.** | W. Hankel, Leipzig. |
| **Hkr.** | R. Helmhacker, Leoben. |
| **Kbl.** | Fr. von Kobell (1803-1882). |
| **Kenng.** | A. Kenngott, Zürich. |
| **Kk.** | N. von Koksharov, St. Petersburg (*Germ.* Kokscharow). |
| **Kln.** | C. Klein, Berlin. |
| **Knr.** | J. A. Krenner, Buda-Pesth. |
| **Lasp.** | H. Laspeyres, Kiel. |
| **Lcx.** | A. Lacroix, Paris. |
| **Lsx.** | A. von Lasaulx (1839-1886). |
| **Mg.** | O. Mügge, Hamburg. |
| **Mgc.** | Ch. Marignac, Geneva. |
| **Mld.** | E. Mallard, Paris. |
| **Mlr.** | W. H. Miller (1801-1880). |
| **Ph.** | W. Phillips (1775-1828). |

| | |
|---|---|
| **Pfd.** | S. L. Penfield, New Haven. |
| **Rath.** | G. vom Rath (1830–1888). |
| **Rg.** | C. F. Rammelsberg, Berlin. |
| **Rosenb.** | H. Rosenbusch, Heidelberg. |
| **Sbk.** | A. Sadebeck (1833–1880). |
| **Sbs.** | J. Schabus, Vienna. |
| **Scc.** | A. Scacchi, Naples. |
| **Sf.** | A. Schrauf, Vienna. |
| **Slg.** | G. Seligmann, Coblenz. |
| **Tsch.** | G. Tschermak, Vienna. |
| **Weisb.** | A. Weisbach, Freiberg. |
| **Zeph.** | V. von Zepharovich (1830–1890) |

### 4. MISCELLANEOUS ABBREVIATIONS.

References are given below to the places in the preceding pages where the meaning of certain general terms, symbols, etc., is more fully explained.

| | |
|---|---|
| **Alt.** | Altered forms, p. xl. |
| **Anal.** | Analyses. |
| **Artif.** | Artificial forms, p. xl. |
| **Ax. pl.** | Optic axial plane, p. xxxv. |
| **B. B.** | Before the blowpipe, p. xl. |
| **Bx, $\mathbf{Bx_a}$** | Bisectrix, i.e. acute bisectrix or first mean line, p. xxxv. |
| **$\mathbf{Bx_o}$** | Obtuse bisectrix, or second mean line, p. xxxv. |
| **Comp.** | Composition, p. xxxvii *et seq.* |
| **G.** | Specific Gravity, p. xxxiv. |
| **H.** | Hardness, p. xxxiv. |
| **Obs.** | Observations, p. xiii. |
| **O. F.** | Oxidizing flame, p. xl. |
| **O. ratio** | Oxygen ratio, p. xxxix. |
| **priv. contr.** | Private contributions (i.e. of unpublished observations). |
| **pt.** | Part, in part. |
| **Pyr.** | Pyrognostics or blowpipe characters, p. xl. |
| **Ref.** | References (p. xiii); also used of abstracts of original articles found in certain journals, e.g. Jb. Min., Zs. Kr., etc. |
| **R. F.** | Reducing flame, p. xl. |
| **Tw. axis** | Twinning axis, p. xviii. |
| **Tw. pl.** | Twinning plane, p. xviii. |
| **Var.** | Varieties. |
| $a$, $b$, $\overset{\mid}{c}$, $\breve{a}$, $\bar{b}$, etc. | Crystallographic axes, p. xiv *et seq.* |
| $\mathfrak{a}$, $\mathfrak{b}$, $\mathfrak{c}$, | Axes of elasticity, p. xxxv. |
| $\alpha$, $\beta$, $\gamma$, | Axial angles, p. xxxii; also indices of refraction, p. xxxv. |
| 2E, 2V, 2H, 2K, 2G, | Optic axial angle in air, etc., p. xxxv. |

The following signs are frequently employed:

| | |
|---|---|
| +, −, | Plus and minus, as defining the optical character of crystals, p. xxxv. |
| ‖, | Parallel to, as *ax. pl.* ‖ *a*. |
| ⊥, | Perpendicular or normal to, as Bx ⊥ *c*. |
| ∧, | Angle between two forms, as $100 \wedge 110 = 45°$. |
| $\frac{2}{2}$, $\frac{3}{3}$, | Mean of two (or three, etc.) analyses; also, in some cases of separate determinations. |

All temperatures are given on the *Centigrade scale.*

# DESCRIPTIVE MINERALOGY.

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## GENERAL CLASSIFICATION.

I. NATIVE ELEMENTS.

II. SULPHIDES, SELENIDES, TELLURIDES, ARSENIDES, ANTIMONIDES.

III. Sulpho-salts.—SULPHARSENITES, SULPHANTIMONITES, SULPHOBISMUTHITES.

IV. Haloids.—CHLORIDES, BROMIDES, IODIDES; FLUORIDES.

V. OXIDES.

VI. Oxygen-Salts.

- 1. CARBONATES.
- 2. SILICATES, TITANATES.
- 3. NIOBATES, TANTALATES.
- 4. PHOSPHATES, ARSENATES, VANADATES; ANTIMONATES. NITRATES.
- 5. BORATES. URANATES.
- 6. SULPHATES, CHROMATES, TELLURATES.
- 7. TUNGSTATES, MOLYBDATES.

VII. Salts of Organic Acids: Oxalates, Mellates, etc.

VIII. HYDROCARBON COMPOUNDS.

# I. NATIVE ELEMENTS.

**I. Non-Metals.** **II. Semi-Metals.** **III. Metals.**

## I. Non-Metals.

### 1. Carbon Group.

| | | | | |
|---|---|---|---|---|
| 1. | **Diamond** | C | Isometric | |
| 2. | **Graphite** | C | Rhombohedral | $\grave{c} = 1{\cdot}3859$ |

### 2. Sulphur Group.

| | | | | |
|---|---|---|---|---|
| 3. | **Sulphur** | S | Orthorhombic | $\breve{a} : \bar{b} : \grave{c} = 0{\cdot}8131 : 1 : 1{\cdot}9034$ |
| 4. | **Selensulphur** | (Se,S) | | |
| *5a.* | **Selenium** (artif.) | Se | Monoclinic, like the monoclinic forms of sulphur. | |

## II. Semi-Metals.

### 3. Tellurium-Arsenic Group. Rhombohedral.

| | | | *rr′* | *c* |
|---|---|---|---|---|
| 5*b.* | **Selenium** (artif.) | Se | 93° | — |
| 6. | **Selen-tellurium** | (Te,Se) | — | — |
| 7. | **Tellurium** | Te | 93° 3′ | 1·3298 |
| 8. | **Arsenic** | As | 94° 54′ | 1·4013 |
| 9. | **Allemontite** | $SbAs_3$ | | |
| 10. | **Antimony** | Sb | 92° 53′ | 1·3236 |
| 11. | **Bismuth** | Bi | 92° 20′ | 1·3036 |
| 12. | **Zinc** (only artif.?) | Zn | 93° 46′ | 1·3564 |

Zinc belongs with this rhombohedral group, and connects the semi-metals to the metals; it is also stated to be isometric like mercury.

## III. Metals.

### 4. Gold Group. Isometric.

| | | |
|---|---|---|
| 13. | **Gold** | Au |
| | Electrum | (Au,Ag) |
| 14. | **Silver** | Ag |
| 15. | **Copper** | Cu |
| 16. | **Mercury** | Hg |
| 17. | **Amalgam** | AgHg, $Ag_2Hg_3$, etc. |
| | 1. Arquerite | $Ag_{12}Hg$ |
| | 2. Kongsbergite | $Ag_{36}Hg$ |
| 18. | **Lead** | Pb |

---

| | | | | |
|---|---|---|---|---|
| 19. | **Tin** (cryst. only artif.) | Sn | Tetragonal | $\grave{c} = 0{\cdot}3857$ |
| | | | Orthorhombic | $\breve{a} : \bar{b} : \grave{c} = 0{\cdot}3874 : 1 : 0{\cdot}3557$ |

Tin is closely related to lead.

### 5. Platinum-Iron Group. Isometric, also in part Rhombohedral.

| | **Isometric.** | | | **Rhombohedral.** | | |
|---|---|---|---|---|---|---|
| 20. | **Platinum** | Pt with Fe<br>also with Ir, Rh, Os | | | | |
| 21. | **Iridium** | (Ir, Pt) | 22. | **Iridosmine** | (Ir,Os) | *rr′* = 95° 8′ |
| | Platiniridium | (Pt, Ir) | | 1. Siserskite | | $\grave{c} = 1{\cdot}4105$ |
| | | | | 2. Nevyanskite | | |

| Isometric. | | Rhombohedral. | |
|---|---|---|---|
| 23. **Palladium** | Pd | 24. **Allopalladium** | Pd |
| 25. **Iron** | Fe with Ni, Co, also Mn | | |
| Awaruite | $Fe Ni_2$ | | |
| Schreibersite, Rhabdite, etc. | | | |

---

## 1. Carbon Group.

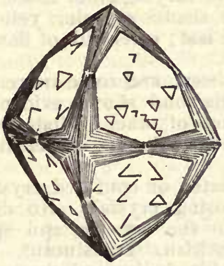
**1. DIAMOND.** Adamas, punctum lapidis pretiosior auro, *Manilius*, Astron., 4, l. 926 (the earliest distinct mention of true diamond). Adamas, in part, *Plin.*, 37, 15. Diamant *Germ.* Diamant *Fr.* Diamante *Ital.*, *Span.*

Isometric; tetrahedral. Observed forms[1]:

*a* (100, *i-i*)
*o* (111, 1)
*d* (110, *i*)
*f* (310, *i*-3)
*e* (210, *i*-2)
*g* (320, *i*-$\frac{3}{2}$)
ϑ (430, *i*-$\frac{4}{3}$)
λ (11·10·0, *i*-$\frac{11}{10}$)
*p* (221, 2)
φ (511, 5-5)
*n* (211, 2-2)
*s* (321, 3-$\frac{3}{2}$)
*u* (431, 4-$\frac{4}{3}$)
ξ (near *o*)
ϑ (near *d*)
Σ (541, 5-$\frac{5}{4}$)
Φ (651, 6-$\frac{6}{5}$)

No distinction can be made between the + and − tetrahedral forms, and the hemihedral character of the species has been questioned.

1.



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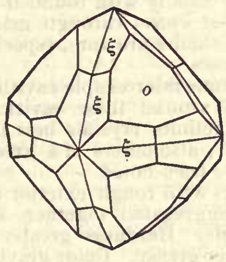

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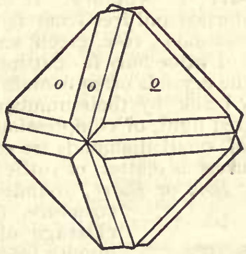

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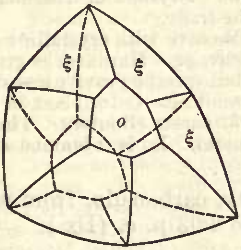

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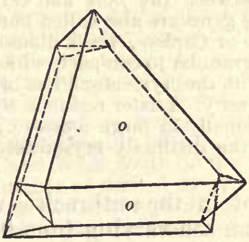

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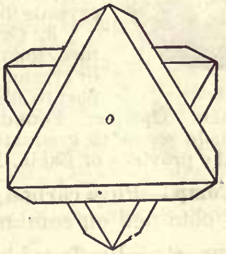

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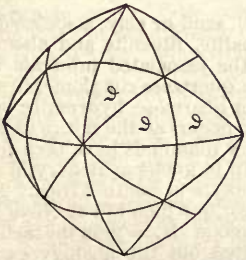

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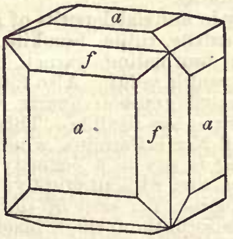

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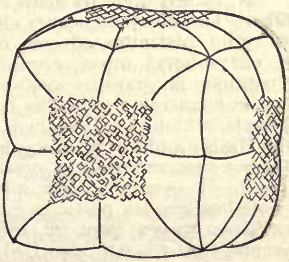

Fig. 1, S. Africa. 2, Haidinger. 3, 7, 8, Rose-Sadebeck. 9, Groth.

Twins: tw. pl. *o* very common, both contact- and penetration-twins; the former often flattened ∥ *o*; also tw. axis a cubic axis, the twins with parallel axes, symmetrical to a cubic plane, and interpenetrating each other. Faces commonly much curved, and often striated, most frequently ∥ intersection with *o*. Inverted triangular depressions common on *o* (f. 1), also others of diagonal quadrilateral form on *a*; octahedral faces built up of successive plates. Crystals distorted into elongated, pear-shaped forms, also irregular; and in groups. In spherical forms with radiated structure and rough exterior. Rarely massive.

Cleavage: *o* highly perfect. Fracture conchoidal. Brittle. H. = 10, but greater on *a* than on *o*. G. = 3·516 – 3·525 crystals; 3·499 – 3·503 bort; 3·15 – 3·29 carbonado, E. v. Baumhauer.[2] Luster adamantine to greasy, sometimes dull. Color white or colorless; occasionally various pale shades of yellow, red, orange, green, blue, brown; sometimes black. Usually transparent; also translucent and opaque. Refractive and dispersive power high; indices:

$$n_{\mathrm{r}} = 2{\cdot}4135 \qquad n_{\mathrm{y}} = 2{\cdot}4195 \qquad n_{\mathrm{gr}} = 2{\cdot}4278, \text{ Dx}^3.$$
$$n_{\mathrm{r}} = 2{\cdot}40845 \text{ Li} \qquad n_{\mathrm{y}} = 2{\cdot}41723 \text{ Na} \qquad n_{\mathrm{gr}} = 2{\cdot}42549 \text{ Tl, Schrauf}^4.$$

Becomes phosphorescent when exposed to light radiation or to an electric discharge in a vacuum tube. Positively electrified by friction; a non-conductor of electricity. Often shows abnormal double refraction, rarely distinctly uniaxial; also occasionally exhibits asterism.

**Var.**—1. *Ordinary.* In crystals usually with rounded faces and varying from those which are colorless and free from flaws (*first water*) through many faint shades of color, yellow the most common; rose, green, and blue shades are rare, especially the last; often full of flaws and hence of value only for cutting purposes.

The crystals often contain numerous microscopic cavities (Brewster), and some are rendered nearly black by their number; and around these cavities the diamond shows evidence, by polarized light, of compression. Sometimes crystals bear impressions of other crystals. Inclusions of small diamonds are common; also others of a green chloritic mineral, of hematite, of carbonaceous matter, of rutile (?) have been noted.

2. *Bort* or *Boort;* rounded forms with rough exterior and radiated or confused crystalline structure, often aggregated together, or enclosing crystals. No distinct cleavage obtainable. Hardness greater than in the crystals, and specific gravity less. Luster greasy. Color grayish to blackish. Translucent. There are gradual transitions from the perfectly crystallized diamond through the forms imperfectly crystallized or made up of several individuals to the true bort, as again between the bort and carbonado. Crystals or fragments of crystals useless as gems are also called bort in the trade.

10.

Bort.

3. *Carbonado* or *Carbon;* black diamond. Massive with crystalline structure, sometimes granular to compact, without cleavage. Hardness as great as, or greater than with the crystals and less brittle, but specific gravity less, due in part to slight porosity. Luster resinous to adamantine. Color black or grayish black. Opaque. Found occasionally in large masses up to 731 carats (Boutan). The true carbonado seems to graduate into the distinctly crystallized mineral. It is obtained chiefly from the province of Bahia, Brazil.

**Comp.**—Pure carbon, except in the anthracitic variety, carbonado, from which Rivot obtained on combustion an ash varying from 0·24 to 2·03 p. c. (Dx.).

**Pyr., etc.**—Unaffected by heat except at very high temperatures, when (in an oxygen atmosphere) it burns to carbon dioxide; out of contact with the air it is transformed into a kind of coke.[5] Not acted upon by acids or alkalies.

**Obs.**—The diamond occurs chiefly in alluvial deposits of gravel, sand or clay, associated with quartz, gold, platinum, zircon, octahedrite, rutile, brookite, hematite, ilmenite and also andalusite, chrysoberyl, topaz, corundum, tourmaline, garnet, etc.; the associated minerals being those common in granitic rocks or granitic veins. Also found in quartzose conglomerates, and further in connection with the laminated granular quartz rock or quartzose hydromica schist, *itacolumyte*, which in thin slabs is more or less flexible. This rock occurs at the mines of Brazil and the Urals; and also in Georgia and North Carolina, where a few diamonds have been found

It has been reported as occurring *in situ* in a pegmatyte vein in gneiss at Bellary in India (Chaper[7]). It occurs further in connection with an eruptive peridotyte in South Africa. It has been noted as grayish particles forming one per cent of the meteorite which fell at Novo-Urei, Govt. Pensa, Russia, Sept. 22, 1886; also in the form of black diamond (H. = 9) in the meteorite of Carcote, Chili[8]. (Cf also Cliftonite, p. 6.) Daubrée has pointed out the analogy existing between the occurrence of the diamond in South Africa (see below) and in meteorites, C. R., 110, 18, 1890.

India was the chief source of diamonds from very early times, as recorded by Sanskrit writers, down to the discovery of the Brazilian mines. There are three principal localities. The first in southern India, in the Madras presidency, embraces the districts of Kadapah (or Cuddapah), Bellary, Karnul, Kistna and Godavari. This region includes the famous "Golconda mines," the name, however, as stated by Ball, being to some extent a misnomer since it was merely the mart where the diamonds were bought and sold; it was originally applied to the capital now represented only by an abandoned fort near Hyderabad, and was thence extended to the surrounding district. A second region farther north covers a large tract between the Mahanadi and Godavari rivers; it includes the neighborhoods of Sambalpur and Wairagarh 80 miles southeast of Nagpur. Connected with this tract there are also two or three localities within the province of Chutia Nagpur, where diamonds have been found. A third region is in Bundelkhand, in central India, especially near the town of Panna. In addition to the preceding some diamonds have also been reported as obtained from a hill stream near Simla. The Indian diamonds were obtained in part from alluvial washings, in part from a quartzose conglomerate; at Panna this conglomerate (Rewah group) appears to be largely made up of fragments of a lower sandstone (Semri sandstone) which it has been suggested may represent the original matrix. The yield of the Indian mines, once so large, is now insignificant; it is mentioned, however, that one stone, weighing when rough 67 and as cut 25 carats, was found in 1881 in the Bellary district (Mallet).

The diamond deposits of Brazil have been worked since the early part of the 18th century, and have yielded very largely, although at the present time the amount obtained is small. The most important region was that near Diamantina in the province of Minas Geraes. It is situated along the crest and on the flanks of the Serro do Espinhaço, the mountain ridge which separates the São Francisco river and its branches, especially the Rio das Velhas on the west, from the Jequitinhonha, and the Doce on the east. The diamonds are obtained in part from river washings (*servicos do rio*), as conspicuously those of the bed of the Jequitinhonha, and in part from prairie washings (*servicos do campo*) as on the high ridge known as the heights of Curralinho. The river deposits (*cascalho*) consist of rolled quartz pebbles, mixed with or cemented by a ferruginous clay, which usually rests on a bed of clay. The most common associated minerals are rutile, octahedrite, brookite, hematite, martite, ilmenite and magnetite, with also quartz, cyanite, tourmaline, lazulite, gold, and many others as garnet, zircon, euclase, topaz, etc. The diamonds are most abundant in the *caldeiroes*, which seem to be large potholes or giant kettles. In the upper plateau diggings, the diamond occurs in part in a sort of conglomerate called the *gurgulho*, consisting of quartz fragments which are less rolled than those of the cascalho, as are also the accompanying minerals, which occur too in less abundance. At some of these mines, as those of São João da Chapada, the diamonds occur in clay (*barro*) which has been regarded as the result of the decomposition *in situ* of veins traversing the hydromica schist and itacolumyte formation. At Grão Mogor, farther north, diamonds have been obtained in the quartzose schist (called itacolumyte), though most of the specimens showing this association are fraudulent.

Other Brazilian localities are those of Bagagem and Abaethe, southwest of Diamantina; further the Lençåes and other mines of the province of Bahia, discovered in 1844, and finally on the Salobro and other branches of the Rio Pardo, two days' journey from the little port of Canavieiras, discovered in 1881.

The discovery of diamonds in South Africa dates from 1867. The diamonds occur in the gravel of the Vaal river, from Potchefstroom, capital of the Transvaal Republic, down to its junction with the Orange river, and thence along the latter stream as far as Hope Town. The principal *river diggings*, however, are along the Vaal river between Klip Drift and its junction with the Hart river. These have yielded well, including some large stones (as the "Stewart," and "Star of South Africa"), but are now comparatively unproductive, and have been nearly abandoned for the *dry diggings*, discovered in 1871.

These are chiefly in Griqualand-West, south of the Vaal river, on the border of the Orange Free State. There are here a number of limited areas approximately spherical or oval in form, with an average diameter of some 200 to 300 yards, of which Kimberley, De Beer's, Du Toit's Pan and Bultfontein are the most important. A circle 3½ miles in diameter encloses the four principal diamond mines.

The general structure is similar: a wall of nearly horizontal black carbonaceous shale with upturned edges enclosing the diamantiferous area. The upper portion of the deposit consists of a friable mass of little coherence of a pale yellow color, called the "yellow ground." Below the reach of atmospheric influences, the rock is more firm and of a bluish green or greenish color; it is called the "blue ground" or simply "the blue." This consists essentially of a serpentinous breccia: a base of hydrated magnesian silicate penetrated by calcite and opaline silica and enclosing fragments of bronzite, diallage, vaalite, also garnet, magnetite, and ilmenite, and less commonly smaragdite, pyrite, zircon, etc. The diamonds are rather abundantly disseminated through the mass, in some claims to the amount of 4 to 6 carats per cubic yard. The original rock seems to have been a peculiar type of peridotite which has been called *Kimberlyte.* These areas are believed to be volcanic pipes and the occurrence of the diamonds is obviously connected with the eruptive outflow, whether brought up from underlying rocks (as the large number of broken stones suggests) or formed by the action of heat upon the carbonaceous shales is uncertain.

Since the discovery of the South African mines in 1867, up to 1886, it has been estimated that the region has yielded stones aggregating upward of 30 million carats, of a value of from 200 to 250 million dollars; the yield for 1886 was over 3 million carats. (Jb. Min., **2**, 81, 1887.) Another estimate (1889) gives as the amount obtained from Kimberley's, De Beer's, Du Toit's Pan, and Bultfontein, between Sept. 1882 and the end of 1888, 18 million carats valued at nearly 100 million dollars; further, the entire production of the 18 years (1871–1889 incl.) is estimated as exceeding 40 million carats, or more than *eight tons*. The single mine of Kimberley is said to have yielded from 1871 to the end of 1885 about 17½ million carats (3½ tons), while the total amount of reef and ground excavated exceeded 20 million tons. (J. Soc. Arts, Oct. 4, 1889.) In 1889 the yield is stated to have been 3 million carats valued at over 20 million dollars.

Diamonds are also obtained in some quantity in Borneo, associated with platinum, etc.: thus on the west in the basin of the Kapoeas river near the town of Pontianak, and also in the southeast near Bandjermassim. In Australia, in alluvial deposits near Mudgee on the Cudgegong river and Bingera in the valley of the Horton river in New South Wales. Other localities, chiefly in connection with gold-washings, have been noted in Victoria, Queensland, and South Australia.

The Ural diamonds were discovered in 1829; they occur in the detritus along the Adolfskoi rivulet near Bisersk, where worked for gold, and also at other places.

In the United States a few crystals have been met with in Rutherford Co., N. C., and Hall Co., Ga.; they occur also at Portis mine, Franklin Co., N. C. (Genth); one handsome one, over ¾ in. in diameter, in the village of Manchester, opposite Richmond, Va.; one weighing 4⅓ carats was found in 1886 at Dysortville, McDowell Co., N. C.

In California, at Cherokee ravine, in Butte Co.; also in N. San Juan, Nevada Co.; in French Corral, one of 1⅛ carats; at Forest Hill, El Dorado Co., of 1½ carats; Fiddletown, Amador Co.; near Placerville. Reported from Idaho and from Oregon with platinum.

The largest diamond of which we have any knowledge is mentioned by Tavernier (1676) as in possession of the Great Mogul. As figured by him it had the form and size of half a hen's egg. It is stated to have weighed originally 790 carats, but there is some question as to this amount, and it may have been much less. Some authors believe that the Kohinoor is identical with this diamond, perhaps reduced in size by cleavage.* The Kohinoor weighed when brought to England 186 carats, and as recut as a brilliant, it weighs now 106 carats. Other famous diamonds are: the Orlov, 193 carats; the Regent or Pitt, 137 carats; the Florentine or Grand Duke of Tuscany, 133 carats; the Sancy, 53 carats. The "Star of the South," found in Brazil in 1853, weighed before and after cutting respectively 254 and 125 carats. Also famous because of the rarity of their color are the green diamond of Dresden, 40 carats, and the deep blue Hope diamond from India, weighing 44 carats. The history of the above stones and of others is given in many works on gems.

Of more recent stones from South Africa may be mentioned: The Victoria (or the Imperial) from one of the Kimberley mines, which weighed as found 457 carats; it was reduced to 230 carats by cutting, and later was recut; is now said to be a perfect brilliant of 180 carats. The Stewart weighed before and after cutting 288 and 120 carats respectively; the Star of South Africa, 83 and 46 carats. The Tiffany diamond, of a brilliant golden yellow, weighs, cut as a double brilliant, 125 carats. The colorless Porter Rhodes diamond, found at Kimberley in 1880, weighed 150 carats uncut. The Julius Pam diamond, 241½ carats (uncut) was found at the new Jagerfonstein United mine in 1889.

**Artif.**—Repeated attempts to form the diamond artificially have been unsuccessful; further, its method of formation in nature is a matter of vague hypothesis and speculation.

**Ref.**—[1] See the monograph of Rose-Sadebeck, Abh. Ak. Berlin, 1876; Zs. G. Ges., **30**, 605, 1878. Some of these planes (e.g., $\vartheta$, $\lambda$, $u$, $\Sigma$) must be regarded as doubtful because of their rounded faces. Cf. also Hirschwald, Zs. Kr., **1**, 212, 1877; Groth, Min. Samml. Strassb., 4, 1878.

[2] Wied. Ann., **1**, 462, 1877. [3] N. R., p. 7, 1867. [4] Wied. Ann., **22**, 424, 1884. [5] On the phenomena accompanying combustion, see Rose, Pogg., **148**, 497, 1873; Schrötter, Ber. Ak. Wien, **63** (1), 462, 1871; E. v. Baumhauer, l. c. [6] On inclusions, see Goeppert, Nat. Vh. Haarlem, 1864.

[7] On the occurrence of diamonds in *India*, see V. Ball, Geol. India, vol. **3**, pp. 1–50, 1881; Chaper, C. R., **98**, 113, 1884. In *Brazil*, of later writers, Gorceix, C. R., **93**, 981, 1881; Derby, Am. J. Sc., **24**, 34, 1882. In *South Africa*, Dunn, Q. J. G. Soc., **30**, 54, 1874, **33**, 879, 1877, **37**, 609, 1881; J. A. Roorda Smit, Arch. Néerl., **15**, 61, 1880; A. Moulle, Ann. Mines, **7**, 193, 1885; H. C. Lewis, Proc. Brit. Assoc., 1887. In the *Ural*, Kk., Min. Russl., **5**, 373, 1866. In *New South Wales*, Liversidge, Min. N. S. W., 116, 1888. *United States*, Kunz, Gems and Precious Stones of North America, 1890.

[8] Diamond in meteorites, Erofeyev and Lachinov, Vh. Min. Ges., **24**, 263, 1884; Sandb., Jb. Min., **2**, 173, 1889; Will and Pinnow, Ber. Ch. Ges., **23**, 345, 1890.

The general literature contains such books as the Edelsteinkunde of Klüge (1871), Schrauf (1869), Groth (1887); Burnham on Precious Stones (Boston, 1886). A good summary of all points in regard to the diamond is given by M. E. Boutan, Le Diamant, Paris, 1886, 323 pp., with numerous plates, etc.; pp. 312–320 give a very *full bibliography*.

CLIFTONITE. *Fletcher*, Min. Mag., **7**, 121, 1887.

In minute cubic crystals, sometimes with dodecahedral faces, or with those of a low tetra-

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* A discussion of this subject is given in Ball's Translation of Tavernier's Travels in India, London, 1889.

hexahedron. No cleavage. Faces often depressed. H. = 2·5. G. = 2·12. Color and streak black. Comp.—Carbon, like graphite, with which it agrees in characters except form and hardness. From the Youndegin, West Australia, meteoric iron, found in 1884. Named after R. B. Clifton, Professor of Physics at Oxford, England. Graphitic crystals, of cubo-octahedral form, occur in the Cocke Co., Tenn. (Sevier) iron.

Haidinger (Pogg., **67**, 437, 1846) described graphite crystals from the Magura, Arva meteorite, regarded by him as pseudomorphs after pyrite, but suggested by Rose to be pseudomorph after diamond, Beschr. Meteor., 40, 1864. Brezina has studied the Arva crystals further, identifying the forms (310, 320); he shows that they and the cliftonite are to be regarded as pseudomorphs after diamond, Ann. Mus. Wien, **4**, 102, 1889.

**2. GRAPHITE.** Plumbago, Molybdæna, Bly-Ertz, *Bromell*, Min., 58, 1739 [not Plumbago *Agric.*, *Gesner*]. Blyertz pt., Mica pictoria nigra, Molybdæna pt., *Wall.*, 131, 1747. Mica des Peintres, Crayon, *Fr. Trl.* Wall., 1753. Black Lead. Reissblei (= Drawing-lead) *Germ.* Molybdænum *Linn.*, 1768. Plumbago *Scheele* (proving its carbon nature), Ak. H. Stockholm, 1779. Plombagine *de Lisle*, Crist., 1783. Graphit *Wern.*, Bergm. J., 380, 1789, *Karst.*, Mus. Lesk., **2**, 339, 1789. Melangraphit *Haid.*, Handb., 513, 1845. Fer carburé *Fr.* Grafite, Pombaggine *Ital.* Grafita *Span.*

Rhombohedral. Axis $\dot{c} = 1{\cdot}3859$; $0001 \wedge 10\bar{1}1 = {}^*58°$ Kenngott[1].

**Forms**[2]: *c* (0001, *O*); *a* $(11\bar{2}0, i\text{-}2)$; *r* $(10\bar{1}1, R)$; *t* $(22\bar{4}6, \frac{2}{3}\text{-}2)$; *s* $(11\bar{2}1, 2\text{-}2)$. Angles: *ct* = 42° 44′; *cs* = 70° 10′; *rr′* = 94° 31′.

In six-sided tabular crystals striated ‖ edge *c/r*, faces rarely distinct. Commonly in imbedded foliated masses, also columnar or radiated; scaly or slaty; granular to compact; earthy. Rarely in globular concretions with radiated structure.

Cleavage: basal, perfect, *r* indistinct(?). Thin laminæ flexible, inelastic. Feel greasy. H. = 1–2. G. = 2·09–2·23; 2·229 Kenng. Luster metallic, sometimes dull, earthy. Color iron-black to dark steel-gray. Opaque. A conductor of electricity.

**Comp.**—Carbon, like the diamond; often impure from the presence of iron sesquioxide, clay, etc.

The purest forms usually yield upon combustion a little ash, from a fraction of one per cent upwards (see 5th Ed. p. 24). The specific gravity varies with the amount of impurities. Rammelsberg obtained as the residue upon ignition of purified graphite: Ticonderoga 0·24 p. c., Siberia (Alibert) 0·60, Arendal 0·64, Upernavik 1·97. Min. Ch., 1, 1875.

**Pyr., etc.**—At a high temperature some graphite burns more easily than diamond, other varieties (e.g. Ticonderoga) much less so (Rose, cf. Rg. l. c.). B.B. infusible; fused with nitre in a platinum spoon, deflagrates, converting the reagent into potassium carbonate, which effervesces with acids. Unaltered by acids.

**Obs.**—Graphite occurs in beds and embedded masses, laminæ, or scales, in granite, gneiss, mica schist, crystalline limestone. It is in some places a result of the alteration by heat of the coal of the coal formation. Sometimes met with in basaltic rocks, as with the metallic iron of Ovifak, Greenland. It is often observed in meteoric irons[3], either in nodules or in veins; the Sevier iron yielded a nodule weighing 92 grams. Cf. also Cliftonite.

A fine variety of graphite occurs at Borrowdale in Cumberland, in nests in trap, which occurs in clay slate; in Glenstrathfarrar in Inverness-shire, forms nests in gneiss; at Arendal in Norway, in quartz; at Pargas in Finland; in the Urals, Siberia, Finland; in various parts of Austria; at Passau in Bavaria; France; at Craigman, Ayrshire, it occurs in coal-beds which have been altered by contact with trap. In Irkutsk, in the Tunkinsk Mts., in eastern Siberia, the Alibert graphite mine affords some of the best graphite of the world and in large quantities (Kk. Min., **4**, 158, 1862). Large quantities are brought from the East Indies, especially from Ceylon.

Forms beds in gneiss, at Sturbridge, Mass.; also at North Brookfield, Brimfield, and Hinsdale, Mass.; in Cornwall, near the Housatonic, and in Ashford, Conn.; at Goshen, Sullivan Co., N. H.; also in Brandon, Vt.; at Grenville, Pr. Q., associated with titanite and wollastonite in granular limestone. Foliated graphite occurs in large quantities at Ticonderoga, on Lake George; also upon Roger's Rock, associated with pyroxene and titanite. Near Amity, Orange Co., N. Y., it is met with in white limestone, accompanying spinel, chondrodite, hornblende, etc.; at Rossie, St. Lawrence Co., N. Y., crystallized with iron ore, and in gneiss; at Hillsdale, Columbia Co., N. Y.; at Bloomingdale, N. J.; at Franklin, N. J., in rounded concretions radiated within; in Loudon Co., Va.; in Wake Co., N. C.; on Tiger River, and at Spartanburgh near the Cowpens Furnace, S. C.; also in Bucks Co., Penn., three miles from Attleboro', associated with wollastonite, pyroxene, and scapolite; and one and a half miles from this locality, it occurs in abundance in syenite, at Mansell's black-lead mine; also at Byers, Chester Co. A graphitic earth is mined for paint in Garland, Montgomery, Hot Spring and Polk Cos., Arkansas.

In California, at Sonora, Tuolumne Co., a deposit was formerly worked; occurs also at

Summit City, Alpine Co., near Fort Tejon, Kern Co., Tejunga, Los Angeles Co., Boser Hill, Fresno Co., and elsewhere. In Humboldt Co., Nevada; Beaver Co., Utah; Albany Co., Wyoming. A large deposit occurs at St. John, New Brunswick.

In the United States, the mines of Ticonderoga furnish most of the graphite mined commercially; 550,000 lbs were produced in 1883, 415,500 in 1886, 328,000 in 1887; also the Heron mine near Raleigh, N. C.. yielded 20,000 lbs. in 1887.

The name *black lead,* applied to this species, is inappropriate, as it contains no lead. The name graphite, of Werner, is derived from *γραφειν, to write.*

Artif.—A common product in iron furnaces.

Ref.—[1] Ticonderoga, Min. Not., xiv. 10; Ber. Ak. Wien, **13**, 1854. Nordenskiöld made the graphite from Ersby and Storgård monoclinic, Pogg., **96**, 110, 1855. The author's observations on Ticonderoga crystals confirm Kenngott. Hj. Sjögren has shown that the species must be regarded as hexagonal, Öfv. Ak. Stockh., **41**, No. 4, 29, 1884. [2] Cf. Kenng., l. c.—some doubt surrounds the measurements and planes because of the extraordinary flexibility of the material. Cf. Dx., Min., **2**, 23, 1874. [3] Meunier, Ann. Ch. Phys., **17**, 46, 1869; J. L Smith, Am. J. Sc., **11**, 388. 433, 1876.

**Tremenheerite**, *Piddington* Appears to be impure graphite, or is between coal and graphite; it is scaly in structure, and highly metallic in luster. Sent from Tenasserim by Capt. Tremenheere. Cf. Mallet, Min. India, p. 11, 1887.

**Graphitoid** from the mica schists and phyllytes of the Saxon Erzgebirge, is a form of combustible carbon, burning in the flame of a Bunsen burner. Analysis: C 99·76, H 0·24 = 100. Occurs as an incrustation, also impregnates the rock mass in fine bands. *Sauer*, Zs. G. Ges., **37**, 441, 1885.

**Schungite**, from the Olonets Government, Russia, is a similar amorphous form of carbon intermediate between anthracite and graphite, occurring in phyllite. Named (1884) from the locality Schunga. G. = 1·98. Contains 0·40 p. c. hydrogen. *Inostrantzev*, Jb. Min., **1**, 97, 1880; **1**, 92, 1886.

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## 2. Sulphur Group.

### 3. SULPHUR. Schwefel *Germ.* Svafvel *Swed.* Soufre *Fr.* Solfo *Ital.* Azufre *Span.*

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}81309 : 1 : 1{\cdot}90339$ Koksharov[1].

$100 \wedge 110 = 39^\circ\ 6'\ 51''$, $001 \wedge 101 = 66^\circ\ 52'\ 8''$, $001 \wedge 011 = 62^\circ\ 17'\ 1''$.

**Forms**[2]:

*a* (100, $i\text{-}\bar{\imath}$)
*b* (010, $i\text{-}\breve{\imath}$)
*c* (001, $O$)
*m* (110, $I$)

*k* (120, $i\text{-}\breve{2}$)
*u* (103, $\frac{1}{3}\text{-}\bar{\imath}$)
*e* (101, $1\text{-}\bar{\imath}$)
*v* (013, $\frac{1}{3}\text{-}\breve{\imath}$)

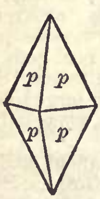
*w* (023, $\frac{2}{3}\text{-}\breve{\imath}$)
*n* (011, $1\text{-}\breve{\imath}$)
*ϑ* (031, $3\text{-}\breve{\imath}$)[6]
*ψ* (119, $\frac{1}{9}$)
*ω* (117, $\frac{1}{7}$)

*t* (115, $\frac{1}{5}$)
*o* (114, $\frac{1}{4}$)[4]
*s* (113, $\frac{1}{3}$)
*y* (112, $\frac{1}{2}$)
*p* (111, 1)

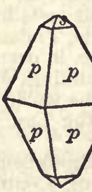
*δ* (221, 2)[6]
*γ* (331, 3)[3]
*β* (315, $\frac{3}{5}\text{-}\bar{3}$)[5]
*α* (313, $1\text{-}\bar{3}$)[6]
*r* (311, $3\text{-}\bar{3}$)

*l* (344, $1\frac{3}{4}$)
*z* (135, $\frac{3}{5}\text{-}\breve{3}$)
*x* (133, $1\text{-}\breve{3}$)
*q* (131, $3\text{-}\breve{3}$)

1.



2.



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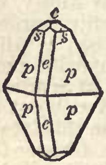

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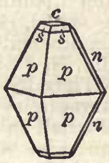

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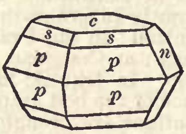

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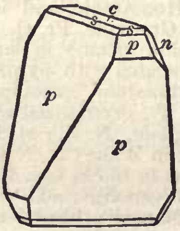

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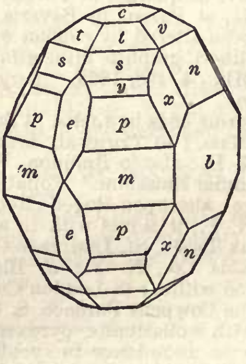


Figs. 1—5, simple forms. 6, Swoszowice, Zeph. 7, Phlegræan Fields, Scc.

$mm''' = 78^\circ\ 14'$
$kk' = 63^\circ\ 11'$

$cu = 37^\circ\ 58'$
$ce = 66^\circ\ 52'$
$uu' = 75^\circ\ 56'$
$ee' = 133^\circ\ 44'$

$vv' = 64^\circ\ 47'$
$ww' = 103^\circ\ 31'$
$nn' = 124^\circ\ 34'$

$c\psi = 18^\circ\ 32'$
$c\omega = 23^\circ\ 19'$
$ct = 31^\circ\ 6\tfrac{1}{2}'$
$co = 37^\circ\ 2'$
$cs = 45^\circ\ 10'$
$cy = 56^\circ\ 28'$
$cp = 71^\circ\ 39\tfrac{3}{4}'$
$c\delta = 80^\circ\ 35\tfrac{1}{2}'$
$c\gamma = 83^\circ\ 42'$
$c\beta = 55^\circ\ 30'$

$cr = 82^\circ\ 10\tfrac{1}{2}'$
$cz = 50^\circ\ 59'$
$cx = 64^\circ\ 4\tfrac{1}{2}'$
$cq = 80^\circ\ 48'$
$pp^{\text{iv}} = {}^*36^\circ\ 40\tfrac{1}{2}'$

$tt' = 47^\circ\ 16'$
$ss' = 66^\circ\ 46'$
$yy' = 80^\circ\ 35'$
$pp' = {}^*94^\circ\ 52'$
$zz' = 34^\circ\ 17'$

$xx' = 39^\circ\ 54'$
$qq' = 43^\circ\ 59'$

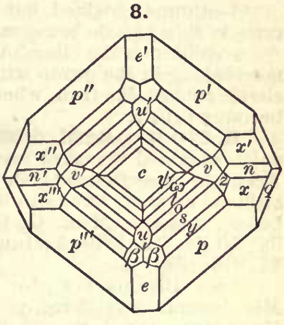
$tt''' = 38^\circ\ 3'$
$ss''' = 53^\circ\ 9'$
$yy''' = 63^\circ\ 27'$
$pp''' = 73^\circ\ 34'$
$\beta\beta''' = 24^\circ\ 54'$
$\alpha\alpha''' = 27^\circ\ 59'$
$rr''' = 30^\circ\ 2\tfrac{1}{2}'$

Twins[7]: tw. plane (1) *e* (101), sometimes as symmetrical penetration twins; (2) *m* rather rare; (3) *n* (011). Crystals commonly acute pyramidal (figs. 1–4); sometimes thick tabular ‖ *c*, also sphenoidal in habit (hemihedral ?), as in f. 6. Also massive, in spherical, reniform shapes, incrusting, stalactitic and stalagmitic; in powder.

Cleavage: *c*, *m*, *p* imperfect. Fracture conchoidal to uneven. Rather brittle to imperfectly sectile. H. = 1·5–2·5. G. = 2·05–2·09. Luster resinous. Color sulphur-yellow, straw- and honey-yellow, yellowish brown, greenish, reddish to yellowish gray. Streak white. Transparent to translucent. A non-conductor of electricity; by friction negatively electrified.

Optically +. Double refraction strong. Ax. plane ‖ *b*. Bx ⊥ *c*. Dispersion $\rho < v$. Axial angles, Dx.[8]:

8.



Rabbit Hole, Nev.[5]

$$2H_{a.r} = 103^\circ\ 18' \quad \beta_r = 2{\cdot}029 \quad \therefore 2V_r = 69^\circ\ 2'$$
$$2H_{a.y} = 104^\circ\ 12' \quad \beta_y = 2{\cdot}043 \quad \therefore 2V_y = 69^\circ\ 5'$$
$$2H_{a.bl} = 106^\circ\ 16' \quad \beta_{bl} = 2{\cdot}082 \quad \therefore 2V_{bl} = 69^\circ\ 13'$$

Refractive indices, Schrauf[9]:

$$\text{Na (D line)} \qquad \alpha = 1{\cdot}95047 \qquad \beta = 2{\cdot}03832 \qquad \gamma = 2{\cdot}24052$$

**Comp., Var.**—Pure sulphur; often contaminated with clay, bitumen, and other impurities.

Sometimes contains traces of Te, Se, etc.; an orange-red variety from Japan (*tellursulphur*, H. Carvill Lewis) gave Divers (Ch. News, 48, 284, 1883) S 99·76, Te 0·17, Se 0·06, As 0·01 = 100.

Sulphur may also be obtained in the laboratory in other allotropic forms, see below.

**Pyr., etc.**—Melts at 108° C., and at 270° burns with a bluish flame yielding sulphur dioxide. Insoluble in water, and not acted on by the acids, but soluble in carbon disulphide.

**Obs.**—The great repositories of sulphur are either beds of gypsum and the associate rocks, or the regions of active and extinct volcanoes. In the valley of Noto and Mazzaro, in Sicily; at Conil, near Cadiz, in Spain; Bex, in Switzerland; Cracow, in Poland, it occurs in the former situation; near Bologna, Italy, in fine crystals, embedded in bitumen. Sicily and the neighboring volcanic isles; the Solfatara, near Naples; the volcanoes of the Pacific ocean, *e.g.*, Kilauea on Hawaii, etc., are localities of the latter kind. The crystals from Girgenti in Sicily are sometimes two or three inches in diameter. It is also deposited from hot springs in Iceland; and in Savoy, Switzerland, Hanover, and other countries, it is met with in certain metallic veins; with lead ores near Müsen and similarly at Monte Poni, Sardinia. Near Cracow and in Upper Egypt there are large deposits, and in the island of Melos. Abundant in the Chilian Andes: also obtained from China, Japan, India, the Philippine islands, etc.

Sulphur is found near the sulphur springs of New York, Virginia, etc., sparingly; in many coal deposits and elsewhere, where pyrites is undergoing decomposition; in microscopic crystals at some of the gold mines of Virginia and North Carolina; in minute crystals on cleavage surfaces of galena, Wheatley mine, Phenixville, Pa.; in small masses in limestone on the Potomac, twenty-five miles above Washington; in an extensive bed at Lake Charles, Calcasieu parish, La.; Tom Green Co., Texas.

Some of the more important deposits in the western U. S. are the following: in Wyoming, in the Uintah Mts., 30 miles s.e. of Evanston; in Nevada near Humboldt House, Humboldt county; also in the same county at the Rabbit Hole Springs; Steamboat Springs, Washoe Co.; Columbus, Esmeralda Co. In southern Utah in large deposits, now mined, at Cove Creek, Millard county. In California, at the geysers of Napa valley, Sonoma Co.; in Santa Barbara in good crystals; near Clear lake, Lake Co., a large deposit, with a vein of cinnabar cutting through it. In the Yellowstone Park, in deposits and about the fumaroles

**Artif.**—Sulphur may also be obtained in the laboratory in several other allotropic forms. As given by Muthmann[11] they are as follows:

| | | à : b̄ : ċ | |
|---|---|---|---|
| *β-sulphur* | Monoclinic | 0·99575 : 1 : 0·99983 | β = 84° 14′ |
| *γ-sulphur* | " | 1·06094 : 1 : 0·70944 | β = 88° 13′ |
| *δ-sulphur* | " | ? | |
| *ε-sulphur* | Rhombohedral? | | |

*β*-sulphur is obtained from fusion in prismatic crystals, often acicular or flattened ‖ 100, with 100, 110, 210, 011, 111, 111; 110 ∧ 110 = 86° 28′. This form was early studied by Mitscherlich.[10]

*γ*-sulphur is obtained from fusion, also by separation by chemical means from hot saturated solutions of various compounds; habit thin tabular ‖ 010, with 100, 210, 012, 111, 1̄11.

*δ*-sulphur obtained, but with difficulty, by separation by chemical means at low temperatures in thin pseudo-hexagonal plates.

*ε*-sulphur is the black sulphur (schwarze Schwefel of Magnus) which, it has been suggested, may belong in the group with metallic selenium and tellurium. Sulphur is also obtained in an elastic rubber-like form when poured in the molten condition into water; this soon, however, becomes brittle.

**Ref.**—[1] Min. Russl., **6**, 368, 1874, on crystals from Germany, Spain, and Lower Egypt. Zepharovich obtained identical results on crystals from Swoszowice, Jb. G. Reichs., **19**, 225, 1869. Accurate measurements, showing some variation in the form, especially between natural and artificial crystals, have also been made by Mitscherlich, Ann. Ch. Phys., **24**, 264, 1823, and l. c. below; Scacchi, Mem. G. Campania, 1849; Schrauf. Ber. Ak. Wien, **41**, 794, 1860; Brezina, ib., **60** (1), 539, 1870; Arzruni, Zs. Kr., **8**, 338, 1884; Molengraaff, ib., **14**, 43, 1888; Busz, ib., **15**, 616, 1889.

[2] See Brezina, l. c., for early authorities; he adds *ω*, *q*, *r*, *l* on artif. cryst. [3] Friedländer, Min.-Samml. Strassburg, p. 262, 1878. [4] Fletcher, Phil. Mag., **9**, 186, 1880. [5] E. S. D., Rabbit Hole, Nev., Am. J. Sc., **32**, 389, 1886. [6] Molengraaff, Saba, W. I., l. c. [7] Cf. Rath, Pogg., Erg., **6**, 349, 1873; **155**, 41, 1875. [8] N. R., 93, 1867. [9] l. c. [10] Abh. Ak. Berlin, June 26, 1823. [11] Zs. Kr., **17**, 336, 1890; cf. also Rg., Kr. Ch., 45, 1881.

### 4. SELENSULPHUR.

Schwefelselen *Stromeyer*, Schw. J., **43**, 452, 1825. Selenschwefel. Volcanite *Adam*, Tabl. Min., 54, 1869. Eolide *Bombicci*, Min., **2**, 186, 1875.

An orange-red or reddish brownish mineral containing sulphur and selenium, but in unknown proportions; occurs in crusts with sal ammoniac on the islands Vulcano and Lipari. A seleniferous sulphur occurs at Kilauea (J. D. D.), also in Japan.

In the laboratory mixtures of sulphur and selenium have been obtained in crystallized form. Muthmann[1] concludes that up to 35 p. c. of Se, the form corresponds to the orthorhombic *α*-sulphur; between 35 and 66 p. c. to *γ*-sulphur; more than 66 p. c. to *α*-selenium, which, it is suggested, may correspond to *δ*-sulphur. Cf. sulphur and selenium.

**Ref.**—[1] Zs. Kr., **17**, 357, 1890, also earlier; Rathke, Lieb. Ann., **152**, 188, 1869, and Bettendorff and Rath, Pogg., **139**, 329, 1870.

### 5. SELENIUM.

Selen *Germ.* Selenio *Ital.*

Del Rio has stated that a mineral from Culebras, Mexico, which he first announced as selenide of mercury and zinc (riolite of Brooke), was later found by him to be a mixture of *native selenium* with selenides of mercury, etc. No confidence, however, can be attached to this conclusion. Cf. Phil. Mag., **4**, 113, 1828; **8**, 261, 1836.

In the laboratory selenium can be obtained in several allotropic forms. As given by Muthmann, they are:

| | | à : b : ċ | |
|---|---|---|---|
| *α-selenium* | Monoclinic | 1·63495 : 1 : 1·6095 | β = 75° 58′ |
| *β-selenium* | " | 1·5916 : 1 : 1·1352 | β = 86° 56′ |
| *γ-selenium* | Rhombohedral | | |

*α*-selenium is obtained from hot saturated solutions in carbon disulphide, crystals thin tabular ‖ 001, of hexagonal habit.

*β*-selenium is obtained by the evaporation of cold saturated solutions in carbon disulphide in short thick prisms, also tabular ‖ 100 and ‖ 001; this form was earlier measured by Mitscherlich.

*γ*-selenium or metallic selenium is rhombohedral, isomorphous with tellurium and occurs of similar habit. G. = 4·5. It is a conductor of electricity, but its resistance varies widely under the action of light.

It has been assumed that the monoclinic selenium of Mitscherlich was isomorphous with the early known monoclinic sulphur (Rg., Kr. Ch., 47, 65, 1881), but Muthmann's measurements fail to show any close resemblance in angle.

## 3. Tellurium-Arsenic Group.

**6. SELEN-TELLURIUM.** *E. S. Dana* and *H. L. Wells*, Am. J. Sc., **40**, 78, 1890.

Massive, with indistinct columnar structure.

Cleavage: hexagonal prismatic perfect. Brittle. H. = 2–2·5. Luster metallic. Color blackish gray. Streak black. Opaque.

**Comp.**—Tellurium and selenium in a ratio of nearly 3 : 2.

**Anal.**—H. L. Wells, after deducting 65·68 p. c. gangue, consisting largely of quartz with some barite:

Te 70·69 Se 29·31 = 100

**Pyr., etc.**—B.B. on charcoal fuses very easily, coloring the flame blue with a greenish tinge, and giving a strong characteristic odor of selenium; the sublimate near the assay is white, and dull reddish at a distance. In the closed tube a nearly black sublimate with a reddish edge above (Se), and below drops with metallic luster (Te). In the open tube a grayish sublimate with a reddish fringe, and above this volatile crystals of $SeO_2$; and below near the assay a copious sublimate of $TeO_2$, fusing into colorless drops.

**Obs.**—Occurs embedded in a gangue consisting largely of quartz with some barite at the El Plomo silver mine, Ojojona district, Tegucigalpa, Honduras.

**7. TELLURIUM.** Aurum paradoxum vel problematicum *Müller v. Reichenstein*, Phys. Arb., Wien, **1**, 1782. Sylvanite *Kirwan*, Min., **2**, 324, 1796. Gediegen-Tellur *Klapr.*, Beitr., **3**, 2, 1802. Tellur, Gediegen Sylvan *Germ.* Tellure natif auro-ferrifère *H.* Tellurio *Ital.*

Rhombohedral. Axis $\dot{c}$ = 1·3298; 0001 ∧ $10\bar{1}1$ = *56° 55½′ Rose[1].

**Forms:** *c* (0001, *O*); *m* ($10\bar{1}0$, *I*); *r* ($10\bar{1}1$, *R*); $r_1$ ($01\bar{1}1$, −1). Angles: $rr'$ = 93° 3′, $rr_1$ = 49° 32.

Crystals minute hexagonal prisms with *r*, or both *r* and *r*, and then hexagonal in aspect. Commonly massive, columnar to fine granular.

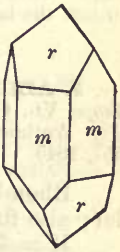
Cleavage: *m* perfect; *c* imperfect. Somewhat brittle. H. = 2–2·5. G. = 6·1–6·3. Luster metallic. Color and streak tin-white.

**Comp.**—Tellurium, with sometimes a little selenium, also gold, iron, etc. A specimen from Nagyág afforded Petz (Pogg., **57**, 477, 1842): Tellurium 97·215, and gold 2·785, with a trace of iron and sulphur. Another from Fačzebaja gave von Foullon: Te 93·31, Se 6·69 = 100, after deducting pyrite 12·40 p. c., quartz 1·10, Vh. G. Reichs., 269, 1884.

**Pyr.**—In the open tube fuses, giving a white sublimate of tellurium dioxide, which B. B. fuses to colorless transparent drops. On charcoal fuses, volatilizes almost entirely, tingeing the flame green, and giving a white coating.

**Obs.**—Occurs at the mine of Maria Loretto, near Zalathna, in Transylvania (whence the name *Sylvan* and *Sylvanite*), in sandstone, accompanying quartz, pyrite, and gold. In Boulder county, Colorado, at the Red Cloud mine; also in Magnolia district at the Keystone, Dun Raven, and other mines; in the Ballerat district at the Smuggler mine; in Central district at the John Jay mine in large masses. An impure variety from the Mountain Lion mine has been called *Lionite* (Berdell).

1.



Artif. cryst.

**Ref.**—[1] Rose, Abh. Ak. Berlin, 84, 1849; also on artif. cryst., *s* ($11\bar{2}1$ 2-2). Penfield obtained on brilliant artif. crystals, $rr'$ = 93° 10′ (priv. contr.); von Foullon, on Fačzebaja crystals, $mr$ = 33° 6′ (l. c.).

**8. ARSENIC.** Gediegen Arsenik, Arsen, Scherbenkobalt, *Germ.* Arsenic natif *Fr.* Arsenico nativo *Ital.*, *Span.*

Rhombohedral. Axis $\dot{c}$ = 1·4013; 0001 ∧ $10\bar{1}1$ = 58° 17′ Zepharovich[1].

**Forms:** *r* ($10\bar{1}1$, *R*); also artif. cryst., *c* (0001, *O*); *z* ($10\bar{1}4$, + ¼); *e* ($01\bar{1}2$, − ½); *h* ($03\bar{3}2$, − $\frac{3}{2}$). Angles: $rr'$ = *94° 54′, $cz$ = 22° 1½′, $ce$ = 38° 58½′, $ch$ = 67° 36′, $zz'$ = 37° 54′, $ee'$ = 66° 0½′.

Twins: tw. plane *e*. Natural crystals rare, usually acicular. Generally granular massive; sometimes reticulated, reniform, and stalactitic (Scherbenkobalt *Germ.*). Structure rarely columnar.

Cleavage: *c* highly perfect; *e* imperfect. Fracture uneven and fine granular. Brittle. H. = 3·5. G. = 5·63–5·73. Luster nearly metallic, Color and streak tin-white, tarnishing soon to dark gray.

**Comp.**—Arsenic, often with some antimony, and traces of iron, silver, gold, or bismuth.

Anal. Janovsky (Ber. Ak. Wien, **71** (1), 276, 1875) from Joachimsthal: As 90·91, Sb 1·56, Ni 4·64, Fe 2·07, $SiO_2$ 0·55, Mn, S *tr.* = 99·73. A variety from Valtellina, with G. = 5·777, contained 8·3 to 10·8 p. c. Sb, Bizzarri and Campani, Zs. Kr., **12**, 194, 1886.

**Pyr.**—B.B. on charcoal volatilizes without fusing, coats the coal with white arsenic trioxide, and affords a garlic odor; the coating treated in R. F. volatilizes, tingeing the flame blue.

**Obs.**—Native arsenic commonly occurs in veins in crystalline rocks and the older schists, and is often accompanied by ores of antimony, ruby silver, realgar, sphalerite, and other metallic minerals.

The silver mines of Freiberg, Annaberg, Marienberg, and Schneeberg afford it in considerable quantities; also Joachimsthal in Bohemia, Andreasberg in the Harz, Kapnik and Orawitza in Hungary, Kongsberg in Norway, Zmeov in Siberia in large masses, and at St. Maria aux Mines in Alsace; also Mt. Corna dei Darden, Valtellina, Italy. Abundant at the silver mines at Chañarçillo, and elsewhere in Chili; at the argentiferous mines of San Augustin, Hidalgo, Mexico, and Kapanga gold mine, New Zealand.

In the U. S. at Haverhill, N. H., in thin layers in dark-blue mica slate; also at Jackson, N. H.; on the E. flank of Furlong Mtn., Greenwood, Me. In nodules in a silver and gold mine near Leadville, Colorado. Watson Creek, Fraser R., British Columbia.

The name arsenic is derived from the Greek ἀρρενικόν or ἀρσενικόν, *masculine*, a term applied to orpiment or sulphide of arsenic, on account of its potent properties.

**Alt.**—Oxidizes on exposure, producing a black crust, which is a mixture of arsenic and arsenolite ($As_2O_3$), also producing pure arsenolite.

**Ref.**—[1] Joachimsthal, Ber. Ak. Wien, **71** (1), 272, 1875. Rose gives for artif. crystals, *rr'* = 94° 56′, Abh. Ak. Berlin, 82, 1849; Miller gives *rr'* = 94° 19′, Min. p. 117, 1852.

ARSENOLAMPRITE.—*C. Hintze*, Zs. Kr., **11**, 606, 1886. Arsenik-wismuth, *Werner;* arsenglanz, hypotyphit, *Breithaupt*.

Apparently an allotropic form of arsenic. Massive, with fibrous foliated structure, showing one cleavage. H. = 2. G. = 5·3–5·5. Luster metallic, brilliant. Color lead-gray. Streak black. Composition, nearly pure arsenic. Werner's mineral contained 3 p. c. bismuth; a specimen examined by Frenzel (Jb. Min., 677, 1874) gave: As 95·86, Bi 1·61, Fe 1·01, S 0·99 = 99·47. The original *arsenglanz* is from Marienberg, Saxony; also reported from Markirch in Alsace. Hintze obtained: As 98·43, Fe 1·00, $SiO_2$ 0·05; his mineral was from Copiapo, Chili. Differs from ordinary arsenic in structure, softness, lower specific gravity and brilliant luster; the last character suggests the name from λαμπρός *lustrous*.

**9. ALLEMONTITE.** Antimoine natif arsenifère *H.*, Tr. **4**, 281, 1822. Arsenikspiessglanz *Zippe*, Vh. Ges. Mus. Böhmen, 1824, 102. Arsenik-Antimon *Hausm.* Arseniure d'Antimoine *Fr.* Antimon-Arsen, Arsenantimon, *Germ.* Arsenical Antimony. Allemontit, *Haid.*, Handb., 557, 1845

Rhombohedral. In reniform masses and amorphous; structure curved lamellar; also fine granular.

H = 3·5. G. = 6·203, Rg. Luster metallic, occasionally splendent; sometimes dull. Color tin-white or reddish gray; often tarnished brownish black.

**Comp.**—$SbAs^3$ = Arsenic 65·2, antimony 34·8.

Analysis, Rg. (Pogg., **62**, 137, 1844), Allemont: Arsenic [62·15], antimony 37·85 = 100.

**Pyr.**—B.B. emits fumes of arsenic and antimony, and fuses to a metallic globule, which takes fire and burns away, leaving antimony trioxide on the charcoal.

**Obs.**—Occurs sparingly at Allemont; Přibram in Bohemia, associated with sphalerite, antimony, siderite, etc.; Schladming in Styria; Andreasberg in the Harz.

ANTIMONIAL ARSENIC.—An antimonial arsenic, containing, according to Schultz (Rg., Min. Ch., 984, 1860), 7·97 p. c. of antimony, occurs at the Palmbaum mine, near Marienberg in Saxony. A similar compound, consisting, according to Genth (Am. J. Sc., 33, 191, 1862), of arsenic 90·82 and antimony 9·18 (= 17 As + 1 Sb), occurs at the Ophir mine, Washoe Co., California, in finely crystalline, and somewhat radiated, reniform masses, between tin-white and iron-black on a fresh fracture, but grayish black on tarnishing, associated with arsenolite, calcite, and quartz.

**10. ANTIMONY.** Gediget Spitsglas (fr. Sahlberg) *v. Swab.*, Ak. H. Stockh., **10**, 100, 1748, *Cronst.*, Min., 201, 1758. Spiesglas, Gediegen Antimon *Germ.* Antimoine natif *Fr.* Antimonio nativo *Ital.*, *Span.*

Rhombohedral. Axis $\dot{c}$ = 1·32362; 0001 ∧ $10\bar{1}1$ = 56° 48′ 12″ Laspeyres'.

**Forms**[2]: *c* (0001, *O*); *r* (1011, *R*), *z* ($10\bar{1}4$, $+\frac{1}{4}$); *e* (0112, $-\frac{1}{2}$); also on artif. crystals[3] *a* ($11\bar{2}0$, *i*-2;, *s* ($02\bar{2}1$, − 2), *x* ($23\bar{5}8$, $-\frac{1^5}{8}$).

$cz = 20° 55'$ $ce = 37° 23'$ $zz' = 36° 1'$ $ee' = 63° 27'$

$cr = 56° 48'$ $cs = 71° 53'$ $rr' = {}^*92° 53' 10''$ $ss' = 110° 47\frac{1}{2}'$.

Twins[4]: tw plane *e*, in complex groups, fourlings and sixlings, also polysynthetic. Generally massive, lamellar and distinctly cleavable; also radiated; sometimes botryoidal or reniform with a granular texture.

Cleavage[3]: *c* highly perfect; *e* distinct; *s* sometimes distinct; *a* indistinct. Fracture uneven; very brittle. H. = 3–3·5. G. = 6·65–6·72. Luster metallic. Color and streak tin-white.

**Comp.**—Antimony, containing sometimes silver, iron, or arsenic.

**Pyr.**—B.B. on charcoal fuses, gives a white coating in both O. F. and R. F.; if the blowing be intermitted, the globule continues to glow, giving off white fumes, until it is finally crusted over with prismatic crystals of antimony trioxide. The white coating tinges the R. F. bluish green. Crystallizes readily from fusion.

Occurs in lamellar concretions in granular limestone near Sala in Sweden; at Andreasberg in the Harz; in argentiferous veins in gneiss at Allemont in Dauphiné; at Přibram in Bohemia; in Mexico; Huasco, Chili; Sarawak in Borneo; at Warren, N. J.; in Kern Co., Cal., between Kernville and Havilah; in argillyte at South Ham, Canada; in considerable quantities at Prince William parish, York Co., N. Brunswick, cf. Kunz, Am. J. Sc., **30**, 275, 1885.

**Alt.**—Oxidizes on exposure and forms valentinite ($Sb_2O_3$).

**Ref.**—[1] On artif. cryst., Zs. G. Ges., **27**, 574, 1875; Rose obtained $rr' = 92° 25'$ and $\dot{c} = 1·3068$, Abh. Ak. Berlin, 73, 1849. [2] Andreasberg, described by Römer, Jb. Min., 310, 1848, but shown by Rose to be complex twins, with tw. plane *e*. [3] Lasp. l. c. [4] Lasp. l. c., also Mgg., Jb. Min., **2**, 40, 1884, **1**, 183, 1886.

**11. BISMUTH.** Bisemutum, Plumbum cinereum, *Agric.*, Foss., 439, Interpr. 467. Antimonium femininum, Tectum Argenti, *Alchem.* Gediegen Wismuth *Germ.* Bismuth natif *Fr.* Bismuto nativo *Ital,, Span.*

Rhombohedral. Axis $\dot{c} = 1·3036$; $0001 \wedge 10\bar{1}1 = 56° 24\frac{1}{6}'$ Rose[1].

**Forms**[1]: *c* (0001, *O*); *r* ($10\bar{1}1$, *R*); *e* ($01\bar{1}2$, $-\frac{1}{2}$), *g* ($04\bar{4}5$, $-\frac{4}{5}$)[2], *s* ($02\bar{2}1$, − 2).
Angles: $rr' = {}^*92° 20'$, $ce = 36° 58'$, $cg = 50° 18'$, $cs = 71° 37\frac{1}{2}'$, $ee' = 62° 46'$, $gg' = 83° 33\frac{1}{2}'$, $ss' = 110° 33'$.

Twins: tw. plane *e*, sometimes produced by pressure[3]. Natural crystals rare and usually indistinct; artificial crystals in parallel groups of cube-like rhombohedrons. Usually in reticulated and arborescent shapes; foliated and granular.

Cleavage: *c* perfect, *s* less so; *e* indistinct. Sectile. Brittle, but when heated somewhat malleable. H. = 2–2·5. G. = 9·70–9·83. Luster metallic. Streak and color silver-white, with a reddish hue; subject to tarnish. Opaque.

**Comp., Var.**—Pure bismuth, with occasional traces of arsenic, sulphur, tellurium.

**Pyr., etc.**—B.B. on charcoal fuses and entirely volatilizes, giving a coating orange yellow while hot, and lemon-yellow on cooling. Fuses at 265° C. Dissolves in nitric acid; subsequent dilution causes a white precipitate. Crystallizes readily from fusion.

**Obs.**—Bismuth occurs in veins in gneiss and other crystalline rocks and clay slate, accompanying various ores of silver, cobalt, lead and zinc. It is most abundant at the silver and cobalt mines of Saxony and Bohemia, as at Schneeberg, Altenberg, Joachimsthal, Johanngeorgenstadt, etc., with various bismuth minerals at Meymac, Corrèze, France. Also at Modum and Gjellebäk in Norway, at Falun and elsewhere in Sweden. At Schneeberg it forms arborescent delineations in brown jasper. At Wheal Sparnon, near Redruth, and elsewhere in Cornwall, and at Carrock Fells in Cumberland, it is associated with ores of cobalt; formerly from near Alva in Stirlingshire; in a large and rich vein at the Atlas mine, Devonshire; at San Antonio, near Copiapo, Chili; Mt. Illampa (Sorata) and Tazna, in Bolivia. In Victoria; the New England district, at Glen Inness, Kingsgate and elsewhere, New South Wales.

At Lane's mine in Monroe, Conn., it is associated in small quantities with wolframite, scheelite, galena, sphalerite, etc., in quartz, also at Booth's mine, Monroe; occurs also at Brewer's mine, Chesterfield district, South Carolina; near Cummins City, Colorado; also in the placers of French Creek, Summit Co., and the Las Animas mine, Boulder Co. (Randall).

**Ref.**—[1] Abh. Ak. Berlin, 90, 1849. [2] Fletcher, Phil. Mag., **9**, 185, 1880. [3] Mgg., Jb. Min., **1**, 183, 1886.

**12. ZINC.** Zink *Germ.* Zinco *Ital.*

Rhombohedral. Axis $\dot{c} = 1\cdot35643$; $0001 \wedge 10\bar{1}1 = {}^*57° 26\cdot6'$ Williams and Burton[1].

**Forms**[1]: $c$ $(0001, O)$, $q$ $(40\bar{4}7, \frac{4}{7})$, $s$ $(20\bar{2}3, \frac{2}{3})$, $r$ $(10\bar{1}1, R)$, $t$ $(30\bar{3}2, \frac{3}{2})$, $u$ $(60\bar{6}1, 6)$; also doubtful $v$ $(50\bar{5}2, \frac{5}{2})$, $w$ $(80\bar{8}3, \frac{8}{3})$, $x$ $(40\bar{4}1, 4)$, $y$ $(13\cdot0\cdot\bar{13}\cdot3, \frac{13}{3})$; also the corresponding negative forms $r_1$ $(01\bar{1}1, -1)$, etc. Angles: $cq = 41° 50'$, $cs = 46° 14'$, $ct = 66° 57'$, $cu = 83° 55\frac{1}{2}'$, $rr_1 = 49° 51'$, $rr' = 93° 46'$.

Obtained artificially in hexagonal prisms with tapering pyramids, strongly striated horizontally—these are either barrel-shaped or tabular; also in complex crystalline aggregates.
Zinc also appears to crystallize in the isometric system, at least in various alloys[2]

Cleavage: $c$ perfect; also rhombohedral (?). Rather brittle. Percussion-figure parallel to edges $cr$ and $cr_1$. H. = 2. G. = 6·9–7·2. Luster metallic. Color and streak white, slightly grayish. Zinc fuses at 420° C. and boils at about 1000° C.

**Obs.**—Native zinc has been reported from near Melbourne, Australia (see 5th Ed. p. 17); also from northeastern Alabama, Am. J. Sc., **11**, 234, 1876; also with sphalerite in Shasta Co., Cal. Its existence in nature, however, needs confirmation.

**Ref.**—[1] Am. Ch. J., **11**, 219, 1889. Cf. also Rose, Pogg., **83**, 129, 1851. [2] Nöggerath, ibid., **39**, 323, 1836. Cf. Rose, ib., **85**, 293, 1852, **107**, 448, 1859. J. P. Cooke, Am. J. Sc., **31**, 194, 1861.

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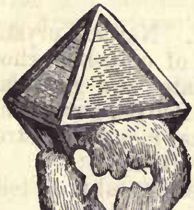
## 4. Gold Group.

**13. GOLD.** Sol Alchem. Gediegen Gold *Germ.* Gediget Guld *Swed.* Or natif *Fr.* Oro nativo *Ital.*, *Span.*

Isometric. Observed forms[1]:

$a$ $(100, i\text{-}i)$
$d$ $(110, i)$
$o$ $(111, 1)$
$h$ $(410, i\text{-}4)$[4]
$f$ $(310, i\text{-}3)$[5]
$k$ $(520, i\text{-}\frac{5}{2})$[3]
$e$ $(210, i\text{-}2)$
$\nu$ $(811, 8\text{-}8)$[4]
$\mu$ $(411, 4\text{-}4)$[6]?
$m$ $(311, 3\text{-}3)$
$n$ $(211, 2\text{-}2)$?
$t$ $(421, 4\text{-}2)$
$s$ $(321, 3\text{-}\frac{3}{2})$[2]
$x$ $(18\cdot10\cdot1, 18\text{-}\frac{9}{5})$[7]

1.



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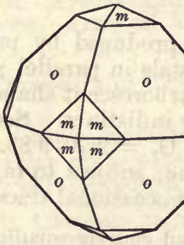

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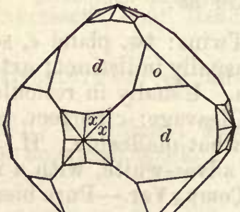

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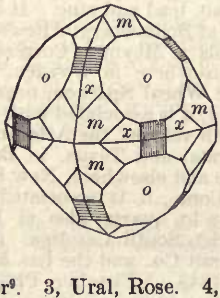

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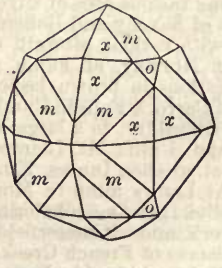
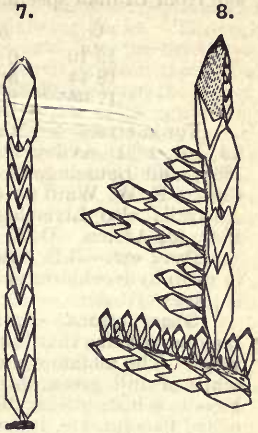


Fig. 1, California, Alger[9]. 3, Ural, Rose. 4, Ural, Helmhacker.
5, 6, California, E. S. D.[7]

Twins: tw. pl. *o*, often flattened ∥ *o*; also repeated and in complex groups[8]. Forms *d*, *o* common, also *m*. Crystals often elongated in direction of an octahedral axis, giving rise to rhombohedral forms (as *m* in f. 7, 8), and with parallel grouping to arborescent shapes; also in plates flattened ∥ *o*, and branching at 60° parallel either to the edges or diagonals of an *o* face. Skeleton crystals common; edges often salient, or again much rounded (f. 1, 4). Crystals irregularly distorted and passing into filiform, reticulated, dendritic shapes, and occasionally spongiform. Also massive and in thin laminæ; often in flattened grains or scales and rolled masses in sand or gravel.

Cleavage none. Fracture hackly. Very malleable and ductile. H. = 2·5–3. G. = 15·6–19·3, 19·33 when pure, Rose. Luster metallic. Color and streak gold-yellow, sometimes inclining to silver-white and rarely to orange-red. Opaque.

**Comp., Var.**—Gold, but usually alloyed with silver in varying amounts and sometimes containing also traces of copper or iron; rare varieties with palladium, rhodium and bismuth have been described.


7. 8.

White Bull Mine, Oregon, E. S. D.[7]

**Var.**—1. *Ordinary.* Containing up to 16 p. c. of silver. Color varying accordingly from deep gold-yellow to pale yellow, and specific gravity from 19·3 to 15·5. The ratio of gold to silver of 3 : 1 corresponds to 15·1 p. c. silver.

The purest gold which has been described is that from Mount Morgan, in Queensland, which has yielded 99·7 to 99·8 of gold, the remainder being copper with a little iron; silver is present only as a minute trace (Leibius, R. Soc. N. S. W., **18**, 37. 1884). Gold from Maryborough, Victoria, assayed 99·3 p. c. The purest Uralian specimen analyzed by Rose gave: Au 98·96, Ag 0·16. Cu 0·35. Fe 0·05 = 99·52, with G. = 19·10.

2. *Argentiferous; Electrum.* *Λευκός χρυσός Herod.; Ἤλεκτρον Homer, Strabo;* Electrum *Plin.*, **33**, 23. Oroche *Span.* Color pale yellow to yellowish-white; G. = 15·5–12·5. Ratio for the gold and silver of 1 : 1 corresponds to 36 p. c. of silver; 1½ : 1, to 26 p. c.; 2 : 1, to 21 p. c.; 2½ : 1. to 18 p. c. Pliny says that when the proportion of silver in the gold is one-fifth (= 20 p. c.) it is called *electrum.* The word in Greek means also *amber;* and its use for this alloy probably arose from the pale yellow color it has as compared with gold.

Electrum from Verespatak has afforded 38·7 p. c. Ag, from the Altai 38·4 p. c., from New Granada 17·6 to 35·1 p. c., from Peru 20 p. c. See 5th Ed. pp. 4, 5. The Bodie electrum has G. = 15·15, and contains Au 63·34, Ag 36·41 = 99·75. (Hanks, 4th Cal. Min. Rep., 191, 1884.) A specimen from Montgomery Co., Va., gave Porcher: Au 65·31, Ag [34·01], Cu 0·14, Fe 0·20, quartz 0·34 = 100; G. = 15·46, Ch. News, **44**, 189, 1881.

3. *Palladium-Gold.* *Porpezite* Fröbel. A variety from "Porpez," Brazil, containing 10 p. c. of palladium, besides some silver, color pale; also from Jacutinga and Condonga with 5 to 6 p. c. Pd. Porpez, however, is probably a corruption of Pompeõ, an old mining settlement near Sabara, in which vicinity palladium-gold occurs rather abundantly (Derby, priv. contr.). A specimen from Taguaril, Minas Geraes, gave Seamon: Au 91·06, Pd 8·21, Ch. News, **46**, 216, 1882

4. *Rhodium-Gold.* *Rhodite,* Adam, Tabl. Min., 83, 1869. Contains, according to del Rio (Ann Ch. Phys., **29**, 137, 1825), 34–43 p. c. of rhodium; G. = 15·5–16·8. Brittle. Requires reëxamination

5. *Bismuth-Gold.* Black gold *Austr. miners.* Maldonite *Ulrich,* Contrib. Min. Victoria, 1870. Corresponds to $Au_2Bi$ = Gold 65·5, bismuth 34·5 = 100. Newbery (l.c.) found Au 64·5, Bi 35·5; and McIvor Au 65·12, Bi 34·88 = 100, Ch. News. **55**, 191, 1887. Color pinkish silver-white, tarnishing on exposure. Luster metallic. Occurs in quartz from Nuggety Reef, Maldon, Victoria. Shepard's doubtful *bismuthaurite,* or bismuthic gold, may be similar.

California gold is mostly from 87 to 89 per cent fine, the average being 88 (U. S. Mint); many analyses, however, run up to 95 p. c. or higher, while others are classed with electrum. The gold from Chaudière, Canada, contains 10 to 15 p. c. silver. that of Nova Scotia is nearly pure. For the Australian gold (Miller, Liversidge), that from Victoria contains about 96 p. c. gold, 3·5 silver, and 0·5 of other metals. North of this in New South Wales the average fineness is 93·5 gold, 6 p. c. silver, the assays ranging mostly from 90 to 96. In Queensland the average is 87·25 p. c. gold and 12 p. c. silver, and for Maryborough 85 p. c. gold and 14 p. c. silver. Farther north the gold becomes richer again, that from the Palmer river washings containing but little silver; that of Mt. Morgan (as noted above) is nearly pure. The New Zealand gold of the Otago, or southern fields, is said to contain less than 6 p. c. silver with a little copper, that of Nelson 10 to 14 p. c. silver, and that of the Thames or northern fields over 30 p. c. silver (S. H. Cox, Trans. N. Z. Inst. **14**, 446, 1881).

Rose (l. c., p. 191) gives the following determinations of specific gravity and silver percentage from Uralian specimens.

| G. | Ag | G. | Ag | G. | Ag |
|---|---|---|---|---|---|
| 19·10 | 0·16 | 17·59 | 9·02 | 16·87 | 13·19 |
| 18·44 | 5·23 | 17·48 | 10·65 | 17·06 | 16·15 |
| 17·955 | 8·35 | 17·40 | 12·07 | 14·56 | 38·38 |

For analyses, see 5th Ed. pp. 4, 5, and authorities there mentioned, especially Rose, Pogg., **23**, 161, 1831; Avdeyev, ib., **53**, 153, 1841, for the Ural. Forbes, Phil. Mag., **29**, 129, **30**, 142, 1865; and Boussingault. Ann. Ch. Phys., **34**, 408, 1827, for So. America; also, Domeyko, Min. Chili. E. W. Ward (in Clarke's Researches in Southern Gold Fields, Sydney, 1860, p. 276) for Australia, also Liversidge, Min. N. S. W., 1888, pp. 14–17. Levol, Ann. Ch. Phys., **27**, 310, 1849, for Africa. O. C. Marsh, Am. J. Sc., **32**, 395, 1861, Nova Scotia.

**Pyr., etc.**—B.B. fuses easily. Not acted on by fluxes. Insoluble in any single acid; soluble in nitro-hydrochloric acid (aqua-regia), the separation is not complete if more than 20 p. c. Ag is present (Rose).

**Observations.**—Native gold is found, when *in situ*, with comparatively small exceptions, in the quartz veins that intersect metamorphic rocks, and to some extent in the wall rock of these veins. The metamorphic rocks thus intersected are mostly chloritic, talcose, and argillaceous schist of dull green, dark gray, and other colors; also, much less commonly, mica and hornblendic schist, gneiss, diorite, porphyry; and still more rarely, granite. A laminated quartzyte, called itacolumyte, is common in many gold regions, as those of Brazil and North Carolina, and sometimes specular schists, or slaty rocks containing much foliated specular iron (hematite), or magnetite in grains. A quartzose conglomerate is sometimes richly auriferous as in Transvaal. Less frequently calcite is the vein material, as at Minersville, Trinity Co., Cal. (Diller), and at many points in New South Wales (Liversidge). Gold has also been noted in scales embedded in serpentine.

The gold occurs in the quartz in strings, scales, plates, and in masses which are sometimes an agglomeration of crystals; and the scales are often invisible to the naked eye, massive quartz that apparently contains no gold frequently yielding a considerable percentage to the assayer. It is always very irregularly distributed, and never in continuous pure bands of metal, like many metallic ores. It occurs both disseminated through the mass of the quartz, and in its cavities, the larger masses and the finer crystallizations mainly in the latter.

The associated minerals are: pyrite, which far exceeds in quantity all others, and is generally *auriferous;* next, chalcopyrite, galena, sphalerite, arsenopyrite, each frequently auriferous; often tetradymite and other tellurium ores, native bismuth, native arsenic, stibnite, cinnabar, magnetite, hematite; sometimes barite, scheelite, apatite, fluorite, siderite, chrysocolla. The quartz at the surface, or in the upper part of a vein, is usually cellular and rusted from the more or less complete disappearance of the pyrite and other sulphides by decomposition; but below, it is commonly solid.

The gold of the world has been mostly gathered, not directly from the quartz veins (the "quartz reefs" of Australia), but from the gravel or sands of rivers or valleys in auriferous regions, or the slopes of mountains or hills, whose rocks contain in some part, and generally not far distant, auriferous veins; and such mines are often called *alluvial washings;* in California *placer-diggings*. Pliny speaks of the "bringing of rivers from the mountains, in many instances for a hundred miles, for the purpose of washing the débris," and this method of hydraulic mining has been carried on in California on a stupendous scale. (See Silliman, in Am. J. Sc., **40**, 10, 1865.) The auriferous gravel beds in California were of vast extent; those of the Yuba, an affluent of Feather River, varying from 80 to 250 feet in depth, and averaging probably 120 feet. Most of the gold of the Urals, Brazil, Australia, and all other gold regions, has come from such alluvial washings. At the present time, however, the alluvial washings are much less depended upon, in many regions all the gold being obtained direct from the quartz.

The alluvial gold is usually in flattened scales of different degrees of fineness, the size depending partly on the original condition in the quartz veins, and partly on the distance to which it has been transported. Transportation by running water is an assorting process; the coarser particles or largest pieces requiring rapid currents to transport them, and dropping first, and the finer (*float gold*) being carried far away—sometimes scores of miles. A cavity in the rocky slopes or bottom of a valley, or a place where the waters may have eddied, generally proves in such a region to be a *pocket* full of gold. The rolled masses when of some size are called *nuggets* (pepitas, *Span. S. A.*); in rare cases these occur very large and of great value. The Australian gold region has yielded many large nuggets; one of these found in 1858 weighed 184 pounds, and another (1869) weighed 190 pounds. In the auriferous sands, crystals of zircon are very common; also garnet and cyanite in grains; often also monazite, diamonds, topaz, corundum, iridosmine, platinum. The zircons are sometimes mistaken for diamonds.

Besides the free gold of the quartz veins and gravels, much gold is also obtained from auriferous sulphides or the oxides produced by their alteration, especially pyrite, also arsenopyrite, chalcopyrite, sphalerite, marcasite, etc. At Steamboat Springs, Nevada, gold is being deposited at the present time and probably from solution in alkaline sulphides, together with sulphides of arsenic, antimony, and mercury, and other compounds, chiefly sulphides. (Cf. Becker, U. S. Geol. Surv., Mon. **13**, 1888.)

Gold is widely distributed over the globe, and occurs in rocks of various ages, from the Archean to the Cretaceous or Tertiary. The schists that contain the auriferous veins were once sedimentary beds of clay, sand, or mud, derived from the wear of preëxisting rocks. Through some process, in which heat was concerned, the latter were metamorphosed into the hard crystalline schists, and at the same time upturned and broken, and often opened between the layers; and then all the fissures (cutting across the layers) and the openings (made between the layers, and therefore conforming with the lamination) became filled with the quartz veins containing gold. The quartz was brought into the intersecting fissures, and the interlaminated open spaces, from the rocks either side by means of the permeating heated waters (such heated waters, at a temperature much above that of boiling water, having great decomposing and solvent power, and carrying into cavities whatever they can gather up from the rocks). Thus, the gold of the veins was derived from the rocks adjoining the openings, either directly adjoining, or above, or below it; and it must therefore have been widely distributed through these rocks before they were crystallized and the veins were made, although in an infinitesimal quantity in a cubic foot. As schists with auriferous quartz veins were made in Archean time, so were they also in Paleozoic, especially at the great mountain-making epoch which closed the Paleozoic era; also later, in the Jurassic period, as in the Sierra Nevada; and still later in the Cretaceous and Tertiary periods, as in the Coast Ranges of California. But whatever the age of the schists and veins, the original source of all the Paleozoic and later gold deposits must be the original rocks of the globe, as they are the great source of the material of the shales and sandstones of subsequent ages, excepting such as may have been derived from aqueous solution or chemical deposition. Auriferous quartz veins are in no case *igneous* veins—that is, veins filled by injection of melted matter from below.

Gold exists more or less abundantly over all the continents in most of the regions of crystalline rocks, especially those of the semi-crystalline schists; and also in some of the large islands of the world where such rocks exist. In Europe, it occurs with silver ores in Hungary at Königsberg, Schemnitz, Kapnik, and Felsöbánya, and in Transylvania at Verespatak, often finely crystallized, and Nagyág chiefly with tellurium minerals; it occurs also in the sands of the Rhine, the Reuss, the Aar, the Rhone, and the Danube; on the southern slope of the Pennine Alps from the Simplon and Monte Rosa to the valley of Aosta; in Piedmont; in Spain, formerly worked in Asturias; in many of the streams of Cornwall; near Dolgelly and other parts of North Wales; in Scotland, in considerable amount, near Leadhills, and in Glen Coich and other parts of Perthshire; in the county of Wicklow, Ireland; in Sweden, at Edelfors; in Norway, at Kongsberg.

In Asia, gold occurs along the eastern flanks of the Urals for 500 miles, and is especially abundant at the Berezov mines near Ekaterinburg (lat. 56° 40′ N.); also obtained at Petropavlovski (60° N.); Nizhni Tagilsk (59° N.); Miask, near Zlatoust and Mt. Ilmen (55° N., where the largest Russian nugget was found), etc. Ekaterinburg is the capital of the mining district. The Urals were within the territory of the ancient Scythians; and the vessels of gold reputed, according to Herodotus, to have fallen from the skies, were probably made from Uralian nuggets. But the mines were not opened until 1819; soon after this they became the most productive in the world, and remained so until the discoveries in California. Siberian mines less extensive occur in the lesser Altai, in the Kolyvan mining region, about 1500 miles east of Ekaterinburg, near long. 100° E., between the Obi and Irtish, and 1500 miles west of the other great Siberian mining region, that of Nerchinsk, which is between 135° and 140° E., east of L. Baikal, including the Kara mines; among the localities are Zmeinogorsk and Ziryanovski, noted for affording the electrum. Asiatic mines occur also in the Cailas Mountains, in Little Thibet, Ceylon, and Malacca, China especially in the Amur district, Corea, Japan, Formosa, Sumatra, Java, Borneo, the Philippines, and other East India Islands; at numerous points in British India, especially Mysore.

In Africa, gold occurs at Kordofan, between Darfur and Abyssinia; also, south of the Sahara in western Africa, from the Senegal to Cape Palmas; in the interior, on the Somat, a day's journey from Cassen. Also in Transvaal in southern Africa, at Lydenburg, both quartz veins and alluvial washings, and at Eersteling; recently the Kaap gold fields in southeastern Transvaal have become very productive: the chief town of the region is Barberton. The quartz reefs of Witwatersrand in the immediate vicinity of Johannesburg, farther west, have also some very rich mines; here the gold occurs largely in a quartzose conglomerate.

In South America, gold is found in Brazil (where formerly the larger part of the annual produce of the world was obtained) along the chain of mountains nearly parallel with the coast, especially near Villa Rica, and in the province of Minas Geraes; in the U. S. of Colombia, at Antioquia, Choco, and Giron; Chili; in Bolivia, especially in the valley of the Rio de Tipuani, east of Sorata; sparingly in Peru. Also in Central America, in Honduras, San Salvador, Guatemala, Costa Rica, and near Panama; most abundant in Honduras, especially along the rivers Guyape and Jálan, in Olancho, while found also in the department of Yoro, and in southern Honduras.

In Australia, the principal gold mines occur along the streams in the mountains of N. S. Wales (S. E. Australia), and along the continuation of the same range in Victoria. It was discovered in N. S. Wales, near Bathurst, in the spring of 1851; and in August of the same year, the far richer deposits of Victoria became known; up to the present time these have yielded double the amount from the remainder of Australia with New Zealand and Tasmania included. Also obtained largely in Queensland, N. Australia, particularly at Mt. Morgan, Rockhampton district. Also occurs in Tasmania. In New Zealand there are three distinct gold fields, as already noted. Found also in New Caledonia.

In North America, there are numberless mines along the mountains of western America, and others along the eastern range of the Appalachians from Alabama and Georgia to Labrador, besides some in portions of the intermediate Archean region about Lake Superior. They occur at many points along the higher regions of the Rocky Mountains, in Mexico, in New Mexico, near Santa Fé, Cerillos, Avo, etc.; in Arizona, in the San Francisco, Wauba, Yuma, and other districts; in Colorado, abundant, the gold largely in auriferous pyrites, also in connection with tellurium minerals; also in Montana, the Black Hills of Dakota, Idaho especially the Cœur d'Alene district, also Utah. Along ranges between the summit and the Sierra Nevada, in the Humboldt region and elsewhere. Also in the Sierra Nevada, mostly on its western slope (the mines of the eastern being principally silver mines). The auriferous belt may be said to begin in the Californian peninsula. Near the Tejon pass it enters California, and beyond for 180 miles it is sparingly auriferous, the slate rocks being of small breadth; but beyond this, northward, the slates increase in extent, and the mines in number and productiveness, and they continue thus for 200 miles or more. Gold occurs also in the Coast ranges in many localities, but mostly in too small quantities to be profitably worked. The regions to the north in Oregon and in Washington and Alaska, with British Columbia, are at many points auriferous, and productively so, though to a less extent than California. The Cariboo region on the Fraser river, and the Cassiar district on the Stickeen have yielded considerable amounts. The Alaska quartz mines have been worked to some advantage, as also the gravels of the Yukon river.

The mines of California were first made known in 1849. They were for some years solely alluvial washings, but in 1852 quartz mining became prominent, and of late years placer mining has largely ceased. The quartz veins are often of great size. Some in the "Mariposa estate" average 12 feet, and in places expand to 40 feet in breadth. North of Mariposa county, the auriferous gravel, which has everywhere been a principal source of the gold thus far obtained, is very extensive. The thick deposits, often semi-indurated, have been washed down by vast streams of water thrown by the pressure of a column of water of 150 feet, that do the work of running off the earth and gravel, and gathering the gold in an incredibly short time. Much of the auriferous gravel formation is under a covering of volcanic rock, either tufa or lavas, which has to be underworked, in one way or another, to get out the gold, making what is called *table-mountain mining;* the flat tops of hard volcanic material giving a table-like look to the heights. See J. D. Whitney's Geol. California (review in Am. J. Sc., **41**, 231, 351, 1866), and, by the same author, The Auriferous Gravels of the Sierra Nevada of California, Cambridge, 1880 (Mem. Mus. Comp. Zoöl., **6**, No. 1). Also Precious Metal Deposits of the Western United States, by S. F. Emmons and G. F. Becker, 1885; and Min. Res. U. S., 1882–1888.

In eastern North America, the mines of the Southern United States produced before the California discoveries about a million of dollars a year. They are mostly confined to the States of Virginia, North and South Carolina, and Georgia, or along a line from the Rappahannock to the Coosa in Alabama. But the region may be said to extend north to Canada; for gold has been found at Albion and Madrid in Maine; Canaan and Lisbon, N. H.; Bridgewater, Vermont; Dedham, Mass. Traces occur also in Franconia township, Montgomery Co., Pennsylvania. In Virginia, the principal deposits are in Spottsylvania county, on the Rappahannock, at the United States mines, and at other places to the southwest; in Stafford county, at the Rappahannock gold mines, ten miles from Falmouth; in Culpepper county, at the Culpepper mines, on Rapidan river; in Orange county, at the Orange Grove gold mine, and at the Greenwood gold mines; in Goochland county, at Moss and Busby's mines; in Louisa county, at Walton's gold mine; in Buckingham county, at Eldridge's mine. In North Carolina, the gold region is mostly confined to the counties of Montgomery, Cabarrus, Mecklenburg, and Lincoln. The mines of Mecklenburg are principally vein deposits; those of Burke, Lincoln, McDowell, and Rutherford, are mostly in alluvial soil; the Davidson county silver mine has afforded gold. In Georgia, the Shelton gold mines in Habersham county have long been famous; and many other places have been opened in Rabun and Hall counties, Lumpkin county, at Dahlonega, etc.; and the Cherokee country. In South Carolina, the principal gold regions are the Fairforest in Union district, and the Lynch's creek and Catawba regions, chiefly in Lancaster and Chesterfield districts; also in Pickens county, adjoining Georgia. There is gold also in eastern Tennessee.

In Canada, gold occurs to the south of the St. Lawrence, in the soil on the Chaudière (where first found in 1835), and over a considerable region beyond, having been derived probably from the crystalline schists of the Notre Dame range (T. S. Hunt). In Nova Scotia, mines are worked near Halifax and elsewhere. Arsenopyrite is worked for gold at Deloro near Hastings, Ontario. Gold also occurs in the Port Arthur region, north of Lake Superior, and in the river-gravels of the Pacific slope, as before noted.

The world's yield of gold has very much increased in amount since the discovery of the mines of California. The mines of South America and Mexico were estimated by Humboldt, in the early part of the century, to yield annually $11,500,000, which considerably exceeds the present proceeds. It is estimated that, between 1790 and 1830, Mexico produced $31,250,000 in gold, Chili $13,450,000, and Buenos Ayres $19,500,000, making an average annual yield of $16,050,000. The Russian mines in 1846 produced about $16,500,000; and in 1851, $15,000,000, while for 1887 the amount is $20,000,000. The yield of California in 1849, the first year after the discovery of the gold, was $5,000,000. It rapidly increased from that year until 1853, when it was nearly $60,000,000. Since then it has diminished, and in 1866 the amount was but $27,000,000;

and from 1881 to 1888 it has varied from \$18,200,000 to \$12,750,000. Montana, Colorado, Nevada, Dakota, Idaho, etc., raise the total from the United States for the year 1888 to over \$33,000,000, with \$59,206,700 for silver in addition. The silver production in the U. S. for 1890 was \$70,485,714 (Leech). Australia produced \$60,000,000 for a numbers of years; but for 1863, 1864, 1865, the average was not above \$30,000,000, and from 1884 to 1887 the yield (including New Zealand and Tasmania) has varied from \$28,284,000 to \$26,425,000.

The following tables are taken from the report for 1891 of the ~~Director of~~ the U. S. Mint, Edward O. Leech; figures for recent years above from the reports of James P. Kimball.

World's Production of Gold for 1890.

| | | | |
|---|---|---|---|
| United States | \$32,845,000 | Austria-Hungary | \$1,398,500 |
| Australasia | 30,416,500 | Germany | 1,230,000 |
| Russia | 21,161,700 | Venezuela | 1,158,000 |
| Africa | 9,887,000 | Mexico | 767,000 |
| China | 5,330,000 | Brazil | 445,300 |
| Colombia | 3,695,000 | Japan | 254,000 |
| British India | 2,000,000 | Italy | 98,000 |
| Dominion of Canada | 1,495,000 | Peru | 69,000 |
| Chili | 1,436,600 | Other Countries* | 2,322,300 |
| | | Total | \$116,008,900 |

United States Production of Gold for 1890.

| | | | |
|---|---|---|---|
| California | \$12,500,000 | Alaska | \$762,500 |
| Colorado | 4,150,000 | Utah | 680,000 |
| Montana | 3,300,000 | Washington | 204,000 |
| Dakota, South | 3,200,000 | N. Carolina | 118,500 |
| Nevada | 2,800,000 | Georgia | 100,000 |
| Idaho | 1,850,000 | S. Carolina | 100,000 |
| Oregon | 1,100,000 | Michigan | 90,000 |
| Arizona | 1,000,000 | Other States† | 40,000 |
| New Mexico | 850,000 | | |
| | | Total | \$32,845,000 |

**Ref.**—[1] See Helmhacker for early authorities and description of crystals from Sysertsk, Min. Mitth., 1, 1877. Note also Rose, Pogg., **23**, 196, 1831, Reis. Ural, **1**, 198 et al., 1837, and Rath, Zs. Kr., **1**, 1, 1877. Dx. mentions also *z* (543).

[2] Lang, artif. cryst., Phil. Mag., **25**, 435, 1863. [3] Erem. Orenburg gold sands, Vh. Min. Ges., **5**, 402, 1870. see also Zs. Kr., **15**, 526, 1889. [4] Lewis, Phil. Mag., **3**, 456, 1877. [5] Fletcher, Berezov, ib., **9**, 185, 1880. [6] Werner, Jb. Min., **1**, 1, 1881. [7] E. S. D., California, Am. J. Sc., **32**, 132, 1886; Rose suggested the symbol 19·11·1 for this form; Naumann wrote it 15·9·1, Pogg., **24**, 385, 1832. [8] See Rath and Werner; Helmhacker following Avdeyev assumes inclined hemihedrism to explain twins. [9] Am. J. Sc., **10**, 102, 1850.

Gold Amalgam.—A variety of gold containing 57·4 p. c. mercury has been reported by Schneider as occurring in small grains with the platinum of Colombia, J. pr. Ch., **43**, 317, 1848. An amalgam from California, Mariposa region, gave Sonnenschein 61 p. c. of mercury with G. = 15·47, Zs. G. Ges., **6**, 243, 1854.

**14. SILVER.** Luna *Alchem.* Gediegen Silber *Germ.* Gediget Silfver *Swed.* Argent natif *Fr.* Argento nativo *Ital.* Plata nativa *Span.*

Isometric. Observed forms[1]:

*a* (100, *i-i*)
*d* (110, *i*)
*o* (111, 1)
*h* (410, *i*-4)
*f* (310, *i*-3)[5]
*k* (520, $i\text{-}\frac{5}{2}$)[3]
*e* (210, *i*-2)
δ (740, $i\text{-}\frac{7}{4}$)[5]
β (332, $\frac{3}{2}$)[6]
χ (552, $\frac{5}{2}$)[6]
φ (331, 3)[6]
*m* (311, 3-3)
*n* (211, 2-2)[4, 6]
*y* (751, $7\text{-}\frac{7}{5}$)[2, 6]

Twins: tw. plane *o*. Often in groups, branching at 60°, parallel to the diagonals of an octahedral face[7]. Crystals commonly distorted, elongated to acicular forms, often in reticulated or arborescent shapes; coarse to fine filiform. Also massive, in plates or superficial coatings, in flattened scales.

Cleavage none. Ductile and malleable. Fracture hackly. H. = 2·5–3. G. = 10·1–11·1, pure 10·5. Luster metallic. Color and streak silver-white, often gray to black by tarnish.

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* British Guiana \$1,125,000, Dutch Guiana 541,000, France 266,000, Central Am'n States 150,000, Argentine R. 82,000, Bolivia 59,800, Sweden 58,500, Gt. Britain 33,000, Turkey 7,000.

† Alabama, Maryland, Tennessee, Virginia, Vermont, Wyoming.

**Comp., Var.**—Silver, with some gold, copper, and sometimes platinum, antimony, bismuth, mercury (Kongsberg, 0·4 p. c. Forbes).

Var. 1. *Ordinary.* (*a*) crystallized; (*b*) filiform, arborescent; (*c*) massive.

2. *Auriferous; Küstelite.* Güldisch-Silber *Hausm.*, Handb. 104, 1813. Küstelit *Breith.*, B. H. Ztg., **25**, 169, 1866. Contains 10 to 30 p. c. of gold; color white to pale brass-yellow. There is a gradual passage to argentiferous gold (see GOLD).

The name *Küstelite* was given to an ore from Nevada, having the following characters: H. = 2–2·5; G. = 11·32–13·10; color silver-white, somewhat darker than native silver on a fresh surface; Richter found in it silver, lead, and gold, the first much predominating. From the Ophir mine, Nevada, in bean-shaped grains. Named after Guido Küstel.

3. *Cupriferous.* Contains sometimes 10 p. c. of copper.

**Pyr., etc.**—B.B. on charcoal fuses easily to a silver-white globule, which in O.F. gives a faint dark red coating of silver oxide; crystallizes on cooling; fusibility about 1050° C. Soluble in nitric acid, and deposited again by a plate of copper. Precipitated from its solutions by hydrochloric acid in white curdy forms of silver chloride.

**Obs.**—Native silver occurs in masses, or in arborescent and filiform shapes, in veins traversing gneiss, schist, porphyry, and other rocks. Also occurs disseminated, but usually invisibly, in native copper, galena, chalcocite, etc.; rarely in volcanic ashes (Mallet).

The mines of Kongsberg, in Norway, have afforded magnificent specimens of native silver, sometimes in very large masses. One in the collection at Copenhagen weighs upward of 5 cwt. The principal Saxon localities are at Freiberg, Schneeberg, and Johanngeorgenstadt; the Bohemian, at Přibram and Joachimsthal. It also occurs in small quantities with other ores, at Andreasberg in the Harz; in Suabia; Hungary; at Allemont in Dauphiné; in the Ural near Berezov; in the Altai, at Zmeov; and in some of the Cornish mines.

Mexico and Peru have been the most productive countries in silver. In Mexico, it has been obtained mostly from its ores, while in Peru it occurs principally native. A Mexican specimen from Batopilas weighed when obtained 400 pounds; and one from southern Peru (mines of Huantaya) weighed over 8 cwt. During the first eighteen years of the present century, more than 8,180,000 marks of silver were afforded by the mines of Guanajuato alone. In Durango, Sinaloa, and Sonora, in northern Mexico, are noted mines affording native silver.

In the United States it is disseminated through much of the copper of Michigan, occasionally in spots of some size, and sometimes in cubes, skeleton octahedrons, etc., at various mines; at Silver Islet and at Port Arthur on the north side of L. Superior. It has been observed at a mine a mile south of Sing Sing prison, which was formerly worked for silver; at the Bridgewater copper mines, New Jersey; at King's mine, Davidson Co., N. C.; rarely in filaments with barite at Cheshire, Ct. In Idaho, at the "Poor Man's lode," large masses of native silver have been obtained. In Nevada, in the Comstock lode, it is rare, and mostly in filaments; at the Ophir mine rare, and disseminated or filamentous; in California, sparingly, in Silver Mountain district, Alpine Co.; in the Maris vein, in Los Angeles Co.

In Colorado, at many localities, common at the Caribou mine, Boulder Co.; Georgetown, Clear Creek Co., with argentiferous ores; rather rare at the Leadville mines, less so in the Ruby district, Gunnison Co. In Montana, near Butte, Silver Bow Co., with manganese ores, also with pyrite and chalcopyrite. In Idaho, at the Jessie Benton mine, Atlanta. In Arizona, common at the Silver King mine, and with argentiferous ores elsewhere.

**Alt.**—Pseudomorphs, consisting of cerargyrite, red silver ore, argentite and stephanite.

**Ref.**—[1] See Sbk., Min. Mitth., **1**, 293, 1878; also Rose, Pogg., **23**, 196, 1831. [2] Dbr., artif. cryst., Lieb. Ann., **78**, 68, 1851. [3] Sbk., Kongsberg, l. c. [4] Groth, Min.-Samml. Strassburg, 13, 1878. [5] Fletcher, Chili, Phil. Mag., **9**, 184, 1880. [6] Rath, artif. cryst., Zs. Kr., **12**, 545, 1887. [7] On the various methods of grouping, see Sbk., l. c.; Rath, Zs. Kr., **3**, 12, 1878; Rose, l. c.

**15. COPPER.** Aes Cyprium *Pliny.* Venus *Alchem.* Gediegen Kupfer *Germ.* Gedlget Koppar *Swed.* Cuivre natif *Fr.* Rame nativo *Ital.* Cobre nativo *Span.*

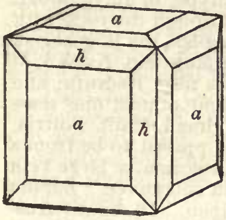
Isometric. Observed forms[1]:

| | | | | |
|---|---|---|---|---|
| *a* (100, *i-i*) | *f* (310, *i*-3) | *δ* (740, *i*-$\frac{7}{4}$)[4] | *m* (311, 3-3)[2] | *x* (12·3·2, 6-4)[1]? |
| *d* (110, *i*) | *k* (520, *i*-$\frac{5}{2}$)[2] | *l* (530, *i*-$\frac{5}{3}$)[4] | *n* (211, 2-2)[1] | *z* (11·6·1, 11-$\frac{11}{6}$)[1] |
| *o* (111, 1) | *ϵ* (730, *i*-$\frac{7}{3}$)[4] | *ω* (511, 5-5)[4] | *t* (421, 4-2) | *y* (18·10·5, $\frac{18}{5}$-$\frac{9}{5}$)[3] |
| *h* (410, *i*-4)[4] | *e* (210, *i*-2) | *μ* (411, 4-4)[4] | *v* (531, 5-$\frac{5}{3}$)[4] | |

Twins: tw. pl. *o*, very common (f. 7); often flattened in direction of twinning axis, also elongated ‖ diagonal of twinning plane to acute spear-shaped forms (figs. 9, 10, 11), sometimes to thin plates. Forms with rhombohedral symmetry about the octahedral axis common especially with twins (f. 8). Often in complex groups branching at 60° in the direction of (1) the edges, and (2) the diagonals of the octahedral face, which is usually the twinning plane, the lower side then in twinning position to the upper, cf. figs. 12, 13, the former ideal; also grouped after more complex methods; sometimes in fivelings[5]. In parallel groupings of simple forms extended in the direction of the cubic axes (f. 14).

The tetrahexahedrons *e, h, k, l*, the most common forms both in twins and simple crystals. Crystals often with cavernous faces; also with elevations, especially octahedral plates hexagonal (*e*) or scalenohedral (*h*, etc.) in form. Crystals often irregularly distorted and passing into twisted bands of indistinct form and thus into wire-like forms. Often filiform and arborescent. Massive; as sand.

1.



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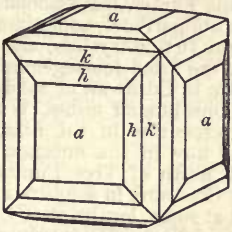

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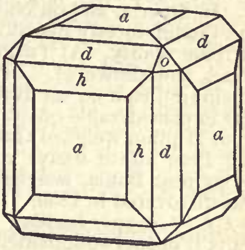
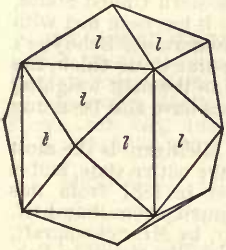


4.



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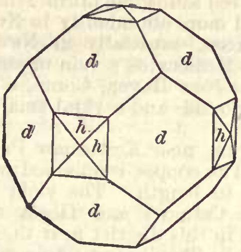
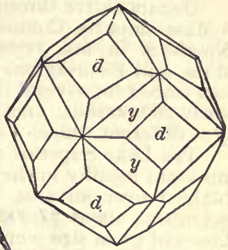


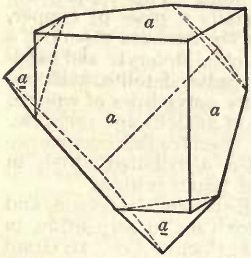
6.



10.

11.

7.



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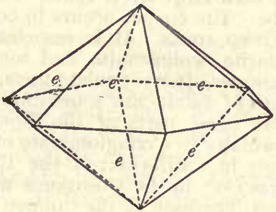

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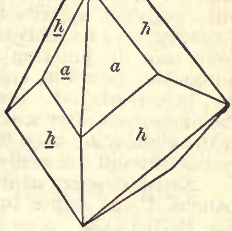

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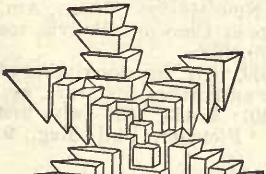

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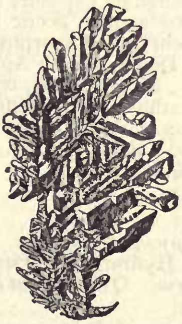

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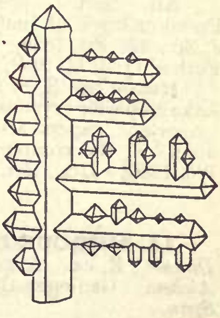


Copper crystals from Lake Superior[1].

Cleavage none. Fracture hackly. Highly ductile and malleable. H. = 2·5–3. G. = 8·8–8·9, 8·838 Whitney. Luster metallic. Color copper-red. Streak metallic shining. Opaque. An excellent conductor for heat and electricity.

**Comp.**—Pure copper; often containing some silver, bismuth, mercury, etc.

**Pyr., etc.**—B.B. fuses readily; on cooling becomes covered with a coating of black oxide. Dissolves readily in nitric acid, giving off red nitrous fumes, and produces a deep azure-blue solution with ammonia. Fusibility 780° C.

**Obs.**—Copper occurs in beds and veins accompanying its various ores, especially cuprite, malachite and azurite; also with sulphides, chalcopyrite, chalcocite, etc. It is often abundant in the vicinity of dikes of igneous rocks; also in clay slate and sandstone.

In Siberia, and on Nalsoe, one of the Färöer, it is associated with mesotype, in amygdaloid, and though mostly disseminated in minute particles, sometimes branches through the rock with extreme beauty. At Turinsk, in the Ural, in fine crystals; also at Nizhni Tagilsk, the Bogoslovsk mines, and elsewhere. In Germany, at the Friedrichssegen mine, near Oberlahnstein, Nassau; at Rheinbreitbach on the Rhine. Common in Cornwall at many of the mines near Redruth; and also in considerable quantities at the Consolidated mines, Wheal Buller, and others; one mass from Mullion weighed three tons. In serpentine in the Lizard district. Brazil, Chili, Bolivia, and Peru afford native copper; a mass now in the museum at Lisbon, supposed to be from a valley near Bahia, weighs 2616 pounds; north of Tres Puntos, desert of Atacama, a large vein was discovered in 1859. In Bolivia, at Corocoro, in sandstone, and called in commerce "*Barilla de Cobre*" (copper barilla). Also found at some localities in China and Japan. In South Australia it occurs abundantly at Wallaroo on Yorke Peninsula and other mines near Adelaide; at Bathurst and elsewhere in New South Wales.

Occurs native throughout the red sandstone (Jura-Trias) region of the eastern United States, in Massachusetts, Connecticut, and more abundantly in New Jersey, where it has been met with sometimes in fine crystalline masses, especially at New Brunswick, Somerville, Schuyler's mines, and Flemington. Near N. Brunswick a vein or sheet of copper, a line or so thick, has been traced for several rods. Near New Haven, Conn., a mass was found in the drift weighing nearly 200 pounds; another of 90 pounds and several smaller isolated masses have also been dug up at different times.

The Lake Superior copper region, near Keweenaw Point, in northern Michigan, is the most important locality in the world. The copper is obtained practically all in the native state, and is obtained over an area 200 miles in length. The yield of native copper in 1887 from this region was about 37,000 tons, the Calumet and Hecla mine yielding much more than half. Masses of great size were observed in this district near the Ontanagon river, by Mr. Schoolcraft, in 1821. (Am. J. Sc., **3**, 201, 1821.) The largest single mass yet found was discovered in February, 1857, in the Minnesota mine, in the belt of conglomerate which forms the foot-wall of the vein. It was 45 feet in length, 22 feet at the greatest width, and the thickest part was more than 8 feet. It contained over 90 p. c. copper, and weighed about 420 tons. This copper contains silver, sometimes in visible grains, lumps, or strings, and occasionally a mass of copper, when polished, appears sprinkled with large silver spots, resembling, as Dr. Jackson observes, a porphyry with its feldspar crystals. The copper occurs in both amygdaloidal doleryte and sandstone, near the junction of these two rocks. It is associated with prehnite, datolite, analcite, laumontite, pectolite, epidote, chlorite, wollastonite, and sometimes coats amygdules of calcite, etc., in amygdaloid. Strings of copper often reticulate through crystals of analcite and prehnite. Pseudomorphs after scalenohedrons of calcite are sometimes met with. Besides this occurrence in the vicinity of trap, it is also in some parts of the Keweenaw region distributed widely in grains through the sandstone, especially in a conglomerate of quartz and jasper pebbles.

Native copper occurs sparingly in California; at the Union and Keystone, Napoleon and Lancha Plana mines in Calaveras Co.; in the Cosumnes mine, Amador Co.; in serpentine, in Sta. Barbara Co. Also in Arizona, common at the Copper Queen mine, Cochise Co. In Grant Co., N. Mexico, at the Santa Rita and other mines.

**Alt.**—Native copper is readily altered on exposure to cuprite, malachite, sometimes to azurite. Pseudomorphs of native copper *after* azurite occur in Grant Co., New Mexico (Yeates, Am. J. Sc., **38**, 405, 1889); also replacement pseudomorphs after aragonite at Corocoro, Bolivia, see Forbes, Q. J. G. Soc., **17**, 45, 1861; Domeyko, 6th App. Min. Chili, 6, 1878.

**Ref.**—[1] See E. S. D., Am. J. Sc., **32**, 413, 1886, or Zs. Kr., **12**, 569, 1887, for description of Lake Superior crystals, twinning, methods of grouping, etc.; also for authorities, literature, etc. Important papers are the following: [2] Rose, Reis. Ural, **1**, 313, 401; **2**, 453, 1837, who first described the complex groups; also [3] Rath, Zs. Kr., **2**, 169, 1878; [4] Fletcher, Phil. Mag., **9** 180, 1880; [5] Lsx., Ber. nied. Ges., **39**, 95, 1882.

**16. MERCURY.** *Χυτός ἄργυρος Theophr.* *Ὑδράργυρος καθ' ἑαυτὴν* [native] *Dioscor.*, E, cx. Argentum vivum, Hydrargyros, *Plin.* **33**, 32, 20, 41. Quicksilver. Mercurius *Alchem.* Gediegen Quecksilber *Germ.* Qvicksilfver *Swed.* Mercure natif *Fr.* Mercurio *Ital., Span.*

Liquid. Occurs in small fluid globules scattered through its gangue.

G. = 13·596 Regnault. Luster metallic, very brilliant. Color tin-white. Opaque.

**Comp.**—Pure mercury (Hg); with sometimes a little silver.

**Pyr., etc.**—B.B. entirely volatile, vaporizing at 350° C. Becomes solid at − 40° C., crystallizing in regular octahedrons with cubic cleavage; G. = 14·4. Dissolves readily in nitric acid.

**Obs.**—Mercury in the metallic state is a rare mineral; the quicksilver of commerce is obtained mostly from cinnabar. The rocks affording the metal and its ores are chiefly clay shales or schists of different geological ages. Also found in connection with hot springs in New Zealand, Iceland (?), and in California and Nevada.

At Cividale, in Venetian Lombardy, it is found in a marl regarded as a part of the Eocene nummulitic beds. Mercury has been observed occasionally in *drift;* and near Eszbetek, in Transylvania, and also Neumarkt, in Galicia, springs, issuing from the Carpathian sandstone, sometimes bear along globules of mercury. Its most important mines are those of Idria, in Carniola, and Almaden in Spain. At Idria it occurs interspersed through a clay slate, from which it is obtained by washing. It is found in small quantities at Wolfstein and Mörsfeld, in the Palatinate; in Carinthia, Hungary, Peru, and other countries; also at Peyrat le Chateau, in the department of the Haute Vienne, in a disintegrated granite, unaccompanied by cinnabar, also similarly near Montpellier in southern France; in California, at various cinnabar mines, especially at the Pioneer mine, in the Napa Valley. where quartz geodes have been found containing several pounds of mercury. Occurs with gold near Johannesburg, Transvaal, S. Africa; at Pakaraka, Bay of Islands, New Zealand.

On the distribution of mercury and cinnabar with a detailed account of the various localities, see Becker, U. S. G. Surv., Mon. **13**, 1888.

**17. AMALGAM.** Quicksilfwer amalgameradt med gediget Silfwer (fr. Sala) *Cronst.*, 189, 1758. Natürlich Amalgam, Silberamalgam, *Germ.* Amalgam natif *de Lisle*, **1**, 420, 1783. Mercure argental *H.* Pella natural *Del Rio.* Amalgama *Ital.*, *Span.* Plata mercurial *Span.*

Arquerite *Berth.*, *de B.*, *& Duf.*, C. R., **14**, 567, 1842, in Rep. on Art. by *Domeyko*, Ann. Mines, **20**, 268, 1841. Bordosite *Domeyko*, Min. Chili, 3d Ed., p. 362. Kongsbergite *Pisani*, C. R., **75**, 1274, 1872.

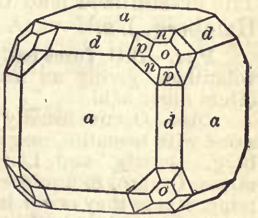
Isometric. Observed forms[1]:

*a* (100, *i-i*) *d* (110, *i*) *o* (111, 1) *f* (310, *i*-3) *e* (210, *i*-2) *p* (221, 2) *n* (211, 2-2) *s* (321, 3-$\frac{3}{2}$)

Crystals often highly modified; common habit dodecahedral. Also massive in plates, coatings, and embedded grains.

Cleavage: *d* in traces. Fracture conchoidal, uneven. Rather brittle to malleable. H. = 3–3·5. G. = 13·75–14·1. Luster metallic, brilliant. Color and streak silver-white. Opaque.

1.



Moschellandsberg
Lévy–Schrauf.

**Comp.**—(Ag,Hg), silver and mercury, varying from $Ag_2Hg_3$ to $Ag_{36}Hg$.

Percentage composition for $Ag_2Hg_3$ = silver 26·4, mercury 73·6 = 100; AgHg = silver 35·0, mercury 65·0 = 100. Also $Ag_5Hg_3$ = silver 52·7; $Ag_3Hg$ = silver 61·8; $Ag_4Hg$ = silver 68·3; $Ag_6Hg$ = silver 76·4; $Ag_{12}Hg$ = silver 86·6; $Ag_{36}Hg$ = silver 95·1.

**Var.**—1. *Ordinary amalgam*, $Ag_2Hg_3$ or AgHg. In crystals often highly modified, rather brittle. No recent analyses have been published. Also $Ag_5Hg_3$ (anal. 5), etc.

2. *Arquerite*, $Ag_{12}Hg$. G. = 10·8. Malleable and soft. Anal. 11–13.

3. *Kongsbergite*, $Ag_{32}Hg$ or $Ag_{36}Hg$. In crystals. Anal. 16, 17; anal. 18 gives $Ag_{39}Hg$.

**Anal.**—1, Cordier, J. Mines, **12**, 1, 1802. 2, Klaproth, Beitr., **1**, 182. 1795. 3, 5, 7, 8, 10, 13, 15, Domeyko, Min. Chili, 3d Ed., 1879, anal. 15 by M. Silva. 4, Nordström, G. För. Förh., **5**, 715, 1881. 6, Pufahl, Zs. G. Ges., **34**, 817, 1882. 9, 14, Flight, Phil. Mag., **9**, 146, 1880. 11, H. G. Hanks, Dana Min., App. III, 4. 12, 16, 17, Pisani, l. c. 18, Darapsky, Jb. Min., **1**, 67, 1888.

| | | Ag | Hg |
|---|---|---|---|
| 1. | Allemont? | 27·5 | [72·5] = 100 |
| 2. | Moschellandsberg | 36·0 | [64·0] = 100 |
| 3. | Rosilla mines, Chili | 43·6 | [56·4] = 100 |
| 4. | Sala, Sweden | 46·30 | 51·12 gangue 2·03 = 99·45 |
| 5. | Rosilla mines | 53·3 | [46·7] = 100 |
| 6. | Friedrichssegen, G. = 12·703 § | 56·70 | 43·27 Cu *tr.* = 99·97 |
| 7. | Rosilla mines | 65·1 | [34·9] = 100 |
| 8. | Bordos, Chili, *Bordosite* | 69·21 | 30·76 = 99·97 |
| 9. | Kongsberg | 75·90 | 23·06 insol. 0·49 = 99·45 |
| 10. | N. Chili | 79·4 | [20·6] = 100 |
| 11. | Br. Columbia | 86·15 | 11·90 $SiO_2$ 0·45 = 98·50 |
| 12. | Kongsberg | 86·3 | 13·7 = 100 |

| | | Ag | Hg | |
|---|---|---|---|---|
| 13. | Arqueros, *Arquerite* .......... | 86·5 | 13·3 | = 99·8 |
| 14. | Kongsberg..... ............... | 92·45 | 7·02 gangue 1·50 | = 99·97 |
| 15. | Rodaito, Chili.... ........... | 94·4 | [5·6] | = 100 |
| 16. | Kongsberg, *Kongsbergite*...... $\frac{2}{2}$ | 94·94 | [5·06] | = 100 |
| 17. | " " ...... $\frac{2}{2}$ | 95·26 | [4·74] | = 100 |
| 18 | Chili.... ................ .... | 95·8 | 3·6 | = 99·4 |

Darapsky (l. c.) found the amount of mercury to vary somewhat widely even in different samples from the same specimen.

**Pyr., etc.**—B.B. on charcoal the mercury volatilizes and a globule of silver is left. In the closed tube the mercury sublimes and condenses on the cold part of the tube in minute globules. Dissolves in nitric acid. Rubbed on copper it gives a silvery luster.

**Obs.**—From the Palatinate at Moschellandsberg, in fine crystals, and said to occur where the veins of mercury and silver intersect one another; at Friedrichssegen near Oberlahnstein, Nassau. Also from Rosenau in Hungary, Sala in Sweden, Kongsberg in Norway, Allemont in Dauphiné, Almaden in Spain. In S. America, from the mines of Arqueros, Coquimbo, Chili (*arquerite* pt.); Rodaito near Arqueros; Rosilla, prov. Atacama; Bordos (*bordosite*). From Vitalle Creek, Br. Columbia (*arquerite*).

**Artif.**—Various artificial amalgams are known, cf. Rg., Kr. Ch., 170, 1881.

**Ref.**—[1] See Schrauf, Atlas, Tf. vi, vii, 1864; also Gdt., Index, **1**, 181, 1886.

**18. LEAD.** Plumbum nigrum *Plin.*, 34, 47. Saturnus *Alchem.* Gediegen Blei *Germ.* Gediget Bly *Swed.* Plomb natif *Fr.* Piombo nativo *Ital.* Plomo metálico *Span.*

Isometric. Observed forms[1]:

*a* (100, *i-i*) *d* (110, *i*) *o* (111, 1) *h* (410, *i*-4) *π* (551, 5) *n* (211, 2-2)

Twins: tw. pl. *o*. Crystals rare, octahedral or dodecahedral; usually in thin plates and small globular masses, also in dendritic, wire-like forms.

Very malleable, and somewhat ductile. H. = 1·5. G. = 11·37. Luster metallic. Color lead-gray. Opaque.

**Comp.**—Nearly pure lead; sometimes contains a little silver, also antimony. The crystallized lead from the Harstig mine gave 99·71 p. c. Pb, with G. = 11·372, Hamberg, l. c.

**Pyr.**—B.B. fuses easily, coating the charcoal with a yellow oxide which, treated in R. F., volatilizes, giving an azure-blue tinge to the flame. Fusibility 330° C. Dissolves easily in dilute nitric acid.

**Obs.**—Occurs usually in thin plates and embedded scales; thus in a compact dolomitic limestone with hematite, magnetite, and hausmannite, etc., at the iron and manganese mines of Pajsberg, Harstig, and Långban in Wermland, Sweden; similarly at Nordmark; at the Sjö mines, Örebro, in a mineral resembling neotocite. Crystals are known only from the Harstig mine, where they occur in cavities associated with the manganese silicate, caryopilite, and the arsenates, sarkinite and brandtite. Hamberg regards the native lead to have been reduced by the oxidation of arsenious acid. Found also in the gold washings of the Urals at Ekaterinburg and in the Altai, also on the Kirghese Steppes.

Also reported (but some of these are doubtful) as occurring in globules in galena at Alstonmoor; in lava in Madeira; at the mines near Carthagena in Spain; in Carboniferous limestone near Bristol, and at Kenmare, Ireland; according to R. P. Greg, Jr., in thin sheets in red oxide of lead near a basaltic dike in Ireland; in an amygdaloid near Weissig; in basaltic tufa, at Rautenberg, in Moravia; in the district of Zomelahuacan, in the State of Vera Cruz, in a granular limestone, containing in some places species of ammonites, in laminæ, in a foliated argentiferous galena; at Huancavelica, Peru.

In the U. S., reported from near Saratoga, N. Y., in crystalline limestone (but doubtful). At Breckinridge and Gunnison, Colorado. Jay Gould mine, Wood River district, Idaho. In the gold placers of Camp Creek, Montana.

**Artif.**—Metallic lead has long been known to crystallize in the isometric system; Lehmann has obtained electrolytically, besides this form, another in plates for which he suggests the monoclinic system[2].

**Ref.**—[1] Öfv. Ak. Stockh., **45**, 483, 1888, Zs. Kr., **17**, 253, 1889. [2] Zs. Kr., **15**, 274, 1889.

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**19. TIN.** Plumbum candidum *Plin.*, 34, 47 Jupiter *Alchem.* Gediegen Zinn *Germ.* Gediget Tenn *Swed.* Etain natif *Fr.* Stagno nativo *Ital.* Estaño nativo *Span.*

In irregular rounded crystalline grains, or aggregations of grains, from 0·1 to 1 mm. in size; color grayish white. Occurs with platinum, iridosmine, gold, copper, cassiterite, corundum in washings from the Aberfoil and Sam rivers (headwaters of the Clarence river) near Oban, New South Wales. Howell, Genth, Am. Phil. Soc., 23, 30, 1885.

Native tin has also been reported as occurring with the Siberian gold; in the Rio Tipuani valley, Bolivia (probably artificial, Forbes); in Guanajuato, Mexico, under bismutite (Frenzel). All these are doubtful.

Artificial crystals are: (α) tetragonal, and (β) orthorhombic.

(α) Tetragonal. Axis ć = 0·3857, Mlr.[1] In prismatic crystals with *a* (100, *i-i*), *m* (110, *I*), *e* (101, 1-*i*), *t* (301, 3-*i*), *p* (111, 1), *r* (331, 3). Angles *pp'* = 39° 35', *pp''* = 57° 13', *ee'* = 29° 29', *ee''* = 42° 1[illegible]'. Also twins: tw. pl. (1) *p* (111), and (2) *r* (331).

H. = 2. G. = 7·178, after fusion 7·293 Mlr. Somewhat malleable. Luster metallic. Color tin-white. Obtained by the electrolytic decomposition of tin protochloride. Also from fusion in oscillatory pyramidal forms.

(β) Orthorhombic. Axes ă : b̄ : ć = 0·3874 : 1 : 0·3557, 100 ∧ 110 = 21° 10½', 001 ∧ 101 = 42° 33½', 001 ∧ 011 = 19° 34⅚', Trechmann[2]. In thin plates of prismatic crystals with *a* (100, *i*-ī), *b* (010, *i*-ĭ), *m* (110, *I*), *γ* (340, *i*-$\frac{4}{3}$)[3], *e* (120, *i*-2̆), *k* (101, 1-ī), *n* (021, 2-ĭ), *d* (111, 1), *p* (121, 2-2̆)[3]. Angles: *mm'* = 42° 21', *bm* = *68° 49½', *bn* = 54° 34', *dd'* = 81° 43', *dd'''* = 29° 22', *bd* = *75° 19'. The form approximates to that of the tetragonal variety, e.g., in the ratio of ă : ć.

Cleavage: *b*, *k* very imperfect. Brittle to mild. H. = above 2. G. = 6·54. Luster metallic. Color dark gray to bluish gray. Streak iron-gray, shining. Chemically nearly pure tin. Obtained from cavities of an arsenical slag produced in the process of tin-making, Cornwall.

**Ref.**—[1] Min., p. 127; Phil. Mag., **22**, 263, 1843. [2] Min. Mag., **3**, 186, 1879. [3] Foullon, Vh. G. Reichs., 237, 1881; see also Jb. G. Reichs., 367, 1884; he describes both the dimorphous forms.

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## 5. Platinum-Iron Group.

**20. PLATINUM.** Platina (fr. Choco) *Ulloa*, Relac. Hist. Viage Amer. Merid., lib. 6, c. 10, Madrid 1748. Platina (fr. Carthagena) *W. Brownrigg* (who received it in 1741 from C. Wood), Phil. Trans., 584, 1750. Platina del Pinto *Scheffer*, Ak. H. Stockh., 269, 1752. Polyxen *Hausm.*, Handb., 97, 1813, 20, 1847.

Gediegen Platin *Germ.* Platine natif *Fr.* Platino *Ital.* Platina *Span.*

Isometric. Observed forms[1]:

*a* (100, *i-i*) *d* (110, *i*) *o* (111, 1) *f* (310, *i*-3) *e* (210, *i*-2) *l* (530, *i*-$\frac{5}{3}$) *g* (320, *i*-$\frac{3}{2}$)

Twins: tw. plane *o*. Crystals rare, cubes most common; often distorted. Usually in grains and scales, occasionally in irregular lumps or nuggets up to 20 pounds in weight.

Cleavage none. Fracture hackly. Malleable and ductile. H. = 4–4·5. G. = 14–19 native; 21–22 chem. pure. Luster metallic. Color and streak whitish steel-gray; shining. Sometimes magnetipolar.

**Comp.**—Platinum alloyed with iron, iridium, osmium and other metals.

**Var.**—1. *Ordinary.* *Non-magnetic* or only slightly magnetic. G. = 16·5–18·0 mostly. After washing in acid a distinction can be made between silver-white, gray, and iron-black grains.

2. *Magnetic.* G. about 14. Here is included Breithaupt's *Iron-platinum* (Eisenplatin), described as $PtFe_2$ with H. = 6 and G. = 14·6–15·8. Much platinum is magnetic, and occasionally it has polarity, so that platinum magnets are spoken of, comparable in power to the lodestone. The magnetic property seems to be connected with high percentage of iron, although this distinction does not hold without exception. Cf. Daubrée, C. R., **80**, 526, 1875.

A *nickeliferous* magnetic platinum from Nizhni Tagilsk gave Terreil: 8·18 Fe and 0·75 Ni, C. R., **82**, 1116, 1876.

**Anal.**—1–14, Minchin, Min. Russl., **5**, 184–190, 1866: anal. 3–7 of black grains washed with acid and then distinguished by color as given; anal. 8–12, ditto white grains. 15–17, Berzelius, Ak. H. Stockh., 113, 1828. 18, Claus, Rg., Min. Ch., p. 10, 1860. 19, Böcking, Lieb. Ann., 96, 243, 1855. 20–23, Deville and Debray, Ann. Ch. Phys., **56**, 449, 1859, and others. 24–26, Hoffmann, Trans. Roy. Soc., Canada, **5** (3), p. 17, 1887, anal. 24 of whole after separation of gold, 25, 26, of samples separated by the magnet. 27, Collier, Am. J. Sc., **21**, 123 1881.

| | G | Pt | Fe | Pd | Rh | Ir | Os | Cu | Iridos. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Goroblag. *non-magnetic* | 17·726 | 83·49 | 8·98 | 1·94 | 3·17 | *tr.* | — | — | 0·93 | | = 98·51 |
| 2. Goroblag. *magn.* | 14·25 | 76·22 | 17·30 | 1·87 | 2·50 | *tr.* | — | 0·36 | 0·50 | | = 98·75 |
| 3. N. Tagilsk *wh. non-magn.* | 17·22 | 81·34 | 11·48 | 0·30 | 2·14 | 2·42 | *tr.* | 1·13 | 0·57 | | = 99·38 |
| 4. N. Tagilsk *gry.* | 16·44 | 82·46 | 11·23 | 0·23 | 2·35 | 1·21 | *tr.* | 0·64 | 1·38 | | = 99·50 |
| 5. “ *blk.* | 14·14 | 70·15 | 18·90 | 0·20 | 3·61 | 1·03 | *tr.* | 1·16 | 3·87 | | = 98·92 |
| 6. N. Tagilsk *gry. magn.* | 14·82 | 73·70 | 16·65 | 0·23 | 3·12 | 1·15 | *tr.* | 1·47 | 2·56 | | = 98·88 |
| 7. N. Tagilsk *blk.* | 13·35 | 68·95 | 18·93 | 0·21 | 3·30 | 1·34 | *tr.* | 1·59 | 3·75 | | = 98·07 |
| 8. N. Tagilsk *wh.* | 17·21 | 78·38 | 11·72 | 0·17 | 2·79 | 5·32 | *tr.* | 0·28 | 0·32 | | = 98·98 |
| 9. “ *non-magn.* | 16·54 | 82·16 | 11·50 | 0·25 | 2·19 | 1·00 | *tr.* | 0·21 | 1·89 | | = 99·20 |
| 10. “ “ | 13·52 | 71·20 | 17·73 | 0·18 | 3·46 | 1·15 | *tr.* | 0·50 | 3·85 | | = 98·07 |
| 11. N. Tagilsk *magn.* | 14·63 | 74·67 | 15·54 | 0·18 | 2·26 | 0·83 | *tr.* | 1·98 | 2·30 | | = 97·76 |
| 12. “ | 13·52 | 71·94 | 15·79 | 0·14 | 2·76 | 1·18 | *tr.* | 3·72 | 2·87 | | = 98·40 |
| 13. N. Tagilsk | | 68·72 | 15·58 | 0·20 | 2·48 | 4·73 | *tr.* | 0·30 | 6·36[a] | | = 98·37 |
| 14. “ | | 77·14 | 12·13 | 0·22 | 2·74 | 5·10 | *tr.* | 0·34 | 0·98[a] | | = 98·65 |
| 15. N. Tagilsk *non-magn.* | | 78·94 | 11·04 | 0·28 | 0·86 | 4·97 | *tr.* | 0·70 | 1·96 | | = 98·75 |
| 16. N. Tagilsk *magn.* | | 73·58 | 12·98 | 0·30 | 1·15 | 2·35 | *tr.* | 5·20 | 2·30[a] | | = 97·86 |
| 17. Goroblag. *non-magn.* | | 86·50 | 8·32 | 1·10 | 1·15 | — | *tr.* | 0·45 | 1·40 | | = 98·92 |
| 18. Goroblag. | | 85·97 | 6·54 | 0·75 | 0·96 | 0·98 | 0·54 | 0·86 | 2·10[a] | | = 98·70 |
| 19. Borneo | | 82·60 | 10·67 | 0·30 | — | 0·66 | — | 0·13 | 3·80 | Au 0·20 | = 98·36 |
| 20. Australia | | 61·40 | 4·55 | 1·80 | 1·85 | 1·10 | — | 1·10 | 26·00 | Au 1·20 sand 1·20 | = 100·20 |
| 21. Choco | | 86·20 | 7·80 | 0·50 | 1·40 | 0·85 | — | 0·60 | 0·95 | Au 1·00 sand 0·95 | = 100·25 |
| 22. California | | 85·50 | 6·75 | 0·60 | 1·00 | 1·05 | — | 1·40 | 1·10 | Au 0·80 sand 2·95 | = 101·15 |
| 23. Oregon | | 51·45 | 4·30 | 0·15 | 0·65 | 0·40 | — | 2·15 | 37·30 | Au 0·85 sand 3·00 | = 100·25 |
| 24. Br. Columbia | 16·656 | 72·07 | 8·59 | 0·19 | 2·57 | 1·14 | — | 3·39 | 10·51 | gangue 1·69 | = 100·15 |
| 25. “ *non-magn.* | 17·017 $\frac{8}{3}$ | 68·19 | 7·87 | 0·26 | 3·10 | 1·21 | — | 3·09 | 14·62 | gangue 1·95 | = 100·30 |
| 26. “ *magn.* | 16·095 $\frac{2}{2}$ | 78·43 | 9·78 | 0·09 | 1·70 | 1·04 | — | 3·89 | 3·77 | gangue 1·27 | = 99·97 |
| 27. Plattsburgh | 17·35 | 82·81 | 11·04 | 3·10 | 0·29 | 0·63 | *tr.* | 0·40 | — | gangue 2·05 | = 100·32 |

[a] Including gangue.

**Pyr., etc.**—B.B. infusible. Not affected by borax or salt of phosphorus, except in the state of fine dust, when reactions for iron and copper may be obtained. Soluble only in heated nitrohydrochloric acid.

**Obs.**—Platinum was first found in pebbles and small grains, associated with iridium, osmium, palladium, gold, copper, and chromite, in the alluvial deposits of the river Pinto, in the district of Choco, near Popayan, in the U. S. of Colombia, South America, where it received its name *platina* (platina del Pinto) from *plata*, silver. In the province of Antioquia, in Brazil, it has been found in auriferous regions in syenite (Boussingault, Ann. Ch. Phys., **32**, 204, 1826).

In Russia, where it was first discovered in 1822, it occurs in alluvial material in the Urals at Nizhni Tagilsk, sometimes in nuggets of considerable size; also at Kushvinsk in the Goroblagodatsk district and at other points; in Nizhni Tagilsk it has been found with chromite in a serpentine probably derived from a peridotyte. In the sand of the Ivalo river, northern Lapland, associated with diamond and probably derived from a serpentine (altered peridotyte) containing chromite and diallage.

Platinum is also found on Borneo; in the sands of the Rhine; at St. Aray, Val du Drac; county of Wicklow, Ireland; on the river Jocky, St. Domingo; according to report, in Choloteca and Gracias, in Honduras. Also from the river Tayaka, in New Zealand, from a region characterized by a chrysolite rock (dunyte) with serpentine; similarly with nickeliferous metallic iron (awaruite) in the drift of the Gorge river; also from quartz lodes in the Thames gold fields (J. A. Pond). In New South Wales, reported as occurring *in situ* in the Broken Hill district, in a feldspathic rock with iridosmine; found in gold washings in small quantities at various points.

In California, in the Klamath region, at Cape Blanco, etc., but not abundant, in the gold washings of Cherokee, Butte Co.; in traces with gold in Rutherford Co., North Carolina; at St. François, Beauce Co., Quebec; at several points in British Columbia, thus on the Fraser river near Lillooet, also on Tranquille river and on Granite Creek, a branch of the Tulameen; further on the tributaries of the Yukon river. A mass weighing 104 grams, with G. = 10·45, and consisting of 46 p. c. platinum (anal. 27) and 54 chromite, was found near Plattsburgh, N. Y.

The metal platinum was brought from Choco, S. A., by Ulloa, a Spanish traveller in America, in the year 1735, and from Carthagena, by Charles Wood, who procured it in Jamaica. Ulloa speaks of specula made by the people of the country, of a peculiar metal, which Brownrigg says was “platina,” and the latter mentions a “pummel of a sword,” and other articles of platinum, received by him from Carthagena.

**Ref.**—[1] Cf. Eremeyev, Vh. Min. Ges., **14**, 155, 1879.

**21. IRIDIUM.** Gediegen Iridium *Breith., Berz.*. JB., **14**, 180, 1835, Ak. H. Stockh., 84, 1834. Platiniridium *Svanberg*, Berz. JB., **15**, 205, 1834.

Isometric. Observed forms[1]:

*a* (100, *i*-*i*) *d* (110, *i*) *o* (111, 1) *f* (310, *i*-3) $\theta$ (430, *i*-$\frac{4}{3}$)

Twins: tw. plane *o*, commonly in polysynthetic groups. Crystals rare, generally cubes. Usually in angular grains.

Cleavage: cubic, indistinct. Fracture hackly. Somewhat malleable. H. = 6–7. G. = 22·65–22·84[2]. Luster metallic. Color silver-white, with tinge of yellow on surface; gray on fracture. Opaque.

**Comp.**—Iridium with platinum and other allied metals.

**Anal.**—Svanberg:

| | Pt | Ir | Pd | Rh | Fe | Cu | Os | |
|---|---|---|---|---|---|---|---|---|
| 1. N. Tagilsk | 19·64 | 76·80 | 0·89 | — | — | 1·78 | — | = 99·11 |
| 2. Brazil | 55·44 | 27·79 | 0·49 | 6·86 | 4·14 | 3·30 | *trace* | = 98·02 |

Prinsep in a specimen from Ava in India found Ir 60, Pt 20; this is called *Avaite* by Heddle, Enc. Brit., **16**, 382, 1883.

**Obs.**—Occurs with the platinum of the Urals and Brazil; perhaps also with the California gold; Ava in Burma.

**Ref.**—[1] Erem., Vh. Min. Ges., **14**, 155, 1879. [2] Of cubic crystals 22·647–22·668, of octahedral 22·770–22·773 from Sukho-Visim, from Nevyansk, 22·805–22·836, Erem. l. c.

**22. IRIDOSMINE.** Ore of Iridium, consisting of Iridium and Osmium, *Wollaston*, Phil. Trans., 316, 1805 (Metals Iridium and Osmium, first announced by *Tennant*, Phil. Trans., 411, 1804). Native Iridium *Jameson*. Osmiure d'Iridium *Berz.*, Nouv. Syst. Min., 195, 1819. Osmium-Iridium *Leonh.*, Handb., 1821. Iridosmium; Osmiridium. Newjanskit, Sisserskit, *Haid.* Handb., 558, 1845.

Rhombohedral. Axis $\dot{c} = 1{\cdot}4105$; $0001 \wedge 10\bar{1}1 = 58° 27'$ Rose.

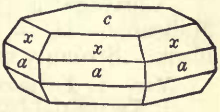
**Forms:** *c* (0001, *O*), *m* ($10\bar{1}0$, *I*), *r* ($10\bar{1}1$, *R*)[2], *z* ($01\bar{1}1$, $-1$)[2], *x* ($22\bar{4}3$, $\frac{4}{3}$-2).
Angles: $cx = {}^{*}62°$, $rr' = 95° 8'$, $xx' = 52° 24'$.

Rarely in hexagonal prisms; usually in irregular flattened grains.

Cleavage: *c* perfect. Slightly malleable to nearly brittle. H. = 6–7. G. = 19·3–21·12. Luster metallic. Color tin-white to light steel-gray. Opaque.

**Comp., Var.**—Iridium and osmium in different proportions. Two varieties depending on these proportions have been named as species, but they are isomorphous, as are also the metals themselves (Rose). Some rhodium, platinum, ruthenium, and other metals are usually present.

1



Ural, Rose.

**Var.**—1. *Nevyanskite.* Newjanskit Haid.; H. = 7; G. = 18·8–19·5. In flat scales; color tin-white. Over 40 p. c. of iridium.

2. *Siserskite.* Sisserskit Haid. In flat scales, often six-sided, color grayish white, steel-gray. G. = 20–21·2. Not over 30 p. c. of iridium. Less common than the light-colored variety.

**Anal.**—Deville and Debray, Ann. Ch. Phys., **56**, 481, 1859.

| | | Ir | Rd | Pt | Ru | Os | Cu | Fe | |
|---|---|---|---|---|---|---|---|---|---|
| 1. N. Grenada | | 70·40 | 12·30 | 0·10 | — | [17·20] | — | — | = 100 |
| 2. " | | 57·80 | 0·63 | — | 6·37 | 35·10 | 0·06 | 0·10 | = 100·06 |
| 3. California | | 53·50 | 2·60 | — | 0·50 | [43·40] | — | — | = 100 |
| 4. Australia | | 58·13 | 3·04 | — | 5·22 | [33·46] | 0·15 | — | = 100 |
| 5. Borneo | | 58·27 | 2.64 | 0·15 | — | [38·94] | — | — | = 100 |
| 6. Ural | | 77·20 | 0·50 | 1·10 | 0·20 | [21·00] | *tr.* | — | = 100 |
| 7. " | G. = 18·9 | 43·28 | 5·73 | 0·62 | 8·49 | [40·11] | 0·78 | 0·99 | = 100 |
| 8. " | G. = 18·8 | 64·50 | 7·50 | 2·80 | — | [22·90] | 0·90 | 1·40 | = 100 |
| 9. " | G. = 20·4 | 43·94 | 1·65 | 0·14 | 4·68 | [48·85] | 0·11 | 0·63 | = 100 |
| 10. " | G. = 20·5 | 70·36 | 4·72 | 0·41 | | [23·01] | 0·21 | 1·29 | = 100 |

**Pyr., etc.**—At a high temperature the siserskite gives out osmium, but undergoes no further change. The nevyanskite is not decomposed and does not give an osmium odor. With niter, the characteristic odor of osmium is soon perceived, and a mass obtained soluble in water, from which a green precipitate is thrown down by nitric acid.

**Obs.**—Occurs with platinum in the province of Choco in South America; near Ekaterinburg, Zlatoust, and Kyshtimsk, in the Ural mountains; in auriferous and other drifts at various points as Bingera, Bathurst, etc., in New South Wales, Australia. Rather abundant in the auriferous beach-sands of northern California, occurring in small bright lead-colored scales, sometimes six-sided. Also traces in the gold-washings on the rivers du Loup and des Plantes, Canada.

**Ref.**—[1] Abh. Ak. Berlin, 97, 1849; Pogg., **29**, 452, 1833. [2] Lsx., also a more acute $m$-2 pyramid, Ber. nied. Ges., p. 99, 1882.

**23. PALLADIUM.** *Wollaston*, Phil. Trans. 1808.

Isometric. In minute octahedrons, Haid. Mostly in grains, sometimes composed of diverging fibers.

Ductile and malleable. H. = 4·5–5. G. = 11·3–11·8, Wollaston. Luster metallic. Color whitish steel-gray. Opaque.

**Comp.**—Palladium, alloyed with a little platinum and iridium.

**Pyr., etc.**—The blowpipe reactions of native palladium are undescribed. As prepared by Deville, it is the most fusible of the platinum metals. Oxidizes at a lower temperature than silver, but is not blackened by sulphurous gases.

**Obs.**—Palladium occurs with platinum in Brazil where masses of the metal are sometimes met with; reported from St. Domingo, also from the Urals (Breith., Berz. JB., **14**, 181, 1835).

**24. ALLOPALLADIUM.** Selenpalladium *Zinken*, Pogg., **16**, 496, 1829. Eugenesite *Adam*, Tabl. Min., 82, 1869.

Rhombohedral. In small six-sided tables, Zinken. Cleavage: basal perfect. Luster bright. Color nearly silver-white to pale steel-gray.

**Comp.**—Palladium under the rhombohedral system, if Zinken's early observations can be relied upon.

**Obs.**—From Tilkerode, in the Harz, in small hexagonal tables with gold.

**25. IRON.** Mars *Alchem.* Gediegen Eisen *Germ.* Jern *Swed.* Fer natif *Fr.* Ferro *Ital.* Hierro *Span.*

Isometric. Usually massive, rarely in crystals, $a$ (100), $o$ (111). Artificial crystals usually dendritic, with branches parallel to the cubic axes. Twins: tw. pl. $o$, as penetration-twins often repeated and producing embedded lamellæ parallel the faces of the trisoctahedron $p$ (221).

Cleavage: $a$ perfect; also a lamellar structure ∥ $o$ and ∥ $d$. Fracture hackly. Malleable. H. = 4–5. G. = 7·3–7·8 Luster metallic. Color steel-gray to iron-black. Strongly magnetic.

**Var.**—1. *Terrestrial;* 2. *Meteoric.*

1. **Terrestrial Iron.** Found in masses, occasionally of great size (up to 20 tons), as well as in small embedded particles, in basalt at Blaafjeld, Ovifak (or Uifak), Disco Island; also at Fortune Bay, Mellemfjord, Asuk, and other points on the same island, and at Niakornak, Disco Bay, and elsewhere on the coast of West Greenland.

The Disco iron was discovered in 1870 by A. E. Nordenskiöld, although the fact that native iron was used by the Greenland natives for knives, utensils, etc., was known much earlier (Captain Ross, 1819). It was supposed at first to be meteoric, but its terrestrial nature has since been placed beyond doubt. It is uncertain, however, whether the iron was brought up as such by the basalt or whether it was reduced by the action of the carbonaceous shales through which the basalt passed; the latter seems most probable, and is confirmed by the presence of graphite and graphitic feldspar in the basalt.

The iron varies in character from the exterior or oxidized crust, to that which is compact and malleable; for the most part the iron oxidizes and disintegrates rapidly upon exposure, in part owing to a deliquescent iron chloride. Some of this iron exhibits when etched a crystalline structure which somewhat resembles that common with meteoric iron (see beyond).

Besides the Greenland irons, some other occurrences, usually classed as meteoric, may be in fact terrestrial; *e.g.*, the Santa Catharina iron of Brazil discovered in 1875.

**Analyses** of various Greenland irons, 1–12, Lorenzen[1]:

| | G. | Fe | Ni | Co | Cu | S | C | P | $SiO_2$[b] | insol. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Blaafjeld, Ovifak | 6·87 | 91·71 | 1·74 | 0·53 | 0·16 | 0·10 | 1·37 | — | 1·52 | 2·39 | = 99·52 |
| 2. " " | | 91·17 | 1·82 | 0·51 | 0·16 | 0·78 | 1·70 | — | 2·58 | 0·77 | = 99·49 |
| 3. " " | | 82·02[a] | 1·39 | 0·76 | 0·19 | 0·08 | 1·27 | — | 1·67 | 8·03 | = 95·41 |
| 4. " " | | 59·77[a] | 1·60 | 0·39 | 0·23 | ? | 1·20 | — | 4·18 | 22·23 | = 89·60 |
| 5. Mellemfjord | 7·5–7·9 | 93·89 | 2·55 | 0·54 | 0·33 | 0·20 | 0·28 | — | 0·46 | 1·48 | = 99·73 |
| 6. " | 6·90, 7·57 | 92·41 | 0·45 | 0·18 | 0·48 | *tr.* | 0·87 | — | 1·50 | 4·57 | = 100·46 |

| | G | Fe | Ni | Co | Cu | S | C | P | $SiO_2$[b] | insol. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 7. Asuk | 7·26 | 95·15 | 0·34 | 0·06 | 0·14 | — | 0·96 | — | 1·19 | 1·90 | = 99·74 |
| 8. Arveprindsens Is. | | 95·67 | — | *tr.*? | 0·06 | 0·09 | 1·94 | — | 1·40 | 1·09 | = 100·25 |
| 9. Niakornak | 7·29 | 92·46 | 1·92 | 0·93 | 0·16 | 0·59 | 3·11 | 0·07 | 0·24 | 1·09 | = 100·57 |
| [a]10. Fortune Bay, Disco (1852) | 7·19 | 92·68 | 2·54 | 0·58 | 0·20 | 0·01 | 2·40 | — | 0·31 | 0·08 | = 98·80 |
| 11. Fiskernæs (1853) | 7·06 | 92·23 | 2·73 | 0·84 | 0·36 | — | 0·20 | — | 1·28 | 1·99 | = 99·63 |
| 12. Ekaluit | | 94·11 | 2·85 | 1·07 | 0·23 | — | — | — | — | 0·61 | = 98·87 |

[a] In part oxidized. [b] With $Al_2O_3$.

Analyses 13–16 J. L. Smith[1]: 1, exterior portion; 2, iron particles from interior of the same mass, separated from gangue; 3, malleable iron; 4, iron in irregular rounded masses.

| | G. | Fe | Ni | Co | Cu | S | C | P | Cl | $Fe_2O_3$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13. Ovifak | 5·0 | 16·56 | 1·08 | 0·48 | 0·08 | 1·12 | 1·36 | 0·14 | *tr.* | 76·21 | 4·50 | = 101·53 |
| 14. " | 6·42 | 93·16 | 2·01 | 0·80 | 0·12 | 0·41 | 2·34 | 0·32 | 0·02 | | | = 99·18 |
| 15. " | 7·46 | 90·17 | 6·50 | 0·79 | 0·13 | — | — | — | — | $SiO_2$ 1·54 | | = 99·13 |
| 16. " | 6·80 | 88·13 | 2·13 | 1·07 | 0·48 | 0·36 | 2·33 | 0·25 | 0·08 | silicates 4·20 | | = 99·03 |

For other analyses see the authors quoted[1].

A nickeliferous metallic iron, called *awaruite* Skey, (Trans. N. Zeal. Inst., **18**, 401, 1885,) occurs in the drift of the Gorge river, which empties into Awarua Bay on the west coast of the south island of New Zealand. It is associated with gold, platinum, cassiterite, chromite, and magnetite, and has probably been derived from a partially serpentinized peridotyte. It has H. = 5, G. = 8·1. Composition $FeNi_2$ = Iron 32·3, nickel 67·7 = 100. Compare anal. 14, p. 30. Analysis by W. Skey yielded:

G. = 8·1 Fe 31·02 Ni 67·63 Co 0·70 S 0·22 $SiO_2$ 0·43 = 100

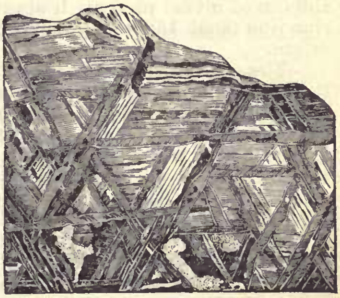
Native iron also occurs sparingly in some basalts (Andrews *et al.*); in pyrite nodules in a Keuper limestone at Mühlhausen in Thuringia; in the Plänerkalk at Chozen in Bohemia (ancient meteorite?) Also reported from gold or platinum washings at various points, but they are not all free from doubt: thus in the Urals, Brazil, Montgomery Co., Va., Burke Co., N. C., Camp Creek, Montana. Reported from shale near New Brunswick, New Jersey. Masses of metallic iron locally reduced from clay ironstone by the burning of a lignite bed have been noted 70 miles above Edmonton on the North Saskatchewan river, Alberta.

Bahr has observed grains of native iron in a fragment of petrified wood. The iron was mixed with limonite and organic matter, and is supposed to have been produced by the deoxidation of a salt of iron by the organic matter of the wood. He calls the iron *sideroferrite*.

SIDERAZOT *O. Silvestri*, Pogg. Ann., **157**, 165, 1876. Silvestrite *A. D'Achiardi*, I Metalli, **2**, 84, 1883. A product of volcanic eruption, observed at Mt. Etna after the eruption of Aug., 1874, as a very thin coating on lava. Non-crystalline. Luster metallic, resembling steel. Slowly attacked by acids. An analysis gave: N 9·14, Fe 90·86 = 100, which corresponds to $Fe_5N_2$ which requires: Nitrogen 9·11, iron 90·89 = 100. This is the composition (Frémy) of the artificial iron nitride.

2. **Meteoric Iron.** Native iron also occurs in most meteorites, forming in some cases (*a*) the entire mass; also (*b*) as a spongy, cellular matrix in which are imbedded grains of chrysolite or other silicates; (*c*) in grains or scales disseminated more or less freely throughout a stony matrix. Rarely a meteorite consists of a single crystalline individual (Braunau) with numerous twinning lamellæ ∥ *o* (cf. above).

1.



Glorieta Mt., New Mexico.

Cubic cleavage sometimes observed; also an octahedral, less often dodecahedral lamellar structure. Etching with dilute nitric acid (or iodine) commonly develops a crystalline structure[2, 3], usually consisting of lines or bands crossing at various angles according to the direction of the section, at 60° if ∥ *o*, 90° ∥ *a*. etc. These figures (f. 1) are called *Widmanstätten figures*, because first described by Widmanstätten in 1808. They are formed by the edges of crystalline plates of the nickeliferous iron in different conditions, as shown by the fact that they are differently attacked by the acid (see also analyses below). These plates are usually parallel to the octahedral faces. Reichenbach named them "Balkeneisen" or *kamacite*, from *κάμαξ*, *pole* or *shaft*. "Bandeisen" or *tænite*, from *ταινία*, *band*, and "Fülleisen" or *plessite*; the first forms the broader plates marking the structure, supposed to be of purer iron and hence more readily attacked; the second forms thin plates bounding the first, rich in nickel, appearing also in thin lamellæ; the third is the ground-mass. Enclosed in the "Balkeneisen" are sometimes areas of a white iron, resisting acids, and having a brilliant luster; this is Reichenbach's "Glanzeisen" or *lamprite*, from *λαμπρός* *lustrous*. Irons with cubic structure and with twinning lamellæ (*e.g.*, Braunau) have a series of fine lines corresponding to these developed by etching (*Neumann lines*). A damascene luster is also produced in some cases, due to quadrilateral depressions. From the distinctly octahe dral iron, showing the figures most perfectly, there are many gradations to the irons which show no distinct crystalline structure at all upon etching.

The exterior of masses of meteoric iron is usually more or less deeply pitted with rounded thumblike depressions, and the surface at the time of fall is covered with a film of iron oxide in fine ridges showing lines of flow due to the melting caused by the heat developed by the resistance of the air; this film disappears when the iron is exposed to the weather.

**Comp.**—Meteoric iron is always alloyed with nickel, which is usually present in amounts varying from 5 to 10 p. c.; small amounts of other metals, as cobalt, manganese, tin, copper, chromium, are also often present. Occluded gases can usually be detected. Wright obtained from the Arva iron 44 volumes of mixed gases by heating up to low redness[4].

**Analyses** of typical irons.—1, Holger, Baumg. Zs., **7**, 138, 1830. 2, Berzelius, Ak. H. Stockh., 163, 1834. 3, Taylor, Am. J. Sc., **22**, 374, 1856. 4, Fickentscher, Buchner, Meteoriten, 144. 5, Böcking, Lieb. Ann., **96**, 246, 1855. 6, Holger, l. c. 7, Silliman and Hunt, Am. J. Sc., **2**, 370, 1846. 8, Berzelius, Ak. H. Stockh., 106, 1832. 9, Bergemann, Pogg., **100**, 254, 1857. 10, Id., ibid., p. 256. 11, Duflos and Fischer, Pogg., **72**, 170, 475, 1847; **73**, 590, 1848. 12. Rube, B. H. Ztg., **21**, 72, 1862. 13, Genth, Am. J. Sc., **12**, 73, 1876. 14, Taylor, ib. **24**, 293, 1857. 15, Damour, C. R., **84**, 478, 1877. 16, J. L. Smith, Am. J. Sc., **13**, 213, 1877. 17, Id.. ib., **19**, 463, 1880. 18, Kinnicutt, Peabody Mus. Arch., **3**, 383, 1884. 19, Riggs, ib., **30**, 312, 1885. 20, Mackintosh, ib., **30**, 238. 21, D. Fisher, ib., **34**, 381, 1887. 22, Mackintosh, ib., **33**, 225. 23, Whitfield, ib., **33**, 499, 1887.

| | | | Fe | Ni | Co | Cu | Mn | |
|---|---|---|---|---|---|---|---|---|
| 1. | Agram, May 26, 1751 | | 83·29 | 11·84 | 1·26 | — | 0·64 | X 2·97=100 |
| 2. | *Pallas Iron*, 1749 | | 88·04 | 10·73 | 0·46 | 0·07 | 0·13 | C 0·04, S *tr.*, X 0·53=100 |
| 3. | Toluca, 1784 | | 90·72 | 8·49 | 0·44 | — | — | P 0·18, X 0·63=100·46 |
| 4. | Bemdego, 1784 | G.=7·731 | 91·90 | 5·71 | — | — | — | X 0·46=98·07 |
| 5. | Cape of Good Hope, 1793 | | 81·30 | 15·23 | 2·01 | *tr.* | — | P 0·08, S *tr.*, Sch. 0·88, Sn *tr.*=99·50 |
| 6. | Lenarto, 1814 | | 85·04 | 8·12 | 3·59 | — | 0·61 | X 2·64=100 |
| 7. | Red River, 1814 | | 90·91 | 8·46 | — | — | — | X 0·50=99 87 |
| 8. | Bohumilitz, 1829 | | 93·78 | 3·81 | 0·21 | — | — | X 2·20=100 |
| 9. | *Sevier Iron*, 1840 | G.=7·26 | 90·10 | 6·52 | 0·33 | — | — | P 0·02, X 2·23=99·20 |
| 10. | Arva, 1840 | | 82·11 | 7·11 | 0·36 | — | — | C 1·54, P 0·34, Sch. 6·56, Gr. 2·00=100·02 |
| 11. | Braunau, July 14, 1847 | | 91·88 | 5·52 | 0·53 | 2·07 | | C,S *tr.*=100 |
| 12 | Rittersgrün, 1847 | | 87·31 | 9·63 | 0·58 | — | — | P 1·37, X 1·38=100 27 |
| 13. | Pittsburg, 1850 | G.=7·74 | 92·81 | 4·67 | 0·39 | 0·03 | 0·14 | S 0·04, P 0·25=98 33 |
| 14. | Octibbeha Co., Miss., 1857 | | 37·69 | 59·69 | 0·40 | 0·90 | — | P 0·10, X 0·41=99·19 |
| 15. | St. Catharina, 1875 | G.=7·75–7·84 | 63·69 | 33·97 | 1·48 | — | — | C 0·20, S 0·16, P 0·05 =99·55 |
| 16. | Bates Co., Mo., 1875 | G.=7·72 | 89·12 | 10·02 | 0·26 | 0·01 | — | P 0·12=99·53 |
| 17. | Estherville, Iowa, May 10, 1879 | | 92·00 | 7·10 | 0·69 | *tr.* | — | P 0·11=99·90 |
| 18. | Turner Mound, Ohio, 1883 | G.=7·894 | 89·00 | 10·65 | 0·45 | *tr.* | — | insol. 0·09=100·19 |
| 19. | Grand Rapids, Mich., 1883 | | 88·71 | 10·69 | — | 0·07 | — | C 0·06, S 0·03, P 0·26 =99·82 |
| 20. | Glorieta Mt., N. M., 1884 | G.=7·66 | 87·93 | 11·15 | 0·33 | — | — | P 0·36=99·77 |
| 21. | St. Croix Co., Wis., 1884 | G.=7·60–7·70 | 89·78 | 7·65 | 1·33 | *tr.* | — | C *tr.*, P 0·51, Sn *tr.*=99·27 |
| 22. | Mazapil, Nov. 27, 1885 | | 91·26 | 7·85 | 0·65 | — | — | P 0·30=100·06 |
| 23. | Cabin Creek, Ark., Mch. 27, 1886 | | 91·87 | 6·60 | *tr.* | — | — | C,S 0·54, P 0·41=99·42 |

X = silicates, insol., etc. Sch. = Schreibersite. Gr. = Graphite.

The Octibbeha iron or *octibbehite* (anal. 14, supposing this correct) is exceptional in the amount of nickel present; it approximates to the terrestrial awaruite (p. 29). The Santa Catharina iron (anal. 15) is also remarkably rich in nickel, but this is regarded by some as of terrestrial origin.

The composition of the portions of the meteoric iron to whose separate formation the structure of the Widmanstätten figures is due has been only partially determined. Meunier assigns to kamacite the formula $Fe_{14}Ni$ with G. = 7·652; to tænite $Fe_6Ni$ with G. = 7·380; and to plessite $Fe_{10}Ni$ with G. = 7·850. Reichenbach assigned to plessite the formula $Fe_{28}Ni_5$. Analyses: 1, 2, 4, Meunier, Météorites, 48–50, 1884. 3, Reichenbach, Jr, Pogg., **114**, 258, 1861. See also p. 1037.

| | | | Fe | Ni | |
|---|---|---|---|---|---|
| 1. | *Kamacite*.—La Caille | G. = 7·652 | 91·9 | 7·0 = 98·9 | |
| 2. | " Charcas | | 92·0 | 7·5 = 99·5 | |
| 3. | *Tænite*.— Cocke Co., Tenn. | | 85·71 | 13·22 | Co 0·55 S 0·23 P 0·29 = 100 |
| 4. | " La Caille | | 85·4 | 14·0 | Co *tr.* = 9·90 |

Weinschenk obtained for thin lamellæ from the Arva iron: Fe 71·50, Ni 26·82, Co 1·68 = 100, corresponding to $Fe_5(Ni,Co)_2$ and approximating to the edmonsonite (see below) of Flight. He thinks these tænite lamellæ are really made up of two compounds, $Fe_8Ni$ and $Fe_5Ni_2$. The subject obviously requires much more investigation.

The following are other more or less well defined iron compounds from meteoric irons:

EDMONSONITE *W. Flight*, Phil. Trans., 888, 1882.

An iron-nickel alloy forming fine lines in the Widmanstätten figures of the Cranbourne, Victoria, meteoric iron. Analysis: Fe 70·14, Ni 29·74 = 99·88. Flight identifies this with the *meteorin* of Abel, see Zimmermann, Jb. Min., 557, 1861. Named after George Edmonson, Head Master of Queenwood College, Hampshire.

CHALYPITE *Shepard*, Am. J. Sc., **43**, 28, 1867.—A compound of iron and carbon found by Forchhammer as a leading constituent of the Niakornak iron. The carbon varied from 7–11 p. c. Meunier uses the name (Ann. Ch. Phys., **17**, 36, 1869; cf. also Météorites, p. 52), and introduces another, Campbellite, for a compound with C = 1·50 p. c., assumed by him as present in the Campbell Co., Tenn., meteoric iron, which was analyzed by J. L. Smith, Am. J. Sc., **19**, 159, 1855.

COHENITE *E. Weinschenk*, Ann. Mus. Wien, **4**, 94, 1889.

In crystals, probably isometric but distorted. Brittle. H. = 5·5–6. G. = 6·977. Luster metallic. Color tin-white, becoming bronze-yellow on exposure. Composition $(Fe,Ni,Co)_3C$. Analysis, after deducting a little schreibersite: $\frac{2}{2}$ Fe 89·88, Ni(Co) 3·71, C 6·41, Sn, Cu *tr.*=100. Named after Dr. E. Cohen of Greifswald.

SCHREIBERSITE *Haid.*, Haid. Ber., **3**, 69, 1847. Phosphornickeleisen *Germ.*

Crystallized; also in steel-gray folia and grains. In some cases brittle; again in flexible folia. H. = 6·5. G. = 7·01–7·22, Haid. Magnetic.

A phosphide of iron and nickel, $(Fe,Ni)_3P$, in part $Fe_2NiP$ = Phosphorus 15·4, iron 55·5, nickel 29·1 = 100. Analyses: 1, Patera, Haid. Ber., l. c., and Am. J. Sc., **8**, 439, 1849. 2, Fisher, Am. J. Sc., **19**, 157, 1855. 3–5, J. L. Smith, ib. 6, Meunier, Ann. Ch. Phys., **17**, 43, 1869. 7, W. Flight, Phil. Trans., 892, 1882. 8, Cohen, Jb. Min., **1**, 219, 1889.

| | P | Fe | Ni | Co | |
|---|---|---|---|---|---|
| 1. Arva | 7·26 | 87·20 | 4·24 | — | =98·70 |
| 2. Braunau | 11·72 | 55·43 | 25·02 | — | C 1·16, Cr 2·85, $SiO_2$ 0·98=97·16 |
| 3. E. Tennessee | 13·92 | 57·22 | 25·82 | 0·32, | Cu, Zn *tr.*, Cl 0·13, $SiO_2$ 1·62, $Al_2O_3$ 1·63=100·66 |
| 4. " G.=7·027 | *undet.* | 56·04 | 26·43 | 0·41, | Cu *tr.* |
| 5. " | 14·86 | 56·53 | 28·02 | 0·28, | Cu *tr.*=99·69 |
| 6. Toluca, G.=7·103 | 15·01 | 57·11 | 28·35 | *tr.* | Mg *tr.*=100·47 |
| 7. Cranbourne $\frac{2}{2}$ | 13·50 | 56·12 | 29·18 | — | =98·80 |
| 8. S. Juliao de Moreira $\frac{2}{2}$ | 15·74 | 69·54 | 14·86 | — | =100·14 |

Flight gives analyses of other compounds corresponding nearly to $Fe_9Ni_2P_4$ and $(Fe,Ni)_4P$. An iron-nickel phosphide from the Deesa iron gave Meunier: P 10·29, Fe 60·00, Ni 26·75=97·04.

Schreibersite is named after Director Carl Fr. A. von Schreibers of Vienna (1775–1882). On Schreibersite of Shepard, see p. 79.

RHABDITE *Rose.*—A phosphide of iron and nickel, occurring in minute tetragonal prisms distributed parallel to the cubic edges in the meteoric irons of Braunau, Seeläsgen, Misteca. A similar compound occurs in the Cranbourne, Australia, iron, in brittle square prisms, with G. = 6·33–6·78. Analysis, Flight, Phil. Trans., 891, 1882:

$\frac{2}{2}$ P 12·95 Fe 49·34 Ni 38·24 = 100·53

An iron phosphide, formed by combustion in the coal mines of Commentry, France, is referred here by Mallard. Tetragonal. Axis $\dot{c}$ = 0·4880. Forms: *a* (100), *m* (110), *e* (101); 001 ∧ 101 = 26° 1′; *me* = *71° 56′, *ee′* = 36° 8′. Hard. G. = 7·14. Luster metallic. Color steel-gray. Brittle. Magnetic. Analysis, Carnot: P 12·10, Fe 84·28, As 1·65, S 1·75, C *tr.*=99·78. Bull. Soc. Min., **4**, 230, 1881.

APPENDIX.—Meteorites are usually classified according to the amount of iron they contain, as follows:

(*a*) *Meteoric iron* proper, *siderites* or *holosiderites* of Daubrée, consisting of iron alone with only occasional veins, grains or nodules of troilite, carbon as graphite or diamond (cf. cliftonite, p. 6), schreibersite, daubreelite, etc. Iron protochloride, lawrencite, is often present, and exudes forming drops of $FeCl_3$ on the surface and often leading to rapid disintegration of the mass.

Upward of one hundred localities of these have been noted, and in a few instances they have been seen to fall.* Some of the masses are very large; the *Butcher* irons of the Bolson de Mapini in the States of Chihuahua and Coahuila, Mexico, include several masses, one estimated to weigh 5 tons. The Red River, Texas, iron (anal. 7) weighs 1635 pounds.

(*b*) *Siderolites* or *syssiderites* of Daubrée, consisting of a more or less continuous spongy mass of iron with embedded grains chiefly of chrysolite, like the Pallas Iron of Krasnoyarsk, Siberia

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* The most important cases are Agram, Croatia, May 26, 1751; Charlotte, Tenn., Aug. 1, 1835; Braunau, Bohemia, July 14, 1847; Tabarz, Saxony, Oct. 18, 1854; Rowton, Shropshire, England, April 20, 1876; Mazapil, Mexico, Nov. 27, 1885; Cabin Creek, Johnson county, Arkansas, March 22, 1886.

(hence called by Rose *pallasites*), which was brought to St. Petersburg by Pallas in 1772 and which weighed originally 1600 pounds. Masses of a meteorite, closely resembling the Pallas Iron, were found in Kiowa Co., Kansas, in March, 1890; they aggregated from 1000 to 1200 lbs. The siderolites graduate through the kinds in which the iron is more scattered (*mesosiderites* of Rose), though forming a large part of the whole, to the meteoric stones.

(*c*) *Meteoric stones, sporadosiderites* of Daubrée, in which iron is more or less disseminated through the mass, including as named by Daubrée the *polysiderites*, *oligosiderites* and *cryptosiderites*. Those stones which contain no iron are called by him *asiderites*.

Meteoric stones have also been classified according to the silicates present in largest amount, and a large number of names introduced, chiefly taken from the names of localities, by Rose, Shepard, Tschermak, Meunier, Wadsworth and others. Many stones are characterized by the presence often to large extent of *chondrules*, or small spherical grains from the size of a cherry down, consisting usually of chrysolite or enstatite (cf. these species), the latter often with eccentric radiated structure—these stones are hence called *chondrites*.

Specimens of two hundred and fifty independent occurrences of meteoric stones have been preserved, and for most of them the date and often the circumstances of the fall are known. In some cases large numbers of stones are the result of a single fall, as that of Pultusk, Poland, in Jan. 30, 1868. Of the Estherville, Iowa, meteorite (siderolite) in addition to large masses weighing 450, 200, 95 lbs., and others, about 60 pounds of minute individuals were picked up, mostly weighing less than an ounce and the smallest of the size of shot, these last chiefly iron. Another fall, remarkable for the number of small stones found, was that of Winnebago Co., Iowa, on May 2, 1890.

**Ref.**—[1] On the Greenland irons, see Nordenskiöld, Öfv. Ak. Stockh., 1058, 1870, and 1, 1871, or Geol. Mag., **9**, 1872; Nordström. Öfv. Ak. Stockh., 453, 1871; Nauckhoff, ib., Bihang, **1**, April, 1872 (or Min. Mitth., 109, 1874); Daubrée, C. R. **74**, 1541, 1872, and **75**, 240, 1872, and **84**, 66, 1877; Wöhler, Gött. Gelehrt. Anzeig., 197, 1872, and Jb. Min., 832, 1879; Tschermak, Min. Mitth., 165, 1874; Steenstrup, Ved. Medd. Copenhagen, 1875, Nos. 16–19 (or Zs. G. Ges., **28**, 225, 1876); Törnebohm, Öfv. Ak. Stockh., Bihang, 1878; Meunier. C. R., **89**, 215, 1879; J. Lawrence Smith, Ann. Ch. Phys., **16**, 452, 1879; J. Lorenzen, Medd. Grönland, 1883, also in Min. Mag., **6**, 14, 1884.

[2] On the crystalline structure of iron in general, see Tschermak, Ber. Ak. Wien, **70** (1), 449, 1874, who also gives the early literature of the subject. Also, [3] on the Widmanstätten and related figures, see Breithaupt, Schweig. J., **52**, 172, 1828, who gives the history of the name; also Neumann, Nat. Abh. Haid., **3**, pt. 2, 45, 1850; Reichenbach, Pogg., **114**, 99, 250, 264, 477, 1861; Rose, see below; Brezina, Denkschr. Ak. Wien, **43**, 1880, **44**, 1881; Huntington, Proc. Amer. Acad., May 12, 1886, or Am. J. Sc., **32**, 284, 1886.

[4] On the gases occluded in meteorites, see Graham, Proc. Roy. Soc., **15**, 502, 1867; Mallet, ib., **20**, 365, 1872; Wright, Am. J. Sc., **9**, 294, 459, **10**, 44, 1875; Flight, Phil. Trans., 1882; Ansdell and Dewar, Proc. Roy. Soc., **40**, 549, 1886.

[5] On the classification of meteorites and the subject in general: Reichenbach, Pogg., **107**, 155, 1859; Rose, Beschreibung und Eintheilung der Meteoriten, etc., Abh. Ak. Berlin, 23, 1863; Daubrée, C. R., **65**, 60, 1867; Shepard, Am. J. Sc., **43**, 22, 1867 (and others earlier); Tschermak, Ber. Ak. Wien, **71** (1), 1875, **75** (1), 1877, **88** (1), 1883; Brezina (see below). Also Die mikroskopische Beschaffenheit der Meteoriten, 1883 et seq. S. Meunier, Météorites, 532 pp., Paris 1884 (Encycl. Chem., vol. **2**, Frémy); Wadsworth, Lithological Studies, Mem. Mus. Zool., Cambridge **11**, 1884, who gives many observations on microscopic structure, also tables of analyses.

On the spectra of meteorites, discussion of origin, etc., see Lockyer, Nature, 1889; also on the latter subject, Newton, Tschermak and others.

See also Rg., Min. Ch., 901, 952, 1860, and Die chemische Natur der Meteoriten, Abh. Ak. Berlin, 75, 1870, 1, 1879; Buchner. Die Meteoriten, etc., 202 pp., Leipzig, 1863; Daubrée, Études synthétiques de géologie expérimentale, Paris; Early papers of importance include those by Chladni, Howard, Biot, Carl von Schreibers, Haidinger, etc.; also, later, Tschermak, Daubrée, Maskelyne, Brezina, J. Lawrence Smith (collected in Original Researches, etc., 1884); W. Flight (collected in "A Chapter on Meteorites," 1887), and many others.

For a list of meteorites with localities, dates, etc., see the catalogues of the Vienna collection (Brezina, Jb. G. Reichs., 151–276, 1885), of the British Museum (Fletcher, 1888), of the Muséum d'Histoire Naturelle, Paris (Daubrée, 1889), and others. A catalogue of the Yale collection (E. S. D.) is given in Am. J. Sc., **32**, appendix, 1886; one of the Harvard collection by O. W. Huntington in Proc. Am. Acad., **23**, 1887.

## II. SULPHIDES, SELENIDES, TELLURIDES, ARSENIDES, ANTIMONIDES.

The sulphides fall into two Groups according to the character of the positive element.

**I. Sulphides, Selenides, Tellurides of the Semi-Metals.**

**II. Sulphides, Selenides, Tellurides, Arsenides, Antimonides of the Metals.**

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### I. Sulphides, Selenides, Tellurides of the Semi-Metals, Arsenic, Antimony, Bismuth; also Molybdenum.

#### 1. Realgar Group. RS. Monoclinic.

| | | | $\grave{a} : \bar{b} : \grave{c}$ | $\beta$ |
|---|---|---|---|---|
| 26. | **Realgar** | $AsS$ | 1·4403 : 1 : 0·9729 | 66° 5′ |

#### 2. Stibnite Group. $R_2S_3$. Orthorhombic.

| | | | $\breve{a} : \frac{2}{3}\bar{b} : \grave{c}$ |
|---|---|---|---|
| 27. | **Orpiment** | $As_2S_3$ | 0·9046 : 1 : 1·0014 |
| | | | $\breve{a} : \bar{b} : \grave{c}$ |
| 28. | **Stibnite** | $Sb_2S_3$ | 0·9926 : 1 : 1·0179 |
| | Metastibnite. | | |
| 29. | **Bismuthinite** | $Bi_2S_3$ | 0·9679 : 1 : 0·9850 |
| 30. | **Guanajuatite** | $Bi_2Se_3$ | 1 : 1 approx. |

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| | | | | $rr'$ | $c$ |
|---|---|---|---|---|---|
| 31. | **Tetradymite** | $Bi_2Te_3$<br>$2Bi_2Te_3.Bi_2S_3$ | Rhombohedral | 98° 58′ | 1·5871 |

32. **Joseite.** 33. **Wehrlite.**

#### 3. Molybdenite Group. $RS_2$.

| | | | |
|---|---|---|---|
| 34. | **Molybdenite** | $MoS_2$ | Hexagonal or rhombohedral (?) |

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#### 1. Realgar Group.

**26. REALGAR.** *Σανδαράκη Theophr.*, 325 B.C. *Σανδαραχη Dioscor.*, 50 A.D. Sandaracha *Plin.*, 35, 6, 77 A.D. Sandaracha *Germ.* Reuschgeel, Rosgeel, *Agric.*, 444, etc., 1529, Interpr., 468, 1546. Rauschgelb pt., Arsenicum sulphure mixtum, Risigallum pt., Realgar, Arsenicum rubrum, *Wall.*, 224, 1747. Arsenic rouge *Fr.* *Trl.* Wall., 406, 1753. Realgar natif, Rubine d'Arsenic *de Lisle*, 3, 333, 1783. Red Sulphuret of Arsenic. Rothes Rauschgelb, *Germ.* Arsenic sulfuré rouge *Fr.* Risigallo *Ital.* Rejalgar *Span.*

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 1·4403 : 1 : 0·9729$; $\beta = {}^*66° \; 5' = 001 \wedge 100$ Marignac[1].

$100 \wedge 110 = 52° \; 47'$, $001 \wedge 101 = 40° \; 22\frac{1}{2}'$, $001 \wedge 011 = 41° \; 39'$.

**Forms**[2]:
$a$ (100, $i\text{-}\bar{i}$)
$b$ (010, $i\text{-}\grave{i}$)
$c$ (001, $O$)
$h$ (610, $i\text{-}\bar{6}$)[3]
$i$ (410, $i\text{-}\bar{4}$)
$\gamma$ (310, $i\text{-}\bar{3}$)[5]

$g$ (520, $i\text{-}\bar{\tfrac{5}{2}}$)
$l$ (210, $i\text{-}\bar{2}$)
$\beta$ (320, $i\text{-}\bar{\tfrac{3}{2}}$)[5]
$w$ (430, $i\text{-}\bar{\tfrac{4}{3}}$)
$e$ (650, $i\text{-}\bar{\tfrac{6}{5}}$)[5]
$m$ (110, $I$)
$h$ (670, $i\text{-}\grave{\tfrac{7}{6}}$)[3]
$v$ (230, $i\text{-}\grave{\tfrac{3}{2}}$)

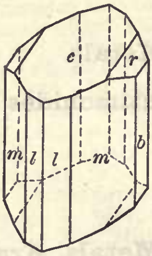
$\mu$ (120, $i\text{-}\grave{2}$)
$\delta$ (250, $i\text{-}\grave{\tfrac{5}{2}}$)[6]
$\xi$ (101, $-1\text{-}\bar{i}$)[3]
$x$ ($\bar{1}01$, $1\text{-}\bar{i}$)
$z$ ($\bar{2}01$, $2\text{-}\bar{i}$)
$r$ (012, $\tfrac{1}{2}\text{-}\grave{i}$)
$t$ (034, $\tfrac{3}{4}\text{-}\grave{i}$)[5]

$q$ (011, $1\text{-}\grave{i}$)
$y$ (032, $\tfrac{3}{2}\text{-}\grave{i}$)
$X$ (052, $\tfrac{5}{2}\text{-}\grave{i}$)[7]
$\phi$ ($\bar{1}12$, $\tfrac{1}{2}$)[5]
$e$ ($\bar{1}11$, 1)
$\pi$ ($\bar{2}21$, 2)[3,4]
$G$ (214, $-\tfrac{1}{2}\text{-}\bar{2}$)

$f$ (212, $-1\text{-}\bar{2}$)
$\lambda$ ($\bar{1}\bar{5}\cdot1\cdot15$, $1\text{-}\bar{15}$)[5]
$s$ ($\bar{6}16$, $1\text{-}\bar{6}$)[5]
$\eta$ ($\bar{6}12$, $3\text{-}\bar{6}$)
$\sigma$ ($\bar{4}14$, $1\text{-}4$)[5]
$d$ ($\bar{4}12$, $2\text{-}\bar{4}$)
$\tau$ ($\bar{2}14$, $\tfrac{1}{2}\text{-}\bar{2}$)
$n$ ($\bar{2}12$, $1\text{-}\bar{2}$)

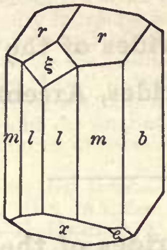
$H$ ($\bar{2}11$, $2\text{-}\bar{2}$)[3]
$u$ ($\bar{4}21$, $4\text{-}\bar{2}$)
$E$ ($\bar{4}3\bar{4}$, $1\text{-}\bar{\tfrac{4}{3}}$)[6]
$o$ ($\bar{4}32$, $2\text{-}\bar{\tfrac{4}{3}}$)[4]
$k$ ($\bar{2}32$, $\tfrac{3}{2}\text{-}\tfrac{3}{2}$)
$F$ ($\bar{1}21$, $2\text{-}\grave{2}$)[6]
$\phi$ ($\bar{1}41$, $4\text{-}\grave{4}$)[7]

1.



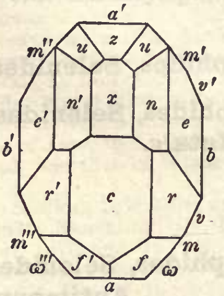
Nagyág.

2.



Binnenthal, Hbg.

3.



Nagyág?, Mlr.

$ii'''$ = 36° 26′
$\gamma\gamma'''$ = 47° 23½′
$gg'''$ = 55° 33′
$ll'''$ = 66° 43′
$mm'''$ = *105° 34′
$vv'$ = 53° 43′

$ac$ = 66° 5′
$c\xi$ = 25° 52′
$a'x$ = 73° 32½′

$cz$ = 69° 53′
$a'z$ = *44° 2′
$rr'$ = 47° 57′
$qq'$ = 83° 81′
$yy'$ = 106° 17′

$c\phi$ = 32° 6′
$ce$ = 56° 9′
$cm'$ = 104° 12′

$cf$ = 30° 51′
$cn$ = 46° 20′
$cd$ = 70° 59′

$a'e$ = 78° 3′
$af$ = 43° 14½′
$ar$ = 68° 15½′
$a'n$ = 75° 7′
$a'd$ = 47° 4′
$a'u$ = 41° 3′

$bf$ = 72° 33′
$bn$ = 64° 59′
$be$ = 46° 59′
$bd$ = 71° 19′
$ff'$ = 34° 53′
$ee'$ = 86° 2′

$uu'$ = 71° 29′
$nn'$ = 50° 1′
$dd'$ = 37° 22′

Crystals short prismatic. Faces in prismatic zone striated vertically. Also granular, coarse or fine; compact; as an incrustation.

Cleavage: *b*, rather perfect; *c*, *a*, *m*, less so; also *l* (Dx.). Fracture small conchoidal. Sectile. H. = 1·5–2. G. = 3·556. Luster resinous. Color aurora-red or orange-yellow. Streak varying from orange-red to aurora-red. Transparent—translucent. Optically −. Double refraction strong. Ax. plane ∥ *b*. Bx $\wedge \dot{c} = +11°$. Dispersion inclined, strong. $2H_r = 96° 20'$, $2H_y = 92° 58'$, Dx.[8].

**Comp.**—Arsenic monosulphide, AsS = Sulphur 29·9, arsenic 70·1 = 100.

**Pyr., etc.**—In the closed tube melts, volatilizes, and gives a transparent red sublimate; in the open tube (if heated very slowly) sulphurous fumes, and a white crystalline sublimate of arsenic trioxide. B.B. on charcoal burns with a blue flame, emitting arsenical and sulphurous odors. Soluble in caustic alkalies.

**Obs.**—Often associated with orpiment; occurs with ores of silver and lead, at Felsöbánya and Kapnik in Hungary, Nagyág in Transylvania, at Joachimsthal in Bohemia, at Schneeberg in Saxony, at Andreasberg in the Harz; at Tajowa in Hungary, in beds of clay; Binnenthal, Switzerland, in dolomite; at Wiesloch in Baden, in the Muschelkalk; on quartz in phyllyte at Kreševo, Bosnia; near Julamerk in Kurdistan; in Vesuvian lavas, in minute crystals, and the solfataras near Naples; also in the trachytic region of Tolfa near Rome, in the calcite veins of a micaceous sandstone. Strabo speaks of a mine of *sandaraca* (the ancient name of this species) at Pompeiopolis in Paphlagonia.

In the U. S., in seams in a sandy clay beneath the lava in Iron county, Utah; also in California, 40 miles from the Needles, San Bernardino Co., and in Trinity Co., in calcite; Norris Geyser Basin, Yellowstone National Park, where it occurs with orpiment as a deposition from the hot waters.

The name *realgar* is from the Arabic Rahj al ghār, *powder of the mine*.

**Alt.**—Changes on exposure to light to orpiment ($As_2S_3$) and arsenolite ($As_2O_3$).

**Artif.**—Obtained in monoclinic crystals by Sénarmont, C. R., **32**, 411, 1851.

**Ref.**—[1] Quoted by Dx., Ann. Ch. Phys., **10**, 422, 1844; with Naumann the vertical axis has one-half this length. [2] See Hbg., Min. Not., **1**, 14, 1856; **3**, 3, 1860; also Mlr., Min. 177, 1852, and earlier Scc., Mem. G. Camp., 110, 1849; Lévy, Min. Heul., **3**, 277, 1837.

[3] Hbg., l. c., all Binnenthal except *h* and *H* from Berezov. [4] Groth, Binnenthal, Min. Samml., 20, 1878. [5] Fletcher, Phil. Mag., **9**, 189, 1880. [6] Knr., Kreševo, Bosnia, Földt. Közl., **13**, 383, 1883. [7] Vrba, Kreševo, Zs. Kr., **15**, 460, 1889. [8] Propt. Opt. **2**, 68, 1858; N. R., 166, 1865.

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## 2. Stibnite Group.

**27. ORPIMENT.** Ἀῤῥενικόν *Theophr.* Ἀρσενικόν *Dioscor.* Auripigmentum, Arrhenicum, *Plin.*, **33**, 22, **34**, 56. Auripigmentum, *Germ.*, Operment, *Agric.*, Interpr., 463, 1546. Orpiment. Rauschgelb pt., Risigallum pt., Arsenicum flavum, *Wall.*, 224, 1747. Arsenic jaune *Fr.trl.* Wall., **1**, 406, 1753. Gelbe Arsenblende, gelbes Rauschgelb, *Germ.* Arsenic sulphuré jaune *Fr.* Orpimento *Ital.* Oropiment *Span.* Yellow sulphuret of Arsenic.

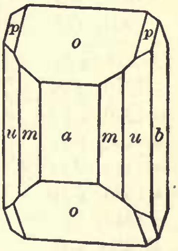
Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c} = 0{\cdot}60304 : 1 : 0{\cdot}67427$ Mohs[1].
$100 \wedge 110 = 31^\circ\ 5\tfrac{1}{2}'$, $001 \wedge 101 = 48^\circ\ 11\tfrac{1}{2}'$, $001 \wedge 011 = 33^\circ\ 59\tfrac{1}{2}'$.

**Forms**[1]: *a* (100, *i*-ī), *b* (010, *i*-ĭ), *t* (710, *i*-7̄)[4], *s* (320, $i\text{-}\bar{\tfrac{3}{2}}$), *m* (110, *I*), *u* (120, *i*-2̆); *o* (101, 1-ī), *p* (111, 1); *β* (232, $\tfrac{3}{2}\text{-}\tfrac{3}{2}$)[2], *v* (121, 2-2̆)[3].

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *ss'''* | = | 43° 48′ | *pp'* | = | 85° 40′ | *ββ'* | = | 76° 21′ | *vv'* | = | 67° 20′ |
| *mm'''* | = | *62° 11′ | *pp''* | = | 105° 6′ | *ββ''* | = | 112° 53′ | *vv''* | = | 120° 34′ |
| *uu'* | = | 79° 20′ | *pp'''* | = | 48° 24½′ | *ββ'''* | = | 67° 59′ | *vv'''* | = | 83° 55′ |
| *oo'* | = | *96° 23′ | | | | | | | | | |

Crystals small and rarely distinct. Usually in foliated or columnar masses; sometimes with reniform surface.

1.



Cleavage: *b* highly perfect, cleavage face vertically striated; *a* in traces; gliding-plane 001 (Mgg., cf. stibnite). Sectile. Cleavage laminæ flexible, inelastic. H. = 1·5–2. G. = 3·4–3·5. 3·480 Mohs. Luster pearly on *b* (cleavage); elsewhere resinous. Color lemon-yellow of several shades; streak the same, but paler. Subtransparent—subtranslucent. Optically +. Ax. pl. ∥ *c*. Bx ⊥ *a*. Ax. angle large, Dx.[5]

**Comp.**—Arsenic trisulphide, $As_2S_3$ = Sulphur 39·0, arsenic 61·0 = 100.

**Pyr., etc.**—In the closed tube, fuses, volatilizes, and gives a dark yellow sublimate; other reactions the same as under realgar. Dissolves in aqua regia and caustic alkalies.

**Obs.**—Orpiment in small crystals is embedded in clay at Tajowa, near Neusohl in Upper Hungary. It is usually in foliated and fibrous masses, and in this form is found at Moldawa in the Banat; at Kapnik and also Felsöbanya in Hungary it exists in metalliferous veins, associated with realgar and native arsenic; at Kreševo, Bosnia, on quartz crystals in a micaceous phyllyte; at Hall in the Tyrol it is found in gypsum; at Wiesloch in Baden in the Muschelkalk; at St. Gothard in dolomite; with calcite in a micaceous sandstone in the trachytic region of Tolfa, near Civita Vecchia, Italy; at the Solfatara near Naples it is the result of volcanic sublimation; in Fohnsdorf, Styria, found in brown coal. Near Julamerk in Kurdistan there is a large Turkish mine. Occurs also at Acobambillo, Peru. Small traces are met with at Edenville, Orange Co., N. Y., on arsenical iron. Occurs with realgar in seams in compact clay beneath lava in Iron county, Utah. Occurs among the deposits of the Steamboat Springs, Nevada (Becker); also with realgar in the Yellowstone Park.

The name orpiment is a corruption of its Latin name auripigmentum, "*golden paint,*" given in allusion to the color, and also because the substance was supposed to contain gold.

**Artif.**—A common artificial product, sometimes called King's yellow (Königsgelb *Germ.*).

**Ref.**—[1] Min., **2**, 613, 1824; some authors make *m* = 120, with Groth *m* = 320. [2] Phillips gives a doubtful prism *g* with *gu* = 2° 6′ (6·13·0?), Min., 277, 1823; for *β* he gives *βo* = 34° 10′. [3] Mlr. Min., 176, 1852. [4] Knr., Földt. Közl., **13**, 381, 1883. [5] Bull. Soc. Min., **5**, 108, 1882.

DIMORPHITE. Dimorfina *A. Scacchi*, Mem. Geol. Campania, Napoli, 116, 1849.

Minute (to ½ mm.) orange-yellow crystals with adamantine luster. H. = 1·5. G. = 3·58. A sulphide of arsenic ($As_4S_3$ suggested). From a fumarole of the Solfatara, Phlegræan fields. Described as occurring in two types. TYPE A with $\breve{a} : \bar{b} : \grave{c} = 0{\cdot}895 : 1 : 0{\cdot}776$, and the forms *C* (100), *B* (010), *A* (001), *o* (110), *o*2 (120), *e* (011), *m* (111). TYPE B with $\breve{a} : \bar{b} : \grave{c} = 0{\cdot}907 : 1 : 0{\cdot}603$, and the forms *C* (100), *B* (010), *o*2 (120), *i* (101), *e* (011), *m* (111). In the positions taken the lateral axes are nearly equal, while the vertical axes are as 9 : 7 (or 5 : 4 or 4 : 3 approx.). Type A, however (see 4th ed. p. 32), is near orpiment in habit and angles and probably identical with it. This is seen when the crystals are placed so that $C$, $B$, $A$, $o$, $o2$, $e$, $m$ correspond to $a$, 001, $b$, $o$, 102, 021, $v$. Then $\breve{a}:\bar{b}:\dot{c} = 0{\cdot}5765 : 1 : 0{\cdot}6441$. The angles for dimorphite (Scc., meas.) and orpiment (calc.) are respectively: $oo'$ = *96° 20′, 96° 33′; $102 \wedge \bar{1}02$ = 58° 19′, 58° 28′; $b \wedge 021$ = 38° 5′, 36° 32′; $av$ = 55° 37′, 56° 19′, $bv$ = *49° 20′, 48° 2′.

The relations of type B are less clear; in the position corresponding to the above, the planes $C$, $B$, $o2$, $i$, $e$, $m$ may perhaps be $a$, $b$, 102, 250, 052, 252. The angles are then for dimorphite (Scc., meas.) and orpiment (calc.) respectively: $102 \wedge \bar{1}02$ = 58° 12′, 58° 28′; $010 \wedge 052$ = 31° 9′, 30° 39′, etc.

Or if placed so that $e$ dimorphite ($ee$ = 62° 18′) corresponds to $m$ orpiment ($mm'''$ = 62° 17′), then, as shown by Kenng. (Jb. Min., 537, 1870), the planes become 001, $b$, 083, 403, $m$, 443. In the latter case the correspondence of angle is closer.

**28. STIBNITE.** *Στίμμι*, *Στίβι*, *Πλατυόφθαλμον*, *Dioscor.* Stimmi, Stibi, Stibium, *Plin.*, 33, 33, 34. Stibi, Spiessglas, *Basil Valentine* (who proved it to contain sulphur), 1430. Lupus metallorum *Alchem.* Spiess-Glass-Erz *Brückmann*, Berkwerke, 1727. Spitsglasmalm, Minera Antimonii, Antimonium Sulphure mineralisatum, *Wall.*, 237, 1747. Grauspiessglaserz, Grauspiessglanzerz, Antimonglanz, *Germ.* Antimoine sulfuré *Fr.* Sulphuret of Antimony; Gray Antimony; Antimony Glance. Stibina, Antimonio grigio *Ital.* Antimonio gris *Span.* Stibine *Beud.*, Tr., **2**, 421, 1832. Antimonit *Haid.*, Handb., 568, 1845. Stibnite *Dana*, Min. 1854.

Orthorhombic. Axes $\breve{a}:\bar{b}:\dot{c} = 0{\cdot}99257 : 1 : 1{\cdot}01788$ E. S. D.[1]
$100 \wedge 110 = 44°\ 47'\ 11''$, $001 \wedge 101 = 45°\ 43'\ 16''$, $001 \wedge 011 = 45°\ 30'\ 28''$.

**Forms**[2]:
$a$ (100, $i$-$\bar{i}$)
$b$ (010, $i$-$\breve{i}$)
$c$ (001, $O$)$^3$
$h$ (310, $i$-$\bar{3}$)
$n$ (210, $i$-$\bar{2}$)
$\iota$ (320, $i$-$\bar{\frac{3}{2}}$)$^4$
$k$ (430, $i$-$\bar{\frac{4}{3}}$)
$m$ (110, $I$)
$\kappa$ (560, $i$-$\breve{\frac{6}{5}}$)$^4$
$r$ (340, $i$-$\breve{\frac{4}{3}}$)
$d$ (230, $i$-$\breve{\frac{3}{2}}$)
$l$ (350, $i$-$\breve{\frac{5}{3}}$)
$o$ (120, $i$-$\breve{2}$)
$\chi$ (250, $i$-$\breve{\frac{5}{2}}$)
$q$ (130, $i$-$\breve{3}$)
$i$ (140, $i$-$\breve{4}$)
$t$ (150, $i$-$\breve{5}$)
$\vartheta$ (160, $i$-$\breve{6}$)$^4$
$\theta$ (170, $i$-$\breve{7}$)$^4$
$R$ (106, $\frac{1}{6}$-$\bar{i}$)
$L$ (103, $\frac{1}{3}$-$\bar{i}$)
$y$ (102, $\frac{1}{2}$-$\bar{i}$)
$\Sigma$ (203, $\frac{2}{3}$-$\bar{i}$)$^4$
$z$ (101, 1-$\bar{i}$)
$\Phi$ (901, 9-$\bar{i}$)$^4$
$\gamma$ (013, $\frac{1}{3}$-$\breve{i}$)
$x$ (012, $\frac{1}{2}$-$\breve{i}$)
$N$ (023, $\frac{2}{3}$-$\breve{i}$)
$u$ (011, 1-$\breve{i}$)
$Q$ (043, $\frac{4}{3}$-$\breve{i}$)
$J$ (053, $\frac{5}{3}$-$\breve{i}$)
$\Pi$ (021, 2-$\breve{i}$)$^4$
$j$ (031, 3-$\breve{i}$)
$Y$ (041, 4-$\breve{i}$)$^4$
$g$ (092, $\frac{9}{2}$-$\breve{i}$)$^3$
$\mathfrak{h}$ (3·3·17, $\frac{3}{17}$)$^5$
$\mathfrak{g}$ (3·3·13, $\frac{3}{13}$)$^5$
$\mu$ (114, $\frac{1}{4}$)$^4$
$\mathfrak{f}$ (5·5·19, $\frac{5}{19}$)$^5$
$\nu$ (227, $\frac{2}{7}$)$^4$
$s$ (113, $\frac{1}{3}$)
$\pi$ (112, $\frac{1}{2}$)
$\sigma_2$ (223, $\frac{2}{3}$)$^4$
$\mathfrak{n}$ (445, $\frac{4}{5}$)$^6$
$\mathfrak{y}$ (9·9·10, $\frac{9}{10}$)$^6$
$p$ (111, 1)
$\xi$ (331, 3)
$\Psi$ (829, $\frac{8}{9}$-$\bar{4}$)$^4$
$M$ (413, $\frac{4}{3}$-$\bar{4}$)
$\sigma_1$ (629, $\frac{2}{3}$-$\bar{3}$)$^4$
$\lambda_1$ (313, 1-$\bar{3}$)$^4$
$\omega_1$ (523, $\frac{5}{3}$-$\bar{\frac{5}{2}}$)$^4$
$T$ (521, 5-$\bar{\frac{5}{2}}$)$^4$
$f$ (214, $\frac{1}{2}$-$\bar{2}$)
$\sigma$ (213, $\frac{2}{3}$-$\bar{2}$)
$\mathfrak{u}$ (211, 2-$\bar{2}$)
$\lambda_2$ (323, 1-$\bar{\frac{3}{2}}$)$^4$
$\alpha$ (434, 1-$\bar{\frac{4}{3}}$)
$X$ (431, 4-$\bar{\frac{4}{3}}$)$^4$
$\lambda_3$ (656, 1-$\bar{\frac{6}{5}}$)$^4$
$\epsilon$ (878, 1-$\bar{\frac{8}{7}}$)
$Z$ (9·10·3, $\frac{10}{3}$-$\breve{\frac{10}{9}}$)$^4$
$\beta$ (676, $\frac{7}{6}$-$\breve{\frac{7}{6}}$)
$\delta$ (4·5·12, $\frac{5}{12}$-$\breve{\frac{5}{4}}$)$^4$
$\Gamma$ (346, $\frac{2}{3}$-$\breve{\frac{4}{3}}$)$^4$
$\tau$ (343, $\frac{4}{3}$-$\breve{\frac{4}{3}}$)
$\mathfrak{x}$ (15·20·16, $\frac{5}{4}$-$\breve{\frac{4}{3}}$)$^6$
$D$ (15·20·3, $\frac{20}{3}$-$\breve{\frac{4}{3}}$)$^4$
$\sigma_3$ (233, 1-$\breve{\frac{3}{2}}$)$^4$
$W$ (20·30·9, $\frac{10}{3}$-$\breve{\frac{3}{2}}$)$^4$
$E$ (10·15·3, 5-$\breve{\frac{3}{2}}$)$^4$
$\omega_2$ (583, $\frac{8}{3}$-$\breve{\frac{8}{5}}$)$^4$
$\eta$ (353, $\frac{5}{3}$-$\breve{\frac{5}{3}}$)$^4$
$F$ (15·25·6, $\frac{25}{6}$-$\breve{\frac{5}{3}}$)$^4$
$e$ (123, $\frac{2}{3}$-$\breve{2}$)
$\sigma_4$ (243, $\frac{4}{3}$-$\breve{2}$)$^4$
$v$ (121, 2-$\breve{2}$)
$\omega_3$ (5·10·3, $\frac{10}{3}$-$\breve{2}$)$^4$
$A$ (361, 6-$\breve{2}$)
$\omega_4$ (5·11·3, $\frac{11}{3}$-$\overset{\frown}{\frac{11}{5}}$)$^4$
$H$ (255, 1-$\breve{\frac{5}{2}}$)$^4$
$\sigma_5$ (253, $\frac{5}{3}$-$\breve{\frac{5}{2}}$)$^4$
$\mathfrak{t}$ (133, 1-$\breve{3}$)$^7$
$\sigma_6$ (263, 2-$\breve{3}$)$^4$
$w$ (131, 3-$\breve{3}$)$^4$
$V$ (10·30·9, $\frac{10}{3}$-$\breve{3}$)$^4$
$\sigma_7$ (273, $\frac{7}{3}$-$\breve{\frac{7}{2}}$)$^4$
$\psi$ (146, $\frac{2}{3}$-$\breve{4}$)
$G$ (144, 1-$\breve{4}$)$^4$
$\phi$ (143, $\frac{4}{3}$-$\breve{4}$)
$\sigma_8$ (283, $\frac{8}{3}$-$\breve{4}$)$^4$
$\rho$ (153, $\frac{5}{3}$-$\breve{5}$)
$\sigma_9$ (2·12·3, 4-$\breve{6}$)$^4$

$hh'''$ = 36° 37′
$nn'''$ = 52° 47′
$mm'''$ = 89° 34′
$oo'$ = 53° 28′
$qq'$ = 37° 8′

$LL'$ = 37° 45′
$yy'$ = 54° 17½′
$\Sigma\Sigma'$ = 68° 43′
$zz'$ = 91° 26½′

$\gamma\gamma'$ = 37° 29′
$xx'$ = 53° 57′
$NN'$ = 68° 19′
$uu'$ = 91° 1′
$QQ'$ = 107° 14′

$\Pi\Pi'$ = 127° 41′

$ms$ = 64° 17′
$m\pi$ = 54° 9′
$m\sigma_2$ = 46° 4′
$mp$ = 34° 41′
$m\xi$ = 12° 59½′

$ss'$ = 35° 52½′
$\pi\pi'$ = 49° 7′
$pp'$ = 71° 24½′
$\tau\tau'$ = 62° 37½′
$\eta\eta'$ = *55° 1′
$vv'$ = 48° 39½′
$\omega_3\omega_3'$ = 51° 35′
$ww'$ = 35° 24′

$\psi\psi'$ = 16° 6′
$ee'$ = 31° 35′

$ss''$ = 51° 26′
$pp''$ = 110° 38′
$\tau\tau''$ = 119° 6′
$\eta\eta''$ = 126° 28′
$\omega_3\omega_3''$ = 150° 30′

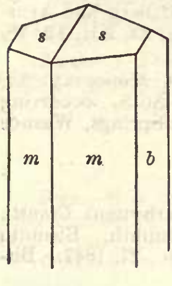
$bp$ = 54° 36′
$b\tau$ = 46° 33′
$b\eta$ = 40° 10½′
$bv$ = 35° 8′
$bw$ = 25° 8′
$b\omega_3$ = 30° 16′
$b\sigma$ = 74° 21′

$b\sigma_2$ = 60° 44½

$ss'''$ = 35° 36′
$\pi\pi'''$ = 48° 44′
$pp'''$ = 70° 48′
$MM'''$ = 22° 39′
$TT'''$ = 42° 35′
$\omega_1\omega_1'''$ = 37° 50′
$\sigma\sigma'''$ = 31° 18′
$\sigma_2\sigma_2'''$ = 58° 31′
$\tau\tau'''$ = 86° 55′
$\eta\eta'''$ = *99° 39′
$\omega_3\omega_3'''$ = 119° 28′

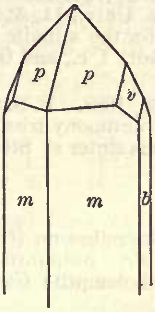
Crystals prismatic, often acutely terminated; vertical planes striated or deeply furrowed longitudinally; crystals often curved, bent in knee-shaped forms or twisted, especially in the axial plane $\bar{b} : \grave{c}$. Common in confused aggregates of acicular crystals, also in radiating groups; massive, coarse or fine columnar, less often granular to impalpable.

1.



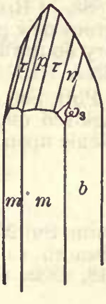
California.

2.



Hungary.

3.

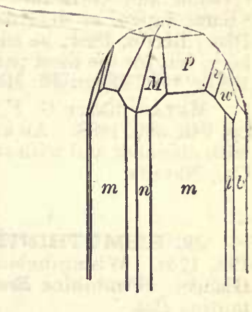


Japan.

4.

Kapnik, Knr.

5.

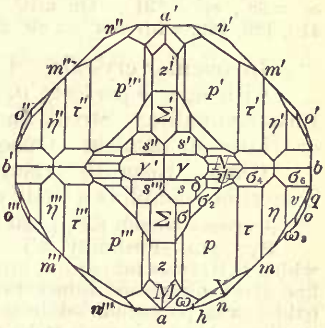


Felsöbánya, Knr.

Cleavage: *b* highly perfect, the face often striated or bent transversely; also *a*, *m* imperfect; *c*, ⊥ to cleavage, a gliding-plane[8]. Crystals flexible under moderate pressure in the plane $\bar{b} : \grave{c}$. Slightly sectile. Fracture small subconchoidal. H. = 2. G. = 4·52–4·62. Luster metallic, highly splendent on cleavage or fresh crystalline surfaces. Color and streak lead-gray, inclining to steel-gray: subject to blackish tarnish, sometimes iridescent.

**Comp.**—Antimony trisulphide, $Sb_2S_3$ = Sulphur 28·6, antimony 71·4 = 100. Sometimes auriferous, also argentiferous.

6.



Japan[4].

**Pyr., etc.**—Fuses very easily (at 1), coloring the flame greenish blue. In the open tube sulphurous ($SO_2$) and antimonial ($Sb_2O_3$) fumes, the latter condensing as a white sublimate which B.B. is non-volatile. On charcoal fuses, spreads out, gives sulphurous fumes, and coats the coal white with antimony trioxide; this coating treated in R.F. volatilizes and tinges the flame greenish blue. When pure perfectly soluble in hydrochloric acid; in nitric acid decomposed with separation of antimony pentoxide.

**Obs.**—Occurs with quartz in beds or veins in granite and gneiss, often accompanied with various other antimony minerals produced by its alteration. Also associated in metalliferous deposits with sphalerite, galena, cinnabar, barite, quartz; sometimes accompanies native gold.

Met with in veins at Wolfsberg, in the Harz; at Bräunsdorf, near Freiberg; at Přibram; at Casparizeche, near Arnsberg, Westphalia; Felsöbánya, Schemnitz, and Kremnitz, in Hungary, where it often occurs in diverging prisms, several inches long, accompanied by crystals of heavy spar and other mineral species; at Pereta, in Tuscany, in crystals; in Ekaterinburg, in the Ural; in Dumfriess-shire, fibrous and laminated; in Cornwall, abundant near Padstow and Tintagel; also crystallized at Wheal Boys; at Hare Hill, in Scotland; in Perthshire. Also found at different Mexican mines. In Algeria. Also abundant in Borneo. In Victoria and New South Wales. Magnificent groups of splendent crystals up to 20 inches in length have been brought from the extensive antimony mines in the Province of Iyo, island of Shikoku, Japan.

In the United States it occurs sparingly at Carmel, Penobscot Co., Me.; at Cornish and Lyme, N. H.; at "Soldier's Delight," Md.; as a vein of considerable extent in Sevier county, Ark.; abundant in California at San Emigdio, Kern county, and near Alta, Benito Co.; also with cinnabar at the Stayton mines, the Knoxville district and elsewhere; in the Humboldt mining region in Nevada, and usually argentiferous; also in the mines of Aurora, Esmeralda Co., Nevada; in Iron county, southern Utah; fine granular and compact in Cœur d'Alene Mts., Shoshone county, Idaho. Also found in New Brunswick in Prince William, York county, 20 m. at Fredericton; in Rawdon township, Hants Co., N. S.; Foster's Bar, Fraser river, B. C.

This ore was employed by the ancients for coloring the hair, eyebrows, etc., to increase the apparent size of the eye; whence they called the ore platyophthalmon (*πλατυόφθαλμον*), from *πλατύς*, *broad*, and *ὀφθαλμός*, *eye*.

**Alt.**—Changes on exposure by partial oxidation to kermesite ($2Sb_2S_3.Sb_2O_3$), and by further oxidation to *valentinite* ($Sb_2O_3$). *Antimony ochre* also results from its alteration.

**Artif.**—Obtained in crystals by several methods, cf. Fouqué-Lévy, Synth. Min., 317, 1882.

**Ref.**—[1] Japan, Am. J. Sc., **26**, 214, 1883. [2] See Krenner for early authorities, etc., and many new planes, Ber. Ak. Wien, **51**, 436, 1865; also Gdt., Index, **1**, 221, 1886, for a careful revision and correction. [3] Slg., Arnsberg, Jb. Min., **1**, 135, 1880. [4] E. S. D., Japan, l. c. [5] Knr., Japan, Földt. Közl., **13**, 304, 1883. [6] Brun, Bibl. Univ., **11**, 514, 1884. [7] Koort, Inaug. Diss., Berlin, 1884; he adds also numerous new planes for the stibnite of Wolfsberg and Arnsberg, but for the most part they are very doubtful, cf. Gdt., l. c., and Grünling, Zs. Kr., **12**, 78, 1886. [8] Cf. Mgg., Jb. Min., **2**, 19, 1883.

METASTIBNITE *G. F. Becker*, Am. Phil. Soc., **25**, 168, 1888. U. S. G. Surv., Monograph 13, pp. 343, 389, 1888. An amorphous brick-red deposit of antimony trisulphide, $Sb_2S_3$, occurring with cinnabar and with sulphide of arsenic upon siliceous sinter at Steamboat Springs, Washoe Co., Nevada.

**29. BISMUTHINITE.** Visimutum Sulphure mineralisatum (fr. Riddarhyttan) *Cronst.*, 193, 1758. Wismuthglanz *Germ.* Bismuth sulphuré *Fr.* Sulphuret of Bismuth. Bismuth Glance. Bismuthine *Beud.*, Tr., **2**, 418, 1832. Bismutholamprite *Glock.*, Syn., 27, 1847. Bismutina *Ital.*

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}9679 : 1 : 0{\cdot}9850$ Groth[1].
$100 \wedge 110 = 44° \; 4'$, $001 \wedge 101 = 45° \; 30'$, $001 \wedge 011 = 44° \; 34'$.

**Forms**[1]: *a* (100, *i*-ī), *b* (010, *i*-ĭ); *m* (110, *I*), *e* (130, *i*-3̆), *r* (101, 1-ī). Angles: $mm''' = {*}88° \; 8'$, $ee' = 38°$, $rr' = {*}91°$. On artif. cryst. see Phillips[2] and Rose[3]; the latter observed *a, b, m*, also 410, 120, 140, with $mm''' = 89° \; 20'$.

In acicular crystals. Usually massive, with a foliated or fibrous structure.

Cleavage: *b* perfect; *a, m* imperfect. Somewhat sectile. H. = 2. G. = 6·4–6·5. Luster metallic. Streak and color lead-gray, inclining to tin-white, with a yellowish or iridescent tarnish. Opaque.

**Comp.**—Bismuth trisulphide, $Bi_2S_3$ = Sulphur 18·8, bismuth 81·2 = 100. Sometimes contains a little copper and iron.

Analyses see 5th Ed., p. 30. Forbes gives for the Bolivia mineral G. = 7·2.

**Pyr., etc.**—Fusibility = 1. In the open tube sulphurous fumes, and a white sublimate which B.B. fuses into drops, brown while hot and opaque yellow on cooling. On charcoal at first gives sulphurous fumes; then fuses with spirting, and coats the coal with yellow bismuth oxide; with potassium iodide a bright red coating of bismuth iodide is obtained. Dissolves readily in hot nitric acid, and a white precipitate falls on diluting with water.

**Obs.**—Accompanies molybdenite and apatite in quartz, at Brandy Gill, Carrock Fells, in Cumberland, having a foliated structure; near Redruth; at Botallack, near Land's End; at Herland Mine, Gwennap; with childrenite, near Callington; at Lanescott mine, near St. Austell. In France at Meymac, Corrèze; at Johanngeorgenstadt, Altenberg, Schneeberg, in limestone; at Wittichen, Baden; with cerium ore at Riddarhyttan, Sweden; at the San Baldomero mine, near Sorata, Bolivia, foliated, massive, and acicular; also from Cerro de Tazna.

Occurs with gold, pyrite, and chalcopyrite in Rowan Co., N. C., at the Barnhardt vein. Reported by Shepard to have been found with chrysoberyl at Haddam, Ct. Sparingly at Willimantic, and Portland, Conn., in part altered to bismuth carbonate. Abundantly with almandine garnet and barite in the Granite mining district, Beaver county, Utah; also at Oasis, Mono Co., and in northeastern Fresno Co., Cal.

**Alt.**—Occurs altered to anhydrous bismuth carbonate, cf. bismutosphærite, 290.

**Artif.**—Obtained in crystals by Sénarmont *et al.*, cf. Fouqué-Lévy, Synth. Min., 318, 1882.

**Ref.**—[1] Tazna, Bolivia, Zs. Kr., **5**, 252, 1880. [2] Phil. Mag., **2**, 181, 1827. [3] Pogg., **91**, 401, 1854.

BOLIVITE *Domeyko*, 6th App. Min. Chili, p. 19, 1878. Described as a bismuth oxysulphide, $Bi_2O_3$ with $Bi_2S_3$. It is derived from the oxidation of the sulphide bismuthinite, and is of very uncertain composition. The description would apply to a mixture of the oxide with the original sulphide, which is enclosed in it. The uncertain character of the mineral seems to have been later accepted by Domeyko, for in the 3d Ed. of his Mineralogy (1879, p. 304) the occurrence is only mentioned briefly, and without any name. Locality, mines of Tazna, in the province of Chorolque, Bolivia.

**30. GUANAJUATITE.** Una nueva especie mineral de bismuto *Castillo*, Naturaleza **2**, 274, 1873; Jb. Min., 225, 1874. Guanajuatite *V. Fernandez*, "La República" of Guanajuato, July 13, 1873. Selenwismuthglanz *Frenzel*, Jb. Min., 679, 1874. Frenzelite 2nd Append. Dana's Min., 22, 1875. Castillite *Domeyko*, Min. Chili, p. 310, 1879.

Orthorhombic, isomorphous with stibnite; $mm''' = 90°$ approx. In acicular prismatic crystals, striated longitudinally, often forming semi-compact masses. Also massive with granular, foliated or fibrous structure.

Cleavage: *b* distinct. Somewhat sectile. H. = 2·5–3·5. G. = 6·25–6·62. Luster metallic. Color bluish gray. Streak gray, shining.

**Comp.**—Bismuth selenide, $Bi_2Se_3$ = Selenium 36·3, bismuth 63·7 = 100; a small part of the selenium is replaced by sulphur.

**Anal.**—1, Frenzel, Jb. Min., 679, 1874. 2, Mallet, Am. J. Sc., **15**, 294, 1878, after deducting 6·72 p. c. halloysite and 0·56 $SiO_2$.

| | Se | S | Bi |
|---|---|---|---|
| 1. | 24·13 | 6·60 | 67·38 = 98·11 |
| 2. | 34·33 | 0·66 | 65·01 = 100 |

**Pyr.**—B.B. on charcoal fuses with a blue flame, giving a strong odor of selenium; with potassium iodide on charcoal a red coating of bismuth iodide. Decomposed by aqua regia on slow heating.

**Obs.**—From the Santa Catarina mine, Sierra de Santa Rosa, near Guanajuato, Mexico. Associated with native bismuth and pyrite.

SILAONITE *V. Fernandez* and *S. Navia*, "La República," Guanajuato, Mexico, Dec. 25, 1873. A massive, bluish gray mineral. H. = 2·75. G. = 6·43–6·45. Described as having the composition $Bi_3Se$. Shown subsequently by Fernandez, and also by H. D. Bruns (Chem. News, **38**, 109, 1878), to be a mixture of guanajuatite and native bismuth, and not a homogeneous mineral.

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**31. TETRADYMITE.** Ore of Tellurium (fr. Tellemark) *Esmark*, Trans. G. Soc., **3**, 413, June 1, 1815. Tellurwismuth (fr. Riddarhyttan) *Berz.*, Ak. H. Stockh., 1823. Telluric Bismuth. Tetradymite, Rhomboëdrische Wismuthglanz (fr. Schubkau) *Haid.*, Baumg. Zs., **9**, 129, 1831. Bismuth telluré, Tellure selenié bismuthifère *Fr.* Bornine *Beud.*, Tr.. **2**, 538, 1832. Bismuthotellurites pt. *Glocker*, Syn., 19, 1847. Tellurbismuth *Balch*, Am. J. Sc., **35**, 99, 1863.

Rhombohedral. Axis $\dot{c} = 1·5871$; $0001 \wedge 10\bar{1}1 = 61° 22\frac{5}{6}'$ Haidinger[1].

**Forms:** *c* (0001, *O*), *e* ($01\bar{1}2$, $-\frac{1}{2}$) as tw. pl., *f* ($20\bar{2}1$, 2), *μ* ($04\bar{4}1$, $-4$). **Angles:** $ce = 42° 30'$, $cf = 74° 44\frac{1}{2}'$, $c\mu = 82° 14'$, $rr' = 98° 58'$, $ff' = 113° 20'$, $\mu\mu' = 118° 12'$.

Twins: tw. pl. *e*; $c\underline{c} = *95°$; in fourlings. Crystals small and rarely distinct; acute rhombohedral, resembling hexagonal prisms; rhombohedral faces horizontally striated. Also in bladed forms and foliated to granular massive.

Cleavage: basal perfect. Laminæ flexible; not very sectile. H. = 1·5–2; soils paper. G. = 7·2–7·6. Luster metallic, splendent. Color pale steel-gray. Thermo-electrically positive in part, also sometimes negative[2].

**Comp., Var.**—Consists of bismuth and tellurium, with sometimes sulphur and a trace of selenium; the analyses for the most part afford the general formula $Bi_2(Te,S)_3$. Some authors regard the species as an isomorphous compound of bismuth and tellurium, and place it in the group of the rhombohedral metals.

**Var.**—1. *Free from sulphur.* $Bi_2Te_3$=Tellurium 48·1, bismuth 51·9; analyses 1–4. G.= 7·868 from Dahlonega, Jackson; 7·642, id., Balch.

2. *Sulphurous.* $2Bi_2Te_3.Bi_2S_3$ = Tellurium 36·4, sulphur 4·6, bismuth 59·0 = 100. This includes *tetradymite* Haid. from Schubkau, whose crystals yielded the above data; also other varieties analyzed by Genth. The name *Bornine*, after von Born, was given by Beudant in 1832, and Wehrle's analysis of the Schubkau ore was the only one cited.

**Anal.**—1, Genth, Am. J. Sc.. **19**, 16, 1855. 2. Id., ibid., **31**, 368, 1861. 3, Balch, ibid., **35**, 99, 1863. 4, Genth, ibid., **45**, 317, 1868. 5, Wehrle, Baumg. Zs., **9**, 133, 1831. 6, Berzelius, Jahresb., **12**, 178, 1833. 7, Hruschauer, J. pr. Ch., **45**, 456, 1848. 8, C. T. Jackson, Dana's Min., 712, 1850. 9, Genth, Am. J. Sc., **16**, 81, 1853. 10, Id., ibid., **45**, 317, 1868. 11, 12, Id., Am. Phil. Soc. Philad., **14**, 224, 1874. 13, Id., Am. J. Sc., **40**, 114, 1890. 14, Frenzel, Jb. Min., 799, 1873.

| *Variety* 1. without sulphur. | | Te | Bi | |
|---|---|---|---|---|
| 1. Fluvanna Co., Va. | $\frac{3}{3}$ | 48·35 | 52·80 | Se *tr.* = 101·15 |
| 2. Dahlonega, Ga. | $\frac{2}{2}$ | 47·73 | 50·90 | Se *tr.*, Fe 0·21, Cu 0·06, Au, $SiO_2$, etc., 0·76 = 99·66 |
| 3. " " G. = 7·642 | $\frac{2}{2}$ | 48·50 | 51·51 | = 100·01 |
| 4. Highland, Montana. | | 47·90 | 50·43 | $Fe_2O_3$ 0·90, $SiO_2$ 0·78 = 100·01 |

*Variety* 2, containing sulphur.

| | | | Te | S | Bi | |
|---|---|---|---|---|---|---|
| 5. | Schubkau | G. = 7·500 | 35·24 | 4·92 | 59·84 | Se *tr.* = 100 |
| 6. | " | | 36·05 | 4·32 | 58·30 | Se *tr.*, gangue 0·75 = 99·42 |
| 7. | " | | 35·8 | 4·6 | 59·2 | = 99·6 |
| 8. | Whitehall, Va. | | 35·05 | 3·65 | 58·80 | Au, $Fe_2O_3$, $SiO_2$ 2·70 = 100·20 |
| 9. | Davidson Co., N. C., | G. = 7·237 | 33·84 | 5·27 | 61·35 | Se *tr.* = 100·46 |
| 10. | Cabarrus Co., N. C. | | 36·28 | 5·01[a] | 57·70 | Fe 0·54, Cu 0·41 = 99·94 |
| 11. | Montana | G. = 7·33 | [34·90] | 4·26 | 60·49 | Se *tr.*, Au 0·21, Cu *tr.*, Fe 0·09, $SiO_2$ 0·05 = 100 |
| 12. | " | G. = 7·54 | [34·41] | 5·16 | 59·24 | Se 0·14, Cu 0·47, $SiO_2$ 0·58 = 100 |
| 13. | Yavapai Co., Arizona. | | 33·25 | 4·50 | 62·23 | = 99·98[b] |
| 14. | Orawitza | | 35·92 | 4·26 | 59·33 | = 99·51 |

[a] S 4·40 after deducting 1·15 pyrite. [b] Deducting 15·6 % quartz, 1·8 $Fe_2O_3$.

**Pyr.**—In the open tube a white sublimate of tellurium dioxide, which B.B. fuses to colorless drops. On charcoal fuses, gives white fumes and entirely volatilizes; tinges the R.F. bluish green; coats the coal at first white ($TeO_2$), and finally orange-yellow ($Bi_2O_3$); some varieties give sulphurous and selenous odors.

**Obs.**—Occurs at Schubkau near Schemnitz; at Rezbanya; at Orawitza in the Banat; at Tellemark in Norway; at Bastnaes mine, near Riddarhyttan, Sweden.

In the United States, in Virginia, at the Whitehall gold mines, Spottsylvania Co., at Monroe mine, Stafford Co., and Tellurium mine, Fluvanna Co., with native gold; in North Carolina, Davidson Co., about 5 m. W. of Washington mine, in foliated scales and lamellar masses with gold, chalcopyrite, magnetite, epidote, limonite, etc.; and at the Phœnix mine, Cabarrus Co., and in gold washings of Burke and McDowell counties; in York district, So. Carolina; in Georgia, Lumpkin Co., 4 m. E. of Dahlonega, and also in Cherokee and Polk and Spaulding counties. In the gold washings of Highland, Montana, and at Uncle Sam's Lode. Rare at the Red Cloud mine, Colorado. In quartz with gold at the Montgomery mine, Hassayampa distr., Arizona also near Bradshaw City, Yavapai Co., in bladed crystals in quartz.

Named from τετράδυμος, *four-fold*, in allusion to the twin crystals.

**Ref.**—[1] Schubkau, Baumg. Zs., **9**, 129, 1831, cf. also Pogg., **21**, 595, 1831. [2] From Schubkau and Orawitza, positive; from Georgia, negative, Schrauf and Dana, Ber. Ak. Wien, **69** (1), 151, 1874, or Am. J. Sc., **8**, 262, 1874.

**32. JOSËITE.** Tellurure de Bismuth *Damour*, Ann. Ch. Phys., **13**, 372, 1845. Borning. Tellure bismuthifère du Brésil, *Dufr.* [not Bornine *Beud.*] Josëit *Kenng.*, Min., 121, 1853.

In laminated masses with perfect cleavage resembling tetradymite. Soft. Fragile. G. = 7·924–7·936. Luster metallic. Color grayish black, steel-gray.

**Comp.**—Bismuth and tellurium with some sulphur and selenium; the formula doubtful.

**Anal.**—1, 2, Damour, l. c. 3, Genth, Am. Phil. Soc. Philad., **23**, 31, 1885.

| | | Te | S | Se | Bi | |
|---|---|---|---|---|---|---|
| 1. | San José, Brazil | 15·93 | 3·15 | 1·48 | 79·15 | = 99·71 |
| 2. | " " | 15·68 | 4·58 | | 78·40 | = 98·66 |
| 3. | " " | 14·67 | 2·84 | 1·46 | 81·23 | = 100·20 |

Rammelsberg obtained from an allied mineral, from Cumberland, England (Min. Ch., 5): Tellurium 6·73, sulphur 6·43, bismuth 84·33 = 97·49.

**Pyr.**—B.B. the Brazil ore acts nearly like tetradymite. In an open tube it gives off some sulphur, then white fumes of tellurium dioxide, and then affords a decided odor of selenium; and in the upper part of the tube a white coating with some brick-red over it, due to the selenium; and a yellowish residue below, due to the bismuth oxide.

**Obs.**—Found in granular limestone at San José, near Mariana, province of Minas Geraes, Brazil, and first brought to France by Mr. Claussen.

**33. WEHRLITE.** Argent molybdique *de Born*, Cat. de Raab., **2**, 419, 1790. Wasserbleisilber, Molybdän-silber, *Wern.*, Letztes Min. Syst., 18, 48, 1817. Molybdic silver. Wismuthglanz *Klapr.*, Beitr., **1**, 254, 1795. Tellurwismuth *Berz.*, Ak. H. Stockh., 1823. Wismuthspiegel *Weiss.* Spiegelglanz *Breith.* Tetradymite pt. *many authors.* Wehrlite *Huot*, Min., **1**, 188, 1841. Pilsenit *Kenng.*, Min., 121, 1853.

In foliated masses with perfect cleavage resembling tetradymite. Thin folia, a little elastic. H. = 1–2. G. = 8·37–8·44. Luster metallic, bright. Color tin-white to light steel-gray.

**Comp.**—Bismuth and tellurium with some sulphur; a little silver is present, probably as silver sulphide.

**Anal.**—1, Wehrle, Baumg. Zs., **9**, 144, 1831. 2, 3, Sipöcz, Zs. Kr., **11**, 212, 1885.

| | G. | Te | S | Bi | Ag | |
|---|---|---|---|---|---|---|
| 1. Deutsch-Pilsen | 8·44 | 29·74 | 2·33 | 61·15 | 2·07 | = 95·29 |
| 2. " " | 8·368 | 35·47 | — | 59·47 | 4·37 | = 99·31 |
| 3. " " | | 28·52 | 1·33 | 70·02 | 0·48 | = 100·35 |

Analysis 2 corresponds to $AgBi_7Te_7$, and 3 to $Bi_8Te_5S$, or $Bi_3Te_2$, excluding $Ag_2S$.

**Pyr., etc.**—Like tetradymite.

**Obs.**—From Deutsch-Pilsen, in Hungary. First reported as an ore of silver and molybdenum. Named after Mining Commissioner Wehrle, of Hungary.

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## 3. Molybdenite Group.

**34. MOLYBDENITE.** Not Molybdæna [ = product fr. partial reduct. and oxid of Galena] *Dioscor.*, *Plin.*, *Agric.* Blyertz, Molybdena pt. [rest graphite] *Wall.*, 131, 1747, *Linn.*, 1748, 1768. Sulphur ferro et stanno saturatum (fr. Bastnaes, etc.), Wasserbley pt., Molybdena pt., *Cronst.*, 139, 1758. Scheele Opuscula, **1**, 1778. Molybdæna (with discov. of metal) *Hielm*, Ak. H. Stockh., 1782, 1788–1793. Wasserblei *Wern.* Molybdänglanz *Germ.* Molybdena *Kirw.*, Min., 1796 (calls the metal Molybdenite). Sulphuret of Molybdena. Molybdénite *Brongn.*, **2**, 92, 1807, citing Kirwan as authority.

Hexagonal (?). Crystals hexagonal in form, tabular, or short prisms slightly tapering, *cx* = 75° Renfrew, resembling some mica. Prismatic planes horizontally striated; on the base sometimes striæ normal to the edges. Commonly foliated, massive or in scales; also fine granular.

Cleavage: basal eminent. Laminæ very flexible, but not elastic. Sectile. H. = 1–1·5. G. = 4·7–4·8; 4·708 Biellese, Cossa. Luster metallic. Color pure lead-gray; a bluish gray trace on paper, on porcelain slightly greenish. Opaque. Feel greasy.

**Comp.**—Molybdenum disulphide, $MoS_2$=Sulphur 40·0, molybdenum 60·0=100.

**Pyr., etc.**—In the open tube sulphurous fumes and a pale yellow crystalline sublimate of molybdenum trioxide ($MoO_3$). B.B. in the forceps infusible, imparts a yellowish-green color to the flame; on charcoal the pulverized mineral gives in O.F. a strong odor of sulphur, and coats the coal with crystals of molybdic oxide, which appear yellow while hot, and white on cooling; near the assay the coating is copper-red, and if the white coating be touched with an intermittent R.F., it assumes a beautiful azure-blue color. Decomposed by nitric acid, leaving a white or grayish residue (molybdic oxide).

**Obs.**—Generally occurs embedded in, or disseminated through, granite, gneiss, zircon-syenite, granular limestone, and other crystalline rocks. At Numedal in Sweden, Arendal, Selba, and Tellemarken in Norway, Nerchinsk in Eastern Siberia, and Auerbach in Saxony, it has been observed in hexagonal prisms. Found also at Altenberg and Ehrenfriedersdorf in Saxony; Schlackenwald and Zinnwald in Bohemia; Rathausberg in Austria; near Miask, Urals; Bastnaes, etc., Sweden; in Finland; Laurvik in Norway; Chessy in France; in Piedmont, Italy, at Traversella and Biellese; Peru; Brazil; Calbeck Fell, Carrock Fells, and near the source of the Caldew in Cumberland, associated with scheelite and apatite; several of the Cornish mines; in Scotland at East Tulloch; at Mount Coryby on Loch Creran, etc.

In *Maine*, at Blue Hill Bay and Camdage farm, in large crystallizations; also at Brunswick, Bowdoinham, and Sanford, but less interesting. In *Conn.*, at Haddam and the adjoining towns on the Connecticut river, in gneiss in crystals and large plates; also at Saybrook. In *Vermont*, at Newport, with crystals of white apatite. In *N. Hampshire*, at Westmoreland, four miles south of the north village meeting-house, in a vein of mica slate, abundant; at Llandaff in regular tabular crystals; at Franconia. In *Mass.*, at Shutesbury, east of Locke's pond; at Brimfield, with iolite. In *N. York*, two miles southeast of Warwick, in irregular plates associated with rutile, zircon, and pyrite. In *Penn.*, in Chester, on Chester Creek, near Reading; near Concord, Cabarrus Co., N. C., with pyrite in quartz. In *California*, at Excelsior gold mine, in Excelsior district and elsewhere. In *Canada*, at Balsam Lake, Terrace Cove, Lake Superior; north of Balsam Lake, on a small island in Big Turtle Lake, with scapolite, pyroxene, etc., in a vein of quartz intersecting crystalline limestone; at St. Jérôme, Quebec; at Seabeach Bay, near Black River, N. W. of L. Superior (48° 46′ N., 87° 17′ W.). In large crystals (1 to 2 inches across) in Renfrew county, Ontario, also in Aldfield township, Pontiac Co., Quebec.

Named from *μόλυβδος lead;* the name, first given to some substances containing lead, later included graphite and molybdenite, and even some compounds of antimony. The distinction between graphite and molybdenite was established by Scheele in 1778–79.

Artif.—Obtained crystallized by Schulten by melting together potassium carbonate, sulphur and molybdic oxide in a platinum crucible, G. = 5·06, G. För. Förh., **11**, 401, 1889.

## II. Sulphides, Selenides, Tellurides, Arsenides, Antimonides of the Metals.

### A. Basic Division.

### B. Monosulphides.

1. **Galena Group.** Isometric, holohedral.
2. **Chalcocite Group.** Orthorhombic.
3. **Sphalerite Group.** Isometric, tetrahedral.
4. **Cinnabar—Wurtzite—Millerite Group.** Hexagonal and rhombohedral.

### C. Intermediate Division.

Embraces Polydymite $Ni_4S_5$?, Melonite $Te_2S_3$, etc.; also Bornite $3Cu_2S.Fe_2S_3$, Linnæite $CoS.Co_2S_3$, Chalcopyrite $Cu_2S.Fe_2S_3$, etc.

### D. Disulphides, Diarsenides, etc.

1. **Pyrite Group.** Isometric, pyritohedral.
2. **Marcasite Group.** Orthorhombic.
3. **Sylvanite Group.**

## II. Sulphides, Selenides, Tellurides, etc., of the Metals.

### A. Basic Division. Dyscrasite Group.

| | | | | $\breve{a} : \bar{b} : \dot{c}$ |
|---|---|---|---|---|
| 35. | **Dyscrasite** | $Ag_3Sb$, $Ag_6Sb$, etc. | | 0·5775 : 1 : 0·6718 |
| | Arsenargentite, Huntilite | $Ag_3As$? | | |
| 36. | **Horsfordite** | $Cu_6Sb$ | | |
| 37. | **Domeykite** | $Cu_3As$ | | |
| 38. | **Algodonite** | $Cu_6As$ | | |
| 39. | **Whitneyite** | $Cu_9As$ | | |
| 40. | **Chilenite** | $Ag_6Bi$? | | |
| 41. | **Stützite** | $Ag_4Te$? | Hexagonal? | $\dot{c}$<br>1·2530 |

35. **DYSCRASITE.** Argentum nativum antimonio adunatum *Bergm.*, Sciagr., 159, 1782. Spiesglanz-Silber *Selb*, Lempe Mag., **3**, 5, 1786. Silberspiessglanz, Spiesglas-Silber, Antimon-Silber *Germ.* Antimonial Silver. Argent Antimonial *Fr.* Discrase *Beud.*, **2**, 613, 1832. Discrasit *Fröbel?*, Prodr. Stöchiolith, 1837.

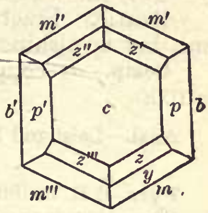
Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·5775 : 1 : 0·6718$ Hausmann[1].
$100 \wedge 110 = 30° 0\frac{1}{3}'$, $001 \wedge 101 = 49° 19'$, $001 \wedge 011 = 33° 53\frac{2}{3}'$[1].

**Forms**[1]: $c$ (001, $O$) $q$ (130, $i$-$\breve{3}$) $e$ (011, 1-$\breve{\imath}$) $y$ (111, 1)
$a$ (100, $i$-$\bar{\imath}$) $m$ (110, $I$) $r$ (150, $i$-$\breve{5}$) $p$ (021, 2-$\breve{\imath}$) $s$ (133, 1-$\breve{3}$)
$b$ (010, $i$-$\breve{\imath}$) $n$ (120, $i$-$\breve{2}$) $d$ (101, 1-$\bar{\imath}$) $z$ (112, $\frac{1}{2}$)

$mm''' = 60° 1'$ $dd' = 98° 38'$ $cy = 53° 20'$ $ss' = 35° 41'$
$nn' = 81° 46'$ $ee' = 67° 47'$ $cs = 37° 48'$ $zz''' = 32° 23'$
$qq' = 59° 59'$ $pp' = 106° 41'$ $zz' = 57° 44\frac{1}{2}'$ $yy''' = *47° 18'$
$rr' = 38° 12'$ $cz = 33° 53'$ $yy' = *88° 0'$ $ss''' = 64° 7'$

Twins: tw. pl. *m*, producing stellate forms, pseudo-hexagonal. Planes *c* striated ‖ *b*. Also massive, granular fine, or coarse and foliated.

1.



Andreasberg ?, Mlr.

Cleavage: *c*, *e* distinct, *m* imperfect. Fracture uneven. Sectile. H. = 3·5–4. G. = 9·44–9·85. Luster metallic. Color and streak silver-white, inclining to tin-white; somtimes tarnished yellow or blackish. Opaque.

**Comp.**—A silver antimonide, including $Ag_3Sb$ = Antimony 27·1, silver 72·9 = 100, and $Ag_6Sb$ = Antimony 15·7, silver 84·3 = 100, and perhaps other compounds.

Analyses (see 5th Ed., p. 35) vary widely, some conforming also to $Ag_2S$, $Ag_4(Sb,As)_3$, etc. Of the following, 1 and 2 agree with $Ag_3Sb$, 3 with $Ag_6Sb$. 1, Rg., Zs. G. Ges., **16**, 618, 1869. 2, 3, Petersen, Pogg., **137**, 377, 1869.

| | | | | Sb | Ag |
|---|---|---|---|---|---|
| 1. | Andreasberg | *cryst.* | G. = 9·73–9·77 | [27·56] | $\frac{3}{3}$ 72·44 = 100 |
| 2. | Wolfach | *cryst.* | G. = 9·611 | $\frac{3}{3}$ 27·20 | 71·52 = 98·72 |
| 3. | “ | *fine gran.* | G. = 10·027 | 15·81 | 83·85 = 99·66 |

Another fragment of the crystal analyzed by Rammelsberg (1) gave ($\frac{3}{3}$) Ag = 74·79, with G. = 9·851. A coarse granular form from Wolfach gave Petersen Sb 23 06, Ag 76·65, As *tr.* = 99·71, with G. = 9·960. Petersen calls the compound $Ag_3Sb$, *stibio-triargentite*, and $Ag_6Sb$, *stibio-hexargentite.*

Because of the similarity of form with chalcocite, etc., it has been urged that the true composition is $Ag_2Sb$, and that the variation is due to mechanical admixture, cf. Kenngott[2], Groth[3]. The analogy, however, of the copper arsenides and still more of artificial compounds (Cooke[4]) of zinc and antimony ($Zn_nSb$), which latter are near dyscrasite in form, speak against this.

Domeyko mentions silver ores with only 4 to 6 p. c. antimony. A silver-white mineral from Chañarcillo conforming approximately to the formula $Ag_4(Sb,As)_3$ has been called *chañarcillite.* (5th Ed., p. 36, 1868.)

**Pyr., etc.**—B.B. on charcoal fuses to a globule, coating the coal with white antimony trioxide and finally giving a globule of almost pure silver. Soluble in nitric acid, leaving antimony trioxide.

**Obs.**—Occurs in the Wenzelgang near Wolfach, Baden, where it is the chief silver ore (cf. Sandb., l. c.); it is crystalline, and in part fine granular, in part coarsely foliated; the latter forming masses in concentric layers, varying in structure and somewhat in composition; also at Wittichen in Suabia, and at Andreasberg in the Harz, commonly associated with other ores of silver, native arsenic, galena, etc.; also at Allemont, Isère in France, Casalla in Spain, and in Bolivia, S. A. Named from *δυσκρᾶσις, a bad alloy. Chanarcillite*, from Chañarcillo, is a silver-white ore for which Domeyko gives $Ag_2(As,Sb)_3$; 5th Ed., p. 36.

**Alt.**—Occurs at Wolfach, altered to pyrargyrite and native silver, cf. Sandberger, l. c.

**Ref.**—[1] Handb. Min., p. 57. 1847. Sandberger adds a pyramid probably 332, Unt. Erzg., **2**, 293, 1882. [2] Ber. Ak. Wien, **9**, 548, 1852. [3] Tab. Ueb. 20, 1882. [4] Am. J. Sc., **18**, 229, 1854; **20**, 222, 1855; cf. Rg., l. c., p. 623.

ARSENICAL SILVER. *Arseniksilber*, from Andreasberg, analyzed by Klaproth (Beitr., **1**. 183, 1795), and DuMenil (Schweig. J., **34**, 357, 1822), is regarded by Rammelsberg as a mixture perhaps of arsenopyrite, arsenical iron, and dyscrasite (Pogg., **77**, 262, 1849, and Min. Ch., 27, 1875). Called *pyritolamprite* by Adam, Tabl. Min., 39, 1869.

MACFARLANITE, HUNTILITE, ANIMIKITE. The ores from Silver Islet, Lake Superior, apparently contain a silver arsenide (*huntilite*) and perhaps also a silver antimonide (*animikite*), the latter related to or identical with dyscrasite. The name *macfarlanite* was given by Sibley to the complex ore consisting of a reddish-brown sectile metallic mineral mixed with silver and other species; this has been investigated by T. Macfarlane (Can. Nat., Feb. 1, 1870; Trans. Am. Inst. Mng. Eng., **8**, 236, 1880). The name huntilite, after Dr. T. Sterry Hunt, was given by Wurtz (Eng. Mng. J., **27**, 55, 1879) to the supposed silver arsenide, stated to be dark gray to black and massive, G. = 7·47; also slate-color and cleavable. Semi-malleable. G. = 6·27. The analyses were made on too impure material to allow of any decision as to the composition. $Ag_3As$ (= As 18·8, Ag 81·2 = 100) is sugested. Compare Koenig, Proc. Acad. Philad., 276, 1877. *Animikite*, Wurtz, l. c. p. 124, occurs on huntilite. Structure fine granular. Somewhat sectile. G. = 9·45. Color white to grayish white. The formula $Ag_9Sb$ is proposed, but very doubtful. Named from animiké, *thunder*, whence Thunder Bay. For analyses, etc., see further Min. 5th Ed., App. III, 71, 1882.

ARSENARGENTITE *J. B. Hannay*, Min. Mag., **1**, 149, 1877. Stated on the basis of a partial examination of a single specimen of doubtful source (Freiberg ?) to be $Ag_3As$, occurring in orthorhombic acicular crystals in native arsenic. G. = 8·825. Analysis: As [18·43], Ag 81·37 = 100. Needs confirmation.

### 36. HORSFORDITE. *A. Laist* and *T. H. Norton*, Am. Ch. J., **10**, 60, 1888.

Only known massive.

Brittle. Fracture uneven. H. = 4–5. G. = 8·812. Luster metallic; brilliant, but tarnishing easily. Color silver-white. Opaque.

**Comp.**—A copper antimonide, probably $Cu_6Sb$ = Antimony 24·0, copper 76·0 = 100.

**Anal.**—Laist and Norton:

$\frac{3}{3}$ Sb 26·86 Cu 73·37 = 100·23

**Pyr.**—B.B. fusibility 1·5. Reacts for antimony and copper.

**Obs.**—Occurs as a large deposit in Asia Minor not far from Mytilene.

Named for E. N. Horsford, formerly Rumford Professor of Chemistry in Harvard University.

**Artif.**—On octahedral crystals containing $Cu_6Sb$, see Brand, Zs. Kr., **17**, 264, 1889.

### 37. DOMEYKITE. Arsenikkupfer (fr. Copiapo) *Zinken*, Pogg., **41**, 659, 1837. Arseniure de cuivre *Domeyko*, Ann. Mines, **3**, 3, 1843; Cobre Blanco *id.*, Min., 138, 1845. Weisskupfer *Hausm.* Cuivre arsenical *Fr.* Arsenical Copper. Domeykite *Haid.*, Handb., 562, 1845. Condurrite *W. Phillips*, Phil. Mag., **2**, 286, 1827.

Reniform and botryoidal; also massive and disseminated.

Fracture uneven. H. = 3–3·5. G. = 7·2–7·75. Luster metallic, but dull on exposure. Color tin-white to steel-gray, with a yellowish to pinchbeck-brown, and afterward an iridescent tarnish.

**Comp.**—A copper arsenide, $Cu_3As$ = Arsenic 28·3, copper 71·7 = 100.

**Anal.**—1, Domeyko, after deducting 2·55 gangue, Ann. Mines, **3**, 6, 1843. 2. 3, Field, J. Ch. Soc., **10**, 289, 1857. 4, Frenzel, Jb. Min., 26, 1873. 5, Forbes, Q. J. G. Soc., **17**, 44, 1861. 6, Genth, Am. J. Sc., **33**, 193, 1862. 7, 8, Frenzel, l. c. 9, Winkler, Jb. Min., **2**, 255, 1882.

| | | | As | Cu | |
|---|---|---|---|---|---|
| 1. Coquimbo (Calabozo), Chili | | | 28·36 | 71·64 | = 100 |
| 2. " " | | | 28·26 | 71·48 | = 99·74 |
| 3. Copiapo " | | | 28·44 | 71·56 | = 100 |
| 4. " (S. Antonio) " | | G. = 6·70 | 25·89 | 70·16 | Fe,Mn 3·50, S 0·49, insol. 0·45 = 100·49 |
| 5. Corocoro, Bolivia | | | 28·41 | 71·13 | Ag 0·46 = 100 |
| 6. L. Superior, Portage Lake | | G. = 7·75 | 29·25 | 70·68 | = 99 93 |
| 7. " | | G. = 7·207 | 28·29 | 72·02 | = 100·31 |
| 8. Cigazuala, Mexico | | G. = 7·547 | 27·10 | 72·99 | = 100·09 |
| 9. Zwickau | H. = 5. | G. = 6·84 | 26·45 | 65·08 | Fe 0·64, Ni 0·44, O 2·49, gangue 3 84 = 98 94 |

**Pyr., etc.**—In the open tube fuses and gives a white crystalline sublimate of arsenic trioxide. B.B. on charcoal arsenical fumes and a malleable metallic globule, which, on treatment with soda, gives a globule of pure copper. Not dissolved in hydrochloric acid, but soluble in nitric acid.

**Obs.**—From the Chilian mines of Algodones in Coquimbo, in Illapel, San Antonio in Copiapo, etc. Also from Zwickau, in Saxony, in porphyry.

In N. America, found on the Sheldon location, Portage Lake; and mixed with niccolite at Michipicoten Island, in L. Superior.

Domeykite is named for the Chilian mineralogist, Ignacio Domeyko.

*Condurrite* is a mixture, the result of alteration (of tennantite?, Rg.). It is black and soft, soiling the fingers. It has been investigated by Rammelsberg (Pogg., **71**, 305, 1847) and Winkler (B. H. Ztg., **18**, 383, 1859), also earlier by Faraday, Blyth and Kobell. Cf. 5th Ed., p. 37. From the Condurrow mine, near Helstone, and Wheal Druid mine at Carnbrae, near Redruth, Cornwall.

ORILEYITE *D. Waldie*, Proc. Asiat. Soc., Bengal, p. 279, September, 1870.

Massive. H. = 5·5. G. = 7·343–7·428. Color steel-gray on fresh fracture with purplish tint. Luster metallic. Streak dark gray. Analysis, D. Waldie: As 38·45, Sb 0·54, Cu 12·13, Fe 42·12, X 6·19, Insol. 0·12 = 99·55. X = oxidized matters soluble in dilute hydrochloric acid = CuO 1·21, FeO 1·97, PbO 1·89, $As_2O_3$ 1·12 = 6·19. Soluble in nitric acid. From Burma, but exact locality not known. Named after Mr. O'Riley, Deputy Commissioner of Martaban, Burma.

The analysis corresponds approximately, as shown by Mallet (Min. India, 14, 1887), to $(Cu_2,Fe)_3$ $(As,Sb)_2$, which if confirmed makes the mineral allied to domeykite.

**38. ALGODONITE.** *F. Field,* J. Ch. Soc., **10**, 289, 1857.

In incrustations minutely crystalline. Commonly massive and distinctly granular.

Fracture subconchoidal, affording a granular surface. H. = 4. G. = 7·62, Chili, Genth. Luster metallic and bright, but becoming dull on exposure. Color steel-gray to silver-white, the latter on a polished surface. Opaque.

**Comp.**—$Cu_6As$ = Arsenic 16·5, Copper 83·5 = 100.

**Anal.**—1, F. Field, l. c. 2–4, Genth, Am. J. Sc., **33**, 192, 1862.

| | | | | As | Cu | Ag | |
|---|---|---|---|---|---|---|---|
| 1. | Chili | | $\frac{5}{5}$ | 16·23 | 83·30 | 0·31 | = 99·84 |
| 2. | " | G. = 7·603 | $\frac{8}{8}$ | 16·95 | 82·42 | *tr.* | = 99·37 |
| 3. | L. Superior | | | 15·30 | 84·22 | 0·32 | = 99·84 |
| 4. | " | | | 16·72 | 82·35 | 0·30 | = 99·37 |

In analysis 3, a little whitneyite was mixed with the ore, and hence the higher percentage of copper (Genth).

**Pyr.**—The same as with domeykite, but less fusible.

**Obs.**—In Chili, at the silver mine of Algodones, near Coquimbo, in the Cerro de los Seguas, Department of Rancagua; in the United States, in the Lake Superior region. A transported mass of mixed whitneyite and algodonite, weighing 95–100 lbs., was found on St. Louis R. The color is grayer, and the texture more granular and less malleable, than in whitneyite.

**39. WHITNEYITE.** *Genth,* Am. J. Sc., **27**, 400, 1859, **33**, 191, 1862. Darwinite *D. Forbes,* Phil. Mag., **20**, 423, 1860.

Massive. Crystalline; very fine granular.

Malleable. H. = 3·5. G. = 8·4–8·6. Luster dull and sub-metallic on surface of fresh fracture, but strong metallic where scratched or rubbed, soon tarnishing. Color pale reddish to grayish white, pale reddish white on a rubbed surface; becoming yellowish bronze, brown, and brownish black on exposure. Sometimes iridescent. Opaque.

**Comp.**—$Cu_9As$ = Arsenic 11·6, copper 88·4 = 100.

**Anal.**—1–3, F. A. Genth, l. c. 4, Id., Am. J. Sc. **45**, 306, 1868. 5, D. Forbes, l. c.

| | | | | As | Cu | Ag & insol. | |
|---|---|---|---|---|---|---|---|
| 1. | Michigan | G. = 8·408 | $\frac{2}{2}$ | 11·61 | 88·13 | 0·40 | = 100·14 |
| 2. | " | | | 12·28 | 87·48 | 0·04 | = 99·80 |
| 3. | " | G. = 8·47 | | 12·28 | 87·37 | 0·03 | = 99·68 |
| 4. | Sonora | | | 11·46 | 88·54 | *tr.* | = 100 |
| 5. | Chili | G. = 8·64 | $\frac{4}{4}$ | 11·58 | 88·14 | 0·28 | = 100 |

**Pyr.**—Less fusible than algodonite; otherwise as in domeykite.

**Obs.**—In Houghton Co., Michigan, coated with red copper. A loose mass, weighing about 15 lbs., and consisting partly of algodonite, was found on the Pewabic location, 1 m. from Hancock village, Portage Lake; also found in place on the Sheldon location, near Houghton, Mich.; stated to occur at the Albion location, about a mile from the Cliff mine, in a vein 4 inches wide; also at the Minnesota mine; also in Sonora (Genth), near La Laguna, a ranch on the road to Libertad, Gulf of California, 35 m. fr. Saric; reported also from the Lape and Fuller mine, Austin, Nevada. Darwinite (anal. 5) is stated to occur near Potrero Grande, southeast of Copiapo, Chili.

Named after Prof. J. D. Whitney of Cambridge, Mass., formerly State Geologist of California.

A mineral related to whitneyite, from Fortuna di Paposa, Chili, gave Bertrand 7·5 p. c. As, Ann. Mines, **1**, 413, 1872.

**40. CHILENITE.** Aleacion de plata con bismuto *Domeyko,* Min., 187, 1845. Plata bismutal *Id.*, ib., 185, 1860. Chilenite *Dana,* Min., 1868, 36.

Amorphous; granular.

Soft. Silver-white, but tarnishing easily to yellowish.

**Comp.**—Contains bismuth and silver, perhaps $Ag_6Bi$ = Bismuth 13·8, silver 86·2. Domeyko obtained: Bi 10·1, Ag 60·1, Cu 6·8, As 2·8, gangue 19·0, corresponding to Bi 14·4, silver 85·6. Also (Ann. Mines, **5**, 456, 1864) Bi 15·3, Ag 84·7. For the last the material was separated from a mass containing 8 to 10 p. c. of it disseminated in small points.

**Obs.**—From the mine of San Antonio, Potrero Grande, in Copiapo.

For the bismuth silver of Schapbach, see p. 122.

**41. Stützite.** Tellursilberblende *Schrauf*, Zs. Kr., **2**, 245, 1878.

Hexagonal, or pseudo-hexagonal. If hexagonal, axis $\acute{c}$ = 1·2530; 0001 ∧ 10$\bar{1}$1 = 55° 21′.

**Forms:** *c* (0001, *O*); *a* (11$\bar{2}$0, *i*-2), *m* (10$\bar{1}$0, *I*), *h* (21$\bar{3}$0, *i*-$\frac{3}{2}$), *l* (41$\bar{3}$0, *i*-$\frac{4}{3}$), *d* (10$\bar{1}$4, $\frac{1}{4}$), *f* (10$\bar{1}$2, $\frac{1}{2}$), *g* (10$\bar{1}$1, 1), *s* (30$\bar{3}$2, $\frac{3}{2}$); *μ* (11$\bar{2}$6, $\frac{1}{3}$-2), *z* (11$\bar{2}$4, $\frac{1}{2}$-2), *y* (11$\bar{2}$2, 1-2), *x* (11$\bar{2}$1, 2-2); *i* (21$\bar{3}$2, $\frac{3}{2}$-$\frac{3}{2}$), *o* (31$\bar{4}$2, 2-$\frac{4}{3}$). Angles: *cf* = 35° 53′, *cs* = 65° 16′, *cz* = 32° 4′, *cy* = 51° 24½′, *cx* = 68° 15′.

Schrauf prefers a monoclinic parameter, viz, $\grave{a} : \bar{b} : \acute{c}$ = 1·73205 : 1 : 1·25829, *β* = 89° 33′. A similarity in form to dyscrasite (as also to chalcocite) is apparent, and it may be orthorhombic and pseudo-hexagonal like them.

Crystals highly modified. Faces mostly brilliant; *m* horizontally striated.

Fracture uneven to subconchoidal. Luster metallic. Color lead-gray, with reddish tinge. Streak blackish lead-gray.

**Comp.**—A silver telluride, perhaps $Ag_4Te$ = Tellurium 22·5, silver 77·5 = 100. The silver percentage determined approximately with the blowpipe in two trials 72 p. c. and 77 p. c.

**Pyr.**—Easily fusible to a dark bead, from which a silver globule is obtained by reduction with soda; yields tellurium dioxide in the open tube.

**Obs.**—Identified on a single specimen in the collection of the Vienna University; locality probably Nagyág, Transylvania. Associated with gold and hessite on quartz. Named after Stütz, who, in 1803, described a tellurium mineral from Nagyág, which is regarded by Schrauf as probably identical with this.

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## B. Monosulphides, Selenides, Tellurides, etc.

### 1. Galena Group. RS. Isometric, holohedral.

Monosulphides, etc., of silver, copper, lead and mercury.

| | | | |
|---|---|---|---|
| 42. | **Argentite** | $Ag_2S$ | |
| | Jalpaite | $(Ag,Cu)_2S$ | |
| 43. | **Hessite** | $Ag_2Te$ | |
| 44. | **Petzite** | $(Ag,Au)_2Te$ | Massive |
| 45. | **Galena** | PbS | |
| | Cuproplumbite, Alisonite | $(Pb,Cu_2)S$, $(Cu_2,Pb)S$ | |
| 46. | **Altaite** | PbTe | |
| 47. | **Clausthalite** | PbSe | |
| 48. | **Naumannite** | $(Ag_2,Pb)Se$ | |
| 49. | **Berzelianite** | $Cu_2Se$ | Massive |
| 50. | **Lehrbachite** | $(Pb,Hg_2)Se$ | " |
| 51. | **Eucairite** | $Cu_2Se.Ag_2Se$ | " |
| 52. | **Zorgite** | $(Pb,Cu_2,Ag_2)Se$? | " |
| 53. | **Crookesite** | $(Cu,Tl,Ag)_2Se$ | " |

**42. ARGENTITE.** Argentum rude plumbei coloris et Galenæ simile, cultro diffinditur, dentibus compressum dilatatur, *Agric.*, 438, 1529; *Germ.* Glaserz, *Agric.*, Interpr., 463, 1546; *Henckel*, Min., 1734 (proving it a sulphur compound). Silfverglas, Minera argenti vitrea, Argentum sulphure mineralisatum. *Wall.*, 308, 1746; *Sage*, Ann. Ch., 2, 250, 1776 (with earliest anal.). Glanzerz, Silberglas, Silberglanz, Schwefelsilber, Weichgewächs, *Germ.* Vitreous Silver, Sulphuret of Silver, Silver Glance. Argent sulfuré *Fr.* Argyrose *Beud.*, Tr., 2, 392, 1832. Argentit *Haid.*, Handb., 565, 1845. Argyrit *Glock.*, Syn., 23, 1847. Argirose *Ital.* Plata sulfurea *Span.* Petlanque nero *Span.*, *S. A.*

Isometric. Observed planes [1]:

| | | | |
|---|---|---|---|
| *a* (100, *i*-*i*) | *f* (310, *i*-3)[2] | *p* (221, 2) | *z* (322, $\frac{3}{2}$-$\frac{3}{2}$) |
| *d* (110, *i*) | *e* (210, *i*-2) | *m* (311, 3-3) | *x* (433, $\frac{4}{3}$-$\frac{4}{3}$)[2] |
| *o* (111, 1) | *g* (320, *i*-$\frac{3}{2}$) | *n* (211, 2-2) | *σ* (533, $\frac{5}{3}$-$\frac{5}{3}$) |

Penetration-twins: tw. plane *o*. Forms *a*, *d*, *o* most common; crystals often distorted, frequently grouped in parallel position making reticulated, arborescent forms; also filiform. Massive, embedded or as a coating.

Cleavage: *a*, *d* in traces. Fracture small subconchoidal. Perfectly sectile. H. = 2–2·5. G. = 7·20–7·36; 7·296 Freiberg, Dbr. Luster metallic. Color and streak blackish lead-gray; streak shining. Opaque.

**Comp.**—Silver sulphide, $Ag_2S$ = Sulphur 12·9, silver 87·1 = 100.

**Pyr., etc.**—In the open tube gives off sulphurous fumes. B.B. on charcoal fuses with intumescence in O. F., emitting sulphurous fumes, and yielding a globule of silver.

**Obs.**—Found at Freiberg, Annaberg, Joachimsthal of the Erzgebirge; at Schemnitz and Kremnitz in Hungary; in Norway near Kongsberg; in the Altai at the Zmeinogorsk mine; in the Urals at the Blagodatsk mine; in Cornwall; in Bolivia; Peru; Chili; Mexico at Guanajuato, Zacatecas, Catorce, San Pedro del Potosi, etc.

Occurs in Nevada, at the Comstock lode, at different mines, along with stephanite, native gold, etc.; in the vein at Gold Hill; common in the ores of Reese river; probably the chief ore of silver in the Cortez district; in the Kearsarge district, Silver-Sprout vein. At the Silver King mine, in Arizona. At mines near Port Arthur on north shore of Lake Superior. Occurs with native silver and copper in northern Michigan.

Acanthite (p. 58) may be only argentite in distorted crystals with orthorhombic symmetry, Krenner.

**Alt.**—Native silver, at Joachimsthal. Also a mixture called silver-black (Silberschwärze *Germ.*).

**Ref.**—[1] Cf. Schrauf, Ber. Ak. Wien, **63** (1), 165, 1871, and Atlas, Taf. xxiii. [2] Groth, Min. Samml., Strassburg, 50, 1878.

JALPAITE *Breithaupt*, B. H. Ztg., **17**, 85, 1858.—A cupriferous argentite from Jalpa, Mexico. Isometric in cleavage, and malleable like ordinary argentite; color blackish lead-gray; G. = 6·877–6·890. Composition according to T. Richter (l.c.): S 14·36, Ag 71·51, Cu 13·12, Fe 0·79 = 99·78, affording the formula $3Ag_2S.Cu_2S$.

Bertrand obtained for a brittle mineral from Tres Puntas, Chili, associated with argentite: S 14·02, Ag 71·63, Cu 13·06, Fe 0 57 = 99·28; Ann. Mines, **1**, 413, 1872. Cf. stromeyerite.

**43. HESSITE.** Tellursilber *G. Rose*, Pogg., **18**, 64, 1830. Savodinskite *Huot*, Min., **1**, 187, 1841. Telluric Silver. Hessit *Fröbel*, Grundz. Syst. Kryst., 49, 1843. Tellursilberglanz *Germ.*

Isometric. Observed forms[1]:

*a* (100, *i-i*); *d* (110, *i*); *o* (111, 1); *f* (310, *i*-3), *e* (210, *i*-2)[2]; *p* (221, 2), *q* (331, 3)[3]; *m* (311, 3-3)[3], *n* (211, 2-2)[2], *z* (322, $\frac{3}{2}$-$\frac{3}{2}$)[3].

Crystals sometimes highly modified, and often much distorted. Also massive, compact or fine-grained; rarely coarse granular.

Cleavage indistinct Fracture even. Somewhat sectile. H. = 2·5–3. G. = 8·31–8·45; 8·89. Luster metallic. Color between lead-gray and steel-gray.

**Comp.**—Silver telluride, $Ag_2Te$ = Tellurium 36·7, silver 63·3 = 100. Gold is often present, replacing part of the silver; it thus graduates toward petzite.

**Anal.**—1, Rose, l. c. 2, Petz, Pogg., **57**, 467, 1842. 3, Becke, Min. Mitth., **3**, 301, 1880. 4, 5, Genth, Am. J. Sc., **45**, 311, 1868. 6–8, Id., Am. Phil. Soc., **14**, 226, 1874. 9, Raht (blowpipe), quoted by Genth, ib., **17**, 115, 1877.

| | | Te | Ag | Au | |
|---|---|---|---|---|---|
| 1. Savodinski, Altai | G. = 8·41–8·56 | $\frac{2}{2}$ 36·93 | 62·37 | — | Fe 0·37 = 99·67 |
| 2. Nagyág | G. = 8·31–8·45 | [37·76] | 61·55 | 0·69 | Fe Pb, S *tr.* = 100 |
| 3. Botés, Transylvania | G. = 8·318 | 37·22 | 60·69 | 1·37 | $SiO_2$ 0·40 = 99·68 |
| 4. Stanislaus Mine, Cal. | | [39·64] | 55·60 | 3·22 | Ni 1·54 = 100 |
| 5. " " " | | 44·45 | 46·34 | 3 28 | Pb 1·65, Ni 4·71 = 100·43 |
| 6. Red Cloud Mine, Col. | G. = 8·178 | 37·86 | 59·91 | 0·22 | Fe 1·35, Pb 0·45, Cu 0·17 = 99·96 |
| 7. " " " " | G. = 8·789 | $\frac{3}{2}$ 37·17 | 59·75 | 3·33 | Fe 0·18, Cu 0·06, $SiO_2$ 0·15 = 100·64 |
| 8. " " " " | G. = 8·897 | 34·91 | 50·56 | 13·09 | Fe 0·36, Cu 0·07, Pb 0·17, Zn 0·15, $SiO_2$ 0·70 = 100·01 |
| 9. Kearsage Mine, Utah | | *undet.* | 58·79 | 0·10 | |

**Pyr.**—In the open tube a faint white sublimate of tellurium dioxide which B.B. fuses to colorless globules. On charcoal fuses to a black globule; this treated in R.F. presents on cooling white dendritic points of silver on its surface; with soda gives a globule of silver.

**Obs.**—Occurs in the Savodinski mine, about 10 versts from the rich silver mine of Zyrianovski, in the Altai, in Siberia, in a talcose rock, with pyrite, black sphalerite, and chalcopyrite. Specimens in the museum of Barnaul, on the Ob, are a cubic foot in size. Also found at Nagyág in Transylvania, and in highly modified crystals at the Jacob and Anna mines, Botés Mt., between Zalathna and Verespatak; also at Rezbanya, Hungary. In Chili, near Arqueros, Coquimbo. A silver telluride (hessite or petzite) has been noted at the Maria mine, Karangahake, New Zealand.

In the U. S., at the Stanislaus mine. Calaveras Co., Cal. Sparingly at the Red Cloud mine, Boulder county, Colorado; also at the Kearsarge mine, Dry Cañon, Utah.

Named after G. H Hess of St. Petersburg (1802–1850).

**Ref.**—[1] Schrauf, Rezbanya, Zs. Kr., **2**, 242, 1878; also [2] Knr., Botés, Transylvania. ibid., **4**, 542, 1880. [3] Becke (l. c.) concludes from irregularity in angles, earlier noted by Schrauf, that the crystals are triclinic. Kenngott referred crystals to the orthorhombic system, Ber. Ak. Wien, **9**, 20, 1853; Hess to the rhombohedral, Pogg., **28**, 407, 1833; cf. Schrauf, l. c.

**44. PETZITE.** Tellursilber Petz, Pogg. **57**, 470, 1842. Tellurgoldsilber *Hausm.* Handb., **2**, 51, 1847. Petzit *Haid.*, Handb., 556, 1845.

Massive; fine granular to compact.

Fracture subconchoidal. Slightly sectile to brittle. H. = 2·5–3. G. = 8·7–9·02. Luster metallic. Color steel- or iron-gray to iron-black; often tarnishing.

**Comp.**—A telluride of silver and gold $(Ag,Au)_2Te$, if Ag : Au = 3 : 1 = Tellurium 32·5, silver 42·0, gold 25·5 = 100.

**Anal.**—1, Petz., l. c. 2, 3, 4, Genth, Am. J. Sc., **45**, 310, 1868. 5, 6, Id., Am. Phil. Soc. **14**, 226, 1874.

| | | Te | Ag | Au | |
|---|---|---|---|---|---|
| Nagyág | G. = 8·72–8·83 | [34·98] | 46·76 | 18·26 | Fe,Pb,S *tr.* = 100 |
| Stanislaus Mine, Cal. | $\frac{2}{3}$ | [32·23] | 42·14 | 25·63 | = 100 |
| Golden Rule Mine, Cal. | | 32·68 | 41·86 | 25·60 | = 100·14 |
| " " " " | | [34·16] | 40·87 | 24·97 | = 100 |
| Red Cloud Mine, Col. | G. = 9·01 | 33·49 | 40·73 | 24·60 | Bi 0·41, Pb 0·26, Zn 0·05, Fe 0·78, $SiO_2$ 0·62 = 100·44 |
| " " " " | G. = 9·020 | [32·97] | 40·80 | 24·69 | Zn 0·21, Fe 1·28, $SiO_2$ 0·05 = 100 |

**Pyr.**—Like hessite, but yields a globule containing both gold and silver.

**Obs.**—Occurs at Nagyág, Transylvania. In the U. S. at the Red Cloud mine, Boulder Co., Colorado; at the Stanislaus and Golden Rule mines, California.

Named after W. Petz.

Groth suggests that petzite may be orthorhombic and hence belong to the chalcocite group.

**45. GALENA**, or GALENITE. Galena *Plin.*, **33**, 31 [not Galena or Molybdæna (= litharge-like product from the ore), *Plin.*, **34**, 47, 53]. Molybdæna pt., Plumbago pt., Galena, Pleiertz, Plei Glanz *Agric.*, 1546. Plumbago pt., Blyglants, Galena, Plumbum sulphure et argento mineralisatum, *Wall.*, 292, 1747, *Cronst.*, 167, 168, 1758. Galenit *von Kbl.*, Min., 201, 1858. Lead glance. Lead sulphide. Bleiglanz *Germ.* Blyglans *Swed.* Galène, Plomb sulfuré *Fr.*

Plumbago, Pleischweis ? *Agric.*, Interpr., 467, 1546. Bleischveif, Plumbago, Plumbum sulphure et arsenico mineralisatum, *Wall.*, 294, 1746. Steinmannite *Zippe*, Verh. Ges. Mus. Böhmen., 1833, 39. Targionite *Bechi*, Am. J. Sc., **14**, 60. 1852. Supersulphuretted Lead *Johnston*, Rep. Brit. Assoc., 572, 1833; *Thomson*, Min., **1**, 552, 1836; Johnstonite *Greg & Lettsom*, Min., 448, 1858.

Isometric. Observed forms[1]:

*a* (100, *i-i*)
*d* (110, *i*)
*o* (111, 1)
*δ* (15·1·0, *i*-15)[8]
*ψ* (10·1·0, *i*-10)[5]
*f* (310, *i*-3)
*λ* (10·10·9, $\frac{10}{9}$)[8]
*u* (554, $\frac{5}{4}$)
*r* (774, $\frac{7}{4}$)
*p* (221, 2)
*q* (331, 3)
*ν* (772, $\frac{7}{2}$)[8]
*ρ* (441, 4)
*Ω* (40·40·1, 40)[8]
*c* (36·1·1, 36-36)[7]
*ζ* (16·1·1, 16-16)[3]
*γ* (15·1·1, 15-15)[6]
*b* (12·1·1, 12-12)
*χ* (11·1·1, 11-11)[3]
*σ* (10·1·1, 10-10)[6]
*φ* (911, 9-9)[5]
*τ* (15·2·2, $\frac{15}{2}$-$\frac{15}{2}$)[2]
*z* (611, 6-6)
*ω* (511, 5-5) ?
*μ* (411, 4-4)[2]
*m* (311, 3-3)
*n* (211, 2-2)
*ξ* (533, $\frac{5}{3}$-$\frac{5}{3}$)[8]
*β* (322, $\frac{3}{2}$-$\frac{3}{2}$)
*α* (433, $\frac{4}{3}$-$\frac{4}{3}$)[2]
*Δ* (821, 8-4)
*x* (10·5·3, $\frac{10}{3}$-2)[3]
*y* (521, 5-$\frac{5}{2}$)[4]
*s* (321, 3-$\frac{3}{2}$)

Twins: tw. pl. *o*, both contact- and penetration-twins, sometimes repeated; twin crystals often tabular ∥ *o*. Also tw. pl. *ρ* (441)[8], *m* (311)[9], and *q* (331)[10] as seen in polysynthetic tw. lamellæ often giving rise to striations on a cleavage surface; in some cases these are secondary and due to pressure.[12] Commonly in cubes, or cubo-octahedrons, less often habit octahedral. Also in skeleton crystals, reticulated, tabular. Massive cleavable, coarse or fine granular, to impalpable; occasionally fibrous or plumose.

Cleavage: cubic, highly perfect; less often octahedral. Fracture flat subconchoidal or even. H. = 2·5–2·75. G. = 7·4–7·6. Luster metallic. Color and streak pure lead-gray. Opaque. Thermo-electrically" positive, Sardinia, G. = 7·428; also negative, Přibram, G. = 7·575.

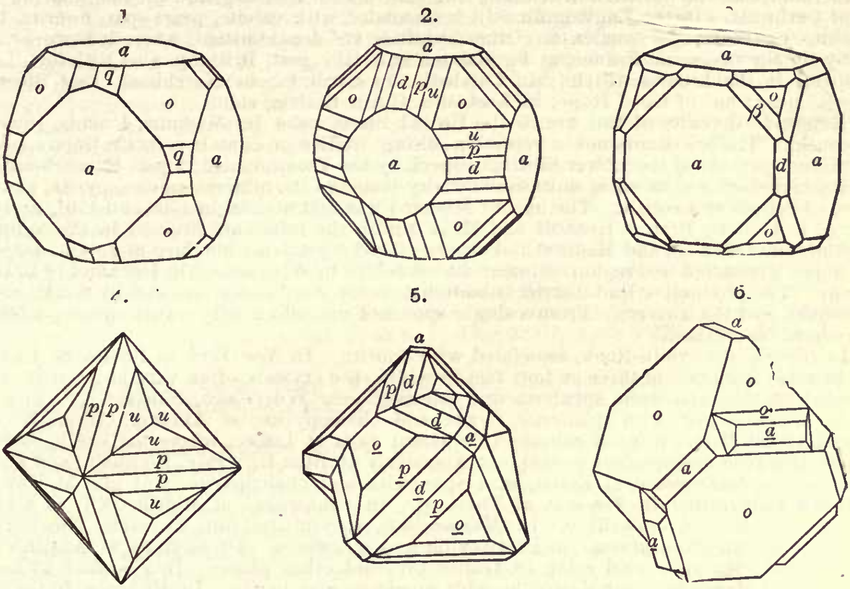

Fig. 1, Freiberg. 2, Neudorf, Schrauf. 3, Rossie, J. D. D. 4, Oberlahr, Schrauf.
5, Neudorf, Sbk. 6, Freiberg, Sbk.

**Comp., Var.**—Lead sulphide, PbS = Sulphur 13·4, lead 86·6 = 100. Contains silver, and occasionally selenium, zinc, cadmium, antimony, bismuth, copper, as sulphides; besides, also, sometimes native silver and gold; and even platinum has been reported as occurring in a galena from the Dept. of Charente, France.

**Var.**—1. *Ordinary.* (*a*) Crystallized; (*b*) somewhat fibrous and plumose; (*c*) cleavable, granular coarse or fine; (*d*) cryptocrystalline.

The variety with octahedral cleavage is rare; the following cases have been noted: Lancaster Co., Penn., with G. = 7·63; Habach, Salzburg, G. = 7·50, $Bi_2S_3$ = 1·97; Glacier Leschant, Mont Blanc, with G. = 7·67 and $Bi_2S_3$ = 1 p. c.; Nordmark, Sweden, G. = 7·508, $Bi_2S_3$ 0·91. In these cases the usual cubic cleavage is obtained readily after heating to 200° or 300° (then G. = 7·475 Nordmark), cf. Cooke, Torrey. Am. J. Sc., **35**, 126, 1863; Zeph, Zs. Kr., **1**, 155, 1877; Brun, Bull. Soc. Min., **4**, 260, 1881; H. Sj., G. För. Förh,, **7**, 124, 1884. It has been suggested that the peculiarity of cleavage may be connected with the bismuth usually present.

2. *Argentiferous.* All galena is more or less argentiferous, and no external characters serve to distinguish the kinds that are much so from those that are not. The silver is detected by cupellation, and may amount from a few thousandths of one per cent to one per cent or more; when mined for silver it ranks as a *silver ore.*

3. Containing arsenic, or antimony, or a compound of these metals, as impurity. Here belong the following, which appear to be merely impure galena. *Bleischweif* from Clausthal with 2·22 Zn, 0·34 Fe, 0·22 Sb (Rg.); *targionite* from Argentiera, Tuscany, with 5·77 Sb, 1·77 Fe, 1·11 Cu, 1·33 Zn, 0·72 Ag (Bechi); and *steinmannite* from Přibram, with both arsenic and antimony. *Supersulphuretted lead* of Johnston and others (or *Johnstonite*) contains an excess of sulphur owing to a decomposition of a portion of the mass, setting part of the sulphur free.

**Pyr.**—In the open tube gives sulphurous fumes. B.B. on charcoal fuses, emits sulphurous fumes, coats the coal yellow near the assay (PbO) and white with a bluish border at a distance ($PbSO_3$), and yields a globule of metallic lead. Decomposed by strong nitric acid with the separation of some sulphur and the formation of lead sulphate.

**Obs.**—One of the most widely distributed of the metallic sulphides. Occurs in beds and veins, both in crystalline and uncrystalline rocks. It is often associated with pyrite, marcasite, sphalerite, chalcopyrite, arsenopyrite, etc., in a gangue of quartz, calcite, barite or fluor, etc.; also with cerussite, anglesite, and other salts of lead, which are frequent results of its alteration It is also common with gold, and in veins of silver ores.

At Freiberg in Saxony it occupies veins in gneiss; in Spain, in granite at Linares [illegible] in Catalonia, Grenada, and elsewhere; at Clausthal and Neudorf in the Harz, and at Přibram in Bohemia, it forms veins in clay slate; in Styria it occurs in the same kind of rock in beds; at Sala in Sweden it forms veins in granular limestone; through the graywacke of Leadhills and the killas of Cornwall, in veins; filling cavities in the Subcarboniferous limestone in Derbyshire, Cumberland, and the northern districts of England; also in Bleiberg, and the neighboring localities of Carinthia. In the English mines it is associated with calcite, pearl spar, fluorite, barite, witherite, calamine, and sphalerite. Other localities are Joachimsthal, where it is worked principally for the silver; in France, at Poullaouen and Huelgoet, Brittany, also Villefort, Lozère; in Spain, in the Linares district; in Catalonia; in Sardinia; in Nerchinsk, East Siberia; in Algeria; near Cape of Good Hope; in Australia; Chili; Bolivia, etc.

Extensive deposits of this ore in the United States exist in Missouri, Illinois, Iowa, and Wisconsin. The ore occurs not in veins but filling cavities or chambers in stratified limestone, of different periods of the Lower Silurian, especially the Trenton, also in part Subcarboniferous. It is associated with sphalerite, smithsonite ("dry-bone" of the miners), calcite, pyrite, and often an ore of copper and cobalt. The lead of Missouri was first noticed in 1700 and 1701, and rediscovered in 1720 by Francis Renault and M. la Motte; the mines are situated in the counties of Washington, Jefferson, and Madison and others. Good crystals are obtained at Joplin, Jasper Co. The upper Mississippi lead region embraces 62 townships in Wisconsin, 8 in Iowa and 10 in Illinois (Owen). The productive lead district is bounded on the west, north, and east by the Mississippi, Wisconsin, and Rock rivers. From a single spot, not exceeding fifty yards square, 1,500 tons of ore have been raised.

In *Illinois*, at Cave-in-Rock, associated with fluorite. In *New York*, at Rossie, St. Lawrence Co., in veins from one to three or four feet in width, the crystals often very large, with calcite, and chalcopyrite, and some sphalerite and celestite; near Wurtzboro, Sullivan Co., in a large vein in millstone grit, with sphalerite, pyrite, and chalcopyrite; at Ancram, Columbia Co.; in Ulster Co. In *Maine*, veins of considerable extent exist at Lubec, where the ore is associated with chalcopyrite and sphalerite; also less extensively at Blue Hill Bay, Bingham, and Parsonsville. In *New Hampshire*, at Eaton, with sphalerite and chalcopyrite; and also at Haverhill, Bath, and Tamworth. In *Vermont*, at Thetford. In *Connecticut*, at Middletown, in a vein in argillyte, massive and crystalline. In *Massachusetts*, at Southampton, Leverett, Newburyport, and Sterling. In *Pennsylvania*, at Phenixville and elsewhere. In *Virginia*, at Austin's mines in Wythe Co., Walton's gold mine in Louisa Co., and other places. In *Tennessee*, at Brown's Creek, and at Haysboro, near Nashville, with sphalerite and barite. In *Michigan*, in the region of Chocolate river and elsewhere, and Lake Superior copper district; on the N. shore of L. Superior, in Neebing on Thunder Bay, and around Black Bay.

In *California*, at many of the gold mines. In *Nevada*, abundant in the Eureka district, and at Steamboat Springs, Washoe Co. In *Arizona*, in the Castle Dome, Eureka, and other districts. In *Colorado*, at Leadville there are productive mines of argentiferous galena, also at Georgetown and in the San Juan district and elsewhere. Mined for silver in the Cœur d'Alene region in Idaho; also at various points in Montana.

The name galena is from the Latin *galena* (γαλήνη), a name given to lead ore or the dros from melted lead. In Spanish South America, galena is called *carne de vaca*, when showin broad crystalline surfaces; when presenting small surfaces, *soroche;* when **granular**, *acerilla;* of a fibrous structure, *frangilla*. Galena, coarse-grained and in lumps large enough to be use to glaze potters' ware, is sometimes called *potters' ore;* also called Glasurerz *Germ.*, alquifoux *Fr.*, archifoglio *Ital.*

**Alt.**—Minium, anglesite, cerussite, pyromorphite, wulfenite, tetrahedrite, chalcocite, rhodochrosite, quartz, limonite, pyrite, pistomesite (pistopyrite Breith.), calamine, occur as pseudomorphs after galena, partly from alteration, and partly through removal and substitution. A change to the carbonate (cerussite), with the setting free of sulphur which is sometimes found in crystals, is the most common.

Galena also occurs as pseudomorph after pyromorphite (Blaubleierz *Germ.*) at Bernkastel on the Mosel and elsewhere. Breithaupt called it *plumbeine*, or one species of his *Sexangulites*, regarding this lead sulphide as crystallized in hexagonal prisms, and not a pseudomorph.

*Fournetite* of Ch. Mène (C. R., **51**, 463, 1860), supposed to be near tetrahedrite, is pronounced by Fournet (C. R., **54**, 1096, 1862) a mixture of galena with copper ore.

**Artif.**—Galena is sometimes a furnace product. It has been made in crystals by heating oxide or silicate of lead with vapor of sulphur (Wurtz); also by suspending lead sulphate in a bag in water saturated with carbon dioxide, and in which putrid fermentation is kept up (as by an oyster in the water), there resulting an incrustation of galena upon the shells (Gages, Brit. Assoc., 206, 1863). Cf. Doelter, Zs. Kr., **11**, 33, 41, 1885, also Fouqué-Lévy, Synth. Min., 308, 1882, and Weinschenk, Zs. Kr., **17**, 497, 1890. Occurs as a recent formation on coins at Bourbonne-les-Bains, Daubrée. It has been deposited as a specular film by means of a thiocarbamide (Reynolds).

**Ref.**—[1] See Schrauf, Atlas, xxxiv–v; also Sbk., Zs. G. Ges., **26**, 617, 1874. [2] Klein, Jb. Min., 311, 1870. [3] D'Achiardi, Bottino, Boll. Com. G., **2**, 160, 1871. [4] Groth, Freiberg, Min.-Samml. 48, 1878. [5] Schimper, Derbyshire, ib., p. 49. [6] Frenzel-Arzruni, Portugal, Min. Mitth., **3**, 508, 1880; also other doubtful forms. [7] Traube, Bottino, Jb. Min., **2**, 253, 1888. [8] Sbk., l. c. [9] Zeph. Habach, Salzburg, Zs. Kr., **1**, 155, 1877. [10] W. Cross, Colorado, Proc. Col. Soc., **2**, 171, 1887. [11] Stefan, Ber. Ak. Wien, **51** (1), 260, 1865; Schrauf & E. S. D., ib., **69** (1), 155, 1874, and Am. J. Sc., **8**, 264, 1874.

[12] On percussion-figures, see Weiss, Zs. G. Ges., **29**, 209, 1877; on gliding-planes, etc., Bauer, Jb. Min., **1**, 138, 1882, **1**, 191, 1886; on etching figures, Becke, Min. Mitth., **6**, 237, 1884, **9**, 16, 1887.

HUASCOLITE *Dana*, Min., 42, 1868. Galena blendosa *Domeyko*, Min., 168, 1860. Sulphide of lead and zinc *D. Forbes*, Phil. Mag., **25**, 110, 1863. The characters are mostly those of galena. It has a granular or saccharoidal structure, a lead-gray color rather paler than ordinary galena, but little luster, and is apparently homogeneous and without any mixture of sphalerite. Domeyko obtained (l. c.) S 19·2, Pb 48·6, Zn 25·6, gangue 3·1; which corresponds nearly to PbS. 1½ ZnS. It comes from Ingahuas, in the province of Huasco, where it forms large aggregated masses or nodules in the lower part of the vein.

A massive mineral having a bluish-gray color is referred to huascolite by *Raimondi* (Min. Pérou, p. 202, 1878). He obtained after deducting 14·50 p. c. gangue: S 27·76, Pb 26·86, Zn 44·50, Fe 0·88 = 100; from the Poderosa mine, Province Dos de Mayo, Peru, where it is called *chumbe blanco* or *pavonado blanco*. *Domeyko* describes a mineral from Morochocha, Peru, corresponding in composition to PbS.(Zn,Fe)S, with Zn = 16·59 p. c.; another from Corocoro, Bolivia, afforded 5 p. c. ZnS (6th App. Min. Chili, p. 17, 1878).

Another similar mineral occurs in the East Ovoca district, county of Wicklow, Ireland, and also in Anglesey; it has been called *kilmacooite*, after the district called Kilmacoo, and is locally known as *bluestone*. It is hard, with fine-grained saccharoidal structure. G. = 4·736. Color steel-gray. According to C. R. C. Tichborne, who characterizes it as an "argentiferous galenitic blende," it consists of ZnS 37·68 p. c., PbS 29·07, $Ag_2S$ 0·275. Sc. Proc. R. Dublin Soc., **4**, 300, 1885.

CUPROPLUMBITE *Breith.*, Pogg., **61**, 672, 1844. Kupferbleiglanz *Germ.* Galena cobriza *Domeyko*, 168, 1860. Alisonite *Field*, Am. J. Sc., **27**, 387, 1859. Plumbocuprite *Adam*, Tabl. Min., 56, 1869.

Cuproplumbite is a massive mineral varying in structure, color, and luster from those of galena to nearly those of chalcocite and covellite; the color a little darker, and passing to iron-gray and indigo-blue; the luster generally feeble and sometimes almost wanting. The specimens contain disseminated ores of copper, and come from a mine in Catemo (Aconcagua), Chili. Plattner's analysis (1 below) corresponds to $Cu_2S.2PbS$.

Alisonite (named after R. E. Alison) is also massive with a deep indigo-blue color quickly tarnishing; the analysis (2) corresponds to $3Cu_2S.PbS$; from Mina Grande, near Coquimbo, Chili. Ulrich mentions a similar mineral from Victoria, Australia.

Analysis 4, corresponding to $2Cu_2S.PbS$, is of a massive, dark bluish gray mineral from an abandoned mine at St. Maurice in the Val Godemas, Hautes Alpes; it is associated with chalcopyrite, sphalerite, galena, and an argentiferous tetrahedrite.

Anal.—1, Plattner, Pogg., **61**, 671, 1844. 2, Field, l. c. 3, Id., J. Ch. Soc., **14**, 160, 1860. 4. Lodin, Bull. Soc. Min., **6**, 178, 1883.

| | | | S | Pb | Cu | Ag | |
|---|---|---|---|---|---|---|---|
| 1. | *Cuproplumbite* | G. = 6·41–6·43 | [15·1 ] | 64·9 | 19·5 | 0·5 | = 100 |
| 2. | *Alisonite* | G. = 6·10 | 17·00 | 28·25 | 53·63 | — | = 98·88 |
| 3. | " | | 17·69 | 28·81 | 53·28 | — | = 99·78 |
| 4. | Val Godemas | G. = 6·17 | 17·54 | 35·87 | 44·52 | 0·11 | Sb 0·62, As *tr.*, Fe 0·79, $SiO_2$ 0·25 = 99·70 |

Whether all the above minerals represent definite homogeneous compounds, or only ill-defined alteration products, is uncertain, and if so it is not clear whether they should be classed with isometric galena or with orthorhombic chalcocite. It may be noted that an artificial compound, crystallizing in the isometric system, consists of $Cu_2S$,PbS and $Fe_2S$ according to Brand, Zs. Kr., **17**, 264, 1889.

**46. ALTAITE.** Tellurblei *G. Rose*, Pogg., **18**, 68, 1830. Elasmose *Huot.*, Min., **1**, 1841; *O. d'Halloy*, Introd. à la Geol., 1833 (not of Beud. Tr., 1832), etc. Altait *Haid.*, Handb., 556, 1845. Plomo telural *Domeyko*.

Isometric. Usually massive; rarely in cubes.

Cleavage: cubic. Fracture subconchoidal. Sectile. H. = 3. G. = 8·16, G. Rose. Luster metallic. Color tin-white, with a yellowish tinge tarnishing to bronze-yellow. Opaque.

**Comp.**—Lead telluride, PbTe = Tellurium 37·7, lead 62·3 = 100.

**Anal.**—1, 2, Genth; 1, Am. J. Sc., **45**, 312, 1868; 2, Am. Phil. Soc. Philad., **14**, 225, 1874.

| | Te | Pb | |
|---|---|---|---|
| 1. Stanislaus Mine, Cal. | 37·31 | 60·71 | Ag 1·17, Au 0·26 = 99·45 |
| 2. Red Cloud Mine, Col. | 38·48 | 61·52 | = 100 |

**Pyr.**—In the open tube fuses, gives fumes of tellurium dioxide, forming a white sublimate, which B.B. fuses into colorless drops. On charcoal in R.F. colors the flame bluish, fuses to a globule, coats the coal near the assay with a lustrous metallic ring of lead telluride, outside of which it is brownish yellow, and in O.F. still more yellow. Entirely volatile, except a trace of silver.

**Obs.**—From the Savodinski mine near Zyrianovski, in the Altai, with hessite. Also in Coquimbo, Chili, at the Condorriaco mine.

In California at the Stanislaus mine, and the Golden Rule mine, Calaveras Co.; in Colorado at the Red Cloud mine, Boulder county, with native tellurium, sylvanite, pyrite, siderite, quartz. North Carolina, at the King's Mountain mine, Gaston Co., in saccharoidal quartz with gold, galena, pyrite, tetrahedrite, and rarely nagyagite.

Named after the original locality.

HENRYITE *Endlich*, Eng. Mng. J., Aug. 29, 1874. An impure altaite, containing admixed pyrite (Genth).

**47. CLAUSTHALITE.** Selenblei *Zinken*, 1823, Pogg., **2**, 415, 1824, 3, 271; *H. Rose*, ib., **2**, 415, 3, 281. Plomb séléniè *Fr.* Clausthalie *Beud.*, Tr., **2**, 531, 1832. Clausthalite. Kobalt-Bleiglanz *Hausm.*, Nordd. Beitr. B. H., 3, 120. Kobaltbleierz *Hausm.*, Handb., 183, 1813; id. *Strom. & Hausm.*, Gött. gel. Anz., 329, 1825. Selenkobaltblei *H. Rose*, Pogg., 3, 288, 290. Tilkerodite *Haid.*, Handb., 566, 1845.

Isometric. Occurs commonly in fine granular masses; some specimens foliated.

Cleavage: cubic. Fracture granular. H. = 2·5–3. G. = 7·6–8·8. Luster metallic. Color lead-gray, somewhat bluish. Streak darker. Opaque.

**Comp., Var.**—Lead selenide, PbSe = Selenium 27·7, lead 72·3 = 100.

*Tilkerodite* Haid., is a cobaltiferous variety; it gave Rose 3·14 p. c. Co. Analyses 5th Ed., p. 43.

**Pyr.**—Decrepitates in the closed tube. In the open tube gives fumes of selenium and a red sublimate. B.B. on charcoal a strong odor of selenium; partially fuses. Coats the coal near the assay at first gray, with a reddish border (selenium), and later yellow (lead oxide); when pure entirely volatile; with soda gives a globule of metallic lead. The *tilkerodite* yields a black residue, and gives a cobalt-blue bead with borax.

**Obs.**—Much resembles a granular galena. Found by Zinken, near Harzgerode, in the Harz with hematite, at Clausthal, Tilkerode, Zorge, and Lehrbach; at Reinsberg, near Freiberg, in Saxony; at the Rio Tinto mines near Seville, Spain; Cacheuta mine, Mendoza, S. A.

**48. NAUMANNITE.** Selensilber *G. Rose*, Pogg., **14**, 471, 1828. Selenbleisilber, Selensilberglanz. Séléniure d'Argent *Fr.* Naumannit *Haid.*, Handb., 565, 1845.

Isometric. In cubes. Also massive, granular, and in thin plates.

Cleavage: cubic, perfect. H. = 2·5. G. = 8·0. Luster metallic, splendent. Color and streak iron-black.

**Comp.**—A selenide of silver, or of silver and lead, $(Ag_2,Pb)Se$. If pure, $Ag_2Se$ = Selenium 26·8, silver 73·2 = 100.

**Anal.**—1, Rose, l. c. 2, Rg., Min. Ch., 34, 1860.

| | | | | | |
|---|---|---|---|---|---|
| 1. Tilkerode | G. = 8·0 | Se [29·53] | Ag 65·56 | Pb 4·91 | = 100 |
| 2. " | | 26·52 | 11·67 | 60·15 | = 98·34 |

No. 2 corresponds nearly to $Ag_2Se.5PbSe$ and approximates to clausthalite. Domeyko (C. R., 63, 1064, 1866) obtained for an ore from Cacheuta: Se 30·0, Ag 21·0, Pb 43·5, Cu 1.8, Co 0·7, Fe 2·2 = 99·2. Adam calls this *cacheutaite*, Tabl. Min., 52, 1869.

**Pyr., etc.**—B.B. on charcoal melts easily in the outer flame; in the inner, with some intumescence. With soda and borax yields a bead of silver.

**Obs.**—Occurs at Tilkerode in the Harz.

Named after the crystallographer and mineralogist, C. F. Naumann (1797–1873).

According to Del Rio, another selenide of silver occurs at Tasco in Mexico, crystallized in hexagonal tables. Beud., Tr., **2**, 535, 1832.

**49. BERZELIANITE.** Selenkupfer *Berz.*, Afh., **6**, 42, 1818. Cuivre séléniè *Fr.* Berzeline *Beud.*, Tr., **2**, 534, 1832. Berzelianite *Dana*, Min., 509, 1850.

In thin dendritic crusts and disseminated.

Soft. G. = 6·71. Luster metallic. Color silver-white, soon tarnishing. Streak shining.

**Comp.**—Copper selenide, $Cu_2Se$ = Selenium 38·4, copper 61·6 = 100.

**Anal.**—Nordenskiöld, Öfv. Ak. Stockh., 23, 364, 1866.

| | Se | Cu | Ag | Fe | Tl |
|---|---|---|---|---|---|
| 1. | 39·85 | 53·14 | 4·73 | 0·54 | 0·38 = 98·64 |
| 2. | 38·74 | 52·15 | 8·50 | 0·35 | *tr.* = 99·74 |

Nordenskiöld remarks that the varying percentage of the silver is possibly due to an admixture of eucairite, and that the amount of thallium in the analyses is probably too low.

**Pyr.**—In the open tube gives a red sublimate of selenium, with white crystals of selenium dioxide. B.B. on charcoal fumes of selenium, and with soda yields a globule of copper.

**Obs.**—Occurs at Skrikerum in Sweden disseminated through calcite as a black or blackish-blue powder, also in crusts; also near Lehrbach in the Harz.

Named after the Swedish chemist, J. J. Berzelius (1779–1848).

**50. LEHRBACHITE.** Selenblei mit Selenquecksilber *H. Rose*, Pogg., **2**, 418, 1824, **3**, **297**, 1825. Selen-Quecksilberblei *Leonh.*, Handb., 592, 1826. Lehrbachite *B. & M.*, Min., 153, 1852. Lerbachite.

Massive, granular.

Brittle. G. = 7·804–7·876. Color lead-gray, steel-gray, iron-black.

**Comp.**—Selenide of lead and mercury, PbSe with HgSe.

**Anal.**—1, Rose, l. c. 2, 3, Schultz, Rg., Min. Ch., 1011, 1860.

| | | Se | Pb | Hg |
|---|---|---|---|---|
| 1. Tilkerode | | 24·97 | 55·84 | 16·94 = 97·75 |
| 2. " | G. = 7·089 | 27·68 | 61·70 | 8·33, S 0·80, $Fe_2O_3$ 0·64 = 99·15 |
| 3. " | G. = 8·104 | 24·41 | 16·93 | 55·52, S 1·10 = 97·96 |

**Pyr.**—In the closed tube gives a lustrous metallic gray sublimate of mercury selenide; with soda, a sublimate consisting of globules of mercury. In the open tube gives reactions for selenium, and a sublimate of selenate of mercury condensing in drops. On charcoal like clausthalite.

**Obs.**—From Tilkerode and Lehrbach, in the Harz.

**51. EUCAIRITE.** Eukairit *Berz.*, Afh. **6**, 42, 1818. Cuivre sélénié argental *H.* Selenkupfersilber *Germ.*

Isometric. Massive and granular; also in black metallic films, staining the calcite in which it is contained.

H. = 2·5. G. = 7·50. Luster metallic. Color between silver-white and lead-gray. Streak shining.

**Comp.**—A selenide of copper and silver, $Cu_2Se.Ag_2Se$ = Selenium 31·6, copper 25·3, silver 43·1 = 100.

Analyses by Berzelius and Nordenskiöld agree rather closely, 5th Ed. pp. 39, 797.

**Pyr., etc.**—B.B. gives copious fumes of selenium, and on charcoal fuses readily to a gray metallic globule, leaving a bead of silver selenide. With borax a copper reaction. Dissolves in boiling nitric acid.

**Obs.**—Occurs in small quantities in the Skrikerum copper mine in Småland, Sweden, in a kind of serpentine rock, embedded in calcite. In Chili at Aguas Blancas, near Copiapo, and at the mines of Flamenco, a few leagues north of Trespuntas, in the desert of Atacama. Also on the east side of the Andes of Chili, in the province of San Juan, where it occurs in a narrow vein (10–12 mm. broad), and has a lead-gray color, tarnishes easily, and is partly granular, and partly very imperfectly lamellar; at the Cacheuta mine, in the province of Mendoza, Argentine Repub., with other selenides. Domeyko has examined the selenides from Cacheuta in the province of Mendoza (C. R., **63**, 1064, 1866), and considers them to consist of mixtures or combinations of three selenides: (A) A compound analogous to eucairite; (B) a selenide of cobalt and iron; and (C) a selenide of lead. See 5th Ed. p. 798, cf. Naumannite.

Named by Berzelius from εὐκαίρως, *opportunely*, because found by him soon after the discovery of the metal selenium.

**52. ZORGITE.** Selenblei mit Selenkupfer *H. Rose*, Pogg., **2**, 415, 1824. Selenkupferblei, Selenbleikupfer, *Rose*, ib., 3, 293, 294, 296. Zorgite *B. & M* 153, 1852. Raphanosmit *Kbl.*, Taf., 6, 1853. Glasbachite *Adam*, Tabl. Min., 52, 1869.

Massive, granular, like clausthalite.

Brittle. H. = 2·5. G. = 7–7·5. Luster metallic. Color dark or light lead-gray, sometimes inclining to reddish, and often with a brass-yellow or blue tarnish. Streak darker.

**Comp.**—A selenide of lead and copper in varying amounts; perhaps only a mixture of clausthalite with other ingredients.

**Anal.**—1, 2, H. Rose, Pogg., **3**, 290, 1825. 3, 4, Kersten, ib., **46**, 265, 1839. 5, Billandot, J. Ch. Soc., **42**, 1269, 1882.

| | Se | Pb | Cu | Ag | |
|---|---|---|---|---|---|
| 1. Tilkerode | 34·26 | 47·43 | 15·45 | 1·29 | $Fe_2O_3$,PbO 2·08 = 100·51 |
| 2. " | 29·96 | 59·67 | 7·86 | — | Fe 0·77 (Pb), insol. 1·00 = 99·26 |
| 3. Glasbach | 30·00 | 53·74 | 8·02 | 0·05 | $Fe_2O_3$ 2·00 S *tr.*, quartz 4·50 = 98·31 |
| 4. " | 29·35 | 63·82 | 4·00 | 0·07 | Fe,S *tr.*, quartz 2·06 = 99·30 |
| 5. Argentine R. | 30·80 | 41·0 | 15·0 | — | Hg 1·66, Fe 6·0, sand 4·6 = 99·06 |

No. 1 is Rose's *Selenbleikupfer*, No. 2 his *Selenkupferblei*.

**Pyr.**—Like clausthalite, but yielding a black residue and a globule of copper, with usually, when cupelled, a trace of silver.

**Obs.**—Occurs under similar circumstances with clausthalite at Tilkerode and Zorge in the Harz; at Glasbach near Gabel in Thuringia, in argillaceous schist with galena, chalcopyrite, malachite, in a gangue of calcite, siderite, fluorite, and quartz. With azurite, malachite, chrysocolla at Cacheuta, Mendoza, Argentine Republic.

Other analyses of the South American selenides by Pisani (C. R., **88**, 391, 1879), and by Heusler, Klinger and Wittkopf (Ber. Ch. Ges., **18**, 2556, 1885), show a varying composition due to admixture. Analyses: 1–4, Pisani. 5–8, H. & K. 9, 10, Wittkopf.

| | Se | Pb | Cu | Ag | |
|---|---|---|---|---|---|
| 1. G. = 5·5 | 48·4 | 30·6 | 20·6 | — | gangue 1·2 = 100·8 |
| 2. G. = 6·38 | 37·3 | 40·0 | 16·7 | 1·2 | Co 0·8, Fe 0.8, gangue 1·7 = 98·5 |
| 3. G. = 7·55 | 29·7 | 62·1 | 6·7 | — | Co 0·2, Fe 0·3 = 99·0 |
| 4. G. = 6·26 | 42·5 | 13·9 | 42·8 | — | Co 0·3, Fe 0·4 = 99·9 |
| 5. *Light col.* | 32·77 | 35·70 | 12·43 | 19·20 | Co *tr.* = 100·10 |
| 6. " | 29·54 | 17·10 | 25·40 | 27·49 | Co 0·39 = 99·92 |
| 7. *Dark col.* | 46·25 | [1·64][a] | 36·30 | 15·81 | = 100 |
| 8. " | | | 36·00 | 15·93 | |
| 9. " | 41·58 | [3·79] | 35·41 | 19·22 | = 100 |
| 10. " | 41·62 | [3·45] | 35·77 | 19·16 | = 100 |

[a] Incl. Co

Pisani calls the locality the Peruvian Andes, but (as noted by H. & K.) the specimens probably came from Cacheuta, Mendoza, Argentine Republic, like those examined by Domeyko, 5th Ed. p. 798 (cf. also Naumannite). They consist in part of a light-colored nearly silver-white mineral and another dark and lead-colored. *Cacheutaite*, Adam, belongs here.

### 53. CROOKESITE. *A. E. Nordenskiöld*, Öfv. Ak. Stockh., 23, 365, 1866.

Massive, compact; no trace of crystallization.

Brittle. H. = 2·5–3. G. = 6·90. Luster metallic. Color lead-gray.

**Comp.**—A selenide of copper and thallium with a small amount of silver, $(Cu,Tl,Ag)_2Se$.

**Anal.**—Nordenskiöld:

| | Se | Cu | Ag | Fe | Tl |
|---|---|---|---|---|---|
| 1. | [33·27] | 46·11 | 1·44 | 0·63 | 18·55 = 100 |
| 2. | 30·86 | 46·55 | 5·04 | 0·36 | 16·27 = 99·08 |
| 3. | 32·10 | 44·21 | 5·09 | 1·28 | 16·89 = 99·57 |

**Pyr., etc.**—B.B. fuses very easily to a greenish black shining enamel, coloring the flame strongly green. Insoluble in hydrochloric acid; completely soluble in nitric acid.

**Obs.**—From the mine of Skrikerum in Sweden. Formerly regarded as copper selenide or berzelianite. Named after Wm. Crookes, the discoverer of the metal thallium.

The Galena Group also includes the silver sulpho-selenide, *Aguilarite*, $Ag_2S.Ag_2Se$, from Guanajuato, Mexico. See p. 1025.

## 2. Chalcocite Group. RS. Orthorhombic.

| | | | $\breve{a} : \bar{b} : \acute{c}$ |
|---|---|---|---|
| 54. | **Chalcocite** | $Cu_2S$ | 0·5822 : 1 : 0·9701 |
| 55. | **Stromeyerite** | $Ag_2S.Cu_2S$ | 0·5822 : 1 : 0·9668 |
| 56. | **Sternbergite** | $Ag_2S.Fe_4S_5$ | 0·5832 : 1 : 0·8391 |
| | Frieseite | | 0·5970 : 1 : 0·7352 |
| | Argyropyrite, Argentopyrite. | | |

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| | | | |
|---|---|---|---|
| 57. | **Acanthite** | $Ag_2S$ | 0·6886 : 1 : 0·9944 |

The supposed orthorhombic $Ag_2S$, acanthite, may be only a distorted argentite.

**54. CHALCOCITE.** Æs rude plumbei coloris pt., *Germ.* Kupferglaserz, *Agric.*, Interpr., 461, 1546. Koppar-Glas pt., Cuprum vitreum, *Wall.*, 282, 1747. Cuivre vitreux *Fr. Trl.* Wall., **1**, 509, 1753. Kopparmalm, Cuprum sulphure mineralisatum pt., *Cronst.*, 174, 1758. Vitreous Copper, Sulphuret of Copper. Cuivre sulfuré *Fr.* Kupferglanz *Germ.* Copper Glance. Chalcosine *Beud.*, Tr., **2**, 408, 1832. Cyprit *Glock.*, Syn., 1847. Redruthite *Nicol*, Min., 1849. Kuprein *Breith.*, B. H. Ztg., **22**, 35, 1863. Cobre sulfureo *Span.* Calcosina, Rame vetroso *Ital.* Digenit *Breith.*, Pogg., **61**, 673, 1844. Carmenite *H. Hahn*, B. H. Ztg., **24**, 86, 1865.

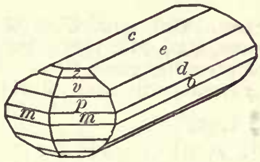
Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·5822 : 1 : 0·9701$ Miller[1].

$100 \wedge 110 = 30° \; 12\frac{1}{2}'$, $001 \wedge 101 = 59° \; 1\frac{5}{6}'$, $001 \wedge 011 = 44° \; 7\frac{5}{6}'$.

**Forms**[1, 2]: *m* (110, *I*) *f* (012, $\frac{1}{2}$-$\breve{i}$) *k* (053, $\frac{5}{3}$-$\breve{i}$) *v* (112, $\frac{1}{2}$)
*a* (100, *i*-$\bar{i}$) *n* (230, *i*-$\frac{3}{2}$) *e* (023, $\frac{2}{3}$-$\breve{i}$) *d* (021, 2-$\breve{i}$) *p* (111, 1)
*b* (010, *i*-$\breve{i}$) *l* (130, *i*-$\breve{3}$) *g* (011, 1-$\breve{i}$) *z* (113, $\frac{1}{3}$) *x* (441, 4)
*c* (001, *O*)

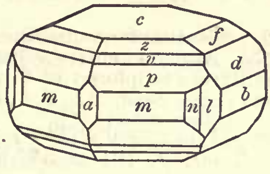
*mm'''* = *60° 25′ *gg'* = 88° 16′ *cv* = 43° 57′ *pp'* = 100° 13′
*nn'* = 97° 44′ *kk'* = 116° 32′ *cp* = 62° 35½′ *zz'''* = 31° 34′
*ll'* = 59° 35′ *dd'* = *125° 28′ *cx* = 82° 37′ *vv'''* = 40° 52′
*ff'* = 51° 45′ *cz* = 32° 44′ *zz'* = 55° 43′ *pp'''* = 53° 3½′
*ee'* = 65° 47′ *vv'* = 73° 43′

1.



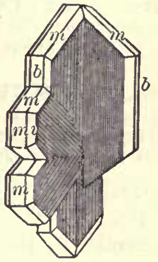
Bristol.

2.



Joachimsthal, Vrba.

3.

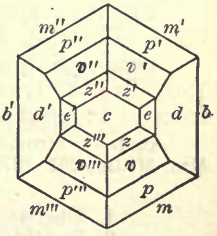


Bristol, J. D. D.

Twins: (1) tw. pl. *m*, producing pseudo-hexagonal stellate forms, sometimes drillings; (2) (032) cruciform twins, crossing at angles of 111° and 69°; (3) *v* (112). Simple crystals often hexagonal in aspect. Faces *c* striated ‖ edge *b*/*c*; also *c*, *d* in oscillatory combination. Also massive, structure granular to compact and impalpable.

Cleavage: *m* indistinct. Fracture conchoidal. Rather brittle. H. = 2·5–3. G. = 5·5–5·8; 5·702 Thomson; 5·648 Ural, Erem. Luster metallic. Color and streak blackish lead-gray, often tarnished blue or green, dull. Opaque.

4.



Bristol.

**Comp.**—Cuprous sulphide, $Cu_2S$ = Sulphur 20·2, copper 79·8 = 100.

Most analyses (5th Ed. pp. 52, 53) agree closely with this formula; sometimes iron in small amount is present, also a little silver.

**Pyr., etc.**—Yields nothing volatile in the closed tube. In the open tube gives off sulphurous fumes. B.B. on charcoal melts to a globule, which boils with spirting; the fine powder roasted at a low temperature on charcoal, then heated in R.F., yields a globule of metallic copper. Soluble in nitric acid.

**Obs.**—Cornwall affords splendid crystals where it occurs in veins and beds with other ores of copper, and especially in the districts of Saint Just, Camborne, and Redruth (*redruthite*). It occurs also at Fassnetburn in Haddingtonshire, in Ayrshire, and in Fair Island, Scotland. In crystals (f. 2) at Joachimsthal, Bohemia. In Tellemarken, Norway. The compact and massive varieties occur in Siberia, Hesse, Saxony, the Banat, etc.; Mt. Catini mines in Tuscany; Mexico, Peru, Bolivia, Chili. Near Angina, Tuscany, a crystal has been obtained, weighing half a pound.

In the United States, compact varieties occur in the red sandstone at Simsbury and Cheshire, Conn.; also at Schuyler's mines, N. J. Bristol, Conn., has afforded large and brilliant crystals. In Virginia, in the United States copper mine district, Blue Ridge, Orange Co. Between Newmarket and Taneytown, Maryland, east of the Monocacey, with chalcopyrite. In Arizona, near La Paz; in N. W. Sonora. In Nevada, in Washoe, Humboldt, Churchill and Nye counties. In Montana, massive at Butte City. In Canada, with chalcopyrite and bornite at the Acton mines and elsewhere in the province of Quebec; at the Canada West mines, L. Huron and Prince's location, L. Superior. In Nova Scotia, in nodules in sandstone.

The *Argent en epis* or *Cuivre spiciforme* of Haüy, which is merely vegetable matter impregnated with this ore, occurs at Frankenberg in Hessia, and also Mahoopeny, Penn.

Under the name *Cupreine* (coperite *Domeyko*), Breithaupt separated the larger part of the specimens, referred to chalcocite, on the ground alleged that they were *hexagonal* instead of orthorhombic, and had a lower specific gravity, but his conclusions were doubtless erroneous.

**Alt.**—Occurs altered to chalcopyrite, bornite, covellite, and melaconite.

Specimens are often penetrated with the covellite, or indigo-copper, resulting from the alteration. *Digenite* of Breithaupt (l. c.) is probably a mineral of this kind. *Carmenite* of Hahn from Carmen island, in the Gulf of California, approaches digenite. It is an impure chalcocite, containing visibly much covelite. Lindström has analyzed a mineral of apparently the same nature from Sunnerskog; G. För. Förh., **7**, 678, 1885

HARRISITE of Shepard from Canton mine, Georgia, and the Polk Co. copper mines in East Tennessee, is chalcocite with the cleavage of galena, and, as Genth has proved, is pseudomorphous after galena. Unaltered galena has been observed within crystals of harrisite both at the Georgia and Tennessee localities. Its color is dark lead-gray and bluish black. Named for W. F. Harris. See further on the above in 5th Ed. p. 53.

**Artif.**—Chalcocite has been formed by Durocher by the action of sulphuretted hydrogen gas on vapors of copper chloride. Cf. Doelter, Zs. Kr., **11**, 34, 1885, also Fouqué-Lévy, Synth. Min., 294, 1882. Formed as a recent product on Roman coins at Bourbonne-les-Bains (Daubrée) and elsewhere.

The artificial $Cu_2S$ belongs in part to the isometric system, Mitsch.

**Ref.**—[1] Min., 159, 1852. [2] J. D. D., Min., 46, 1854. 52, 1868; for the twin (2) the angles given correspond to (032), not (043). On Joachimsthal crystals (f. 2) cf. Vrba, Zs. Kr., **15**, 208, 1888; on those from the Tugrinsk copper mines in the Ural, Erem., Vh. Min. Ges., **25**, 315, 1889.

**55. STROMEYERITE.** Silberkupferglanz *Hausm. & Strom.*, Gel. Anz. Gött., **2**, 1249, 1816; Schw. J., **19**, 325, 1817. Argent et cuivre sulfuré *Bournon*, Cat., 212, 1817. Sulphuret of Silver and Copper. Argentiferous Sulphuret of Copper. Kupfersilberglanz *Germ*. Cuivre sulfuré argentifère *Fr*. Stromeyerine *Beud.*, Tr., **2**, 410, 1832. Stromeyerite *Shep.*, **2**, 211, 1835.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}5822 : 1 : 0{\cdot}9668$ Rose[1].

$100 \wedge 110 = 30° 12\frac{1}{2}'$, $001 \wedge 101 = 58° 56\frac{2}{3}'$, $001 \wedge 011 = 44° 2'$.

**Forms**[1]. *b* (010, *i*-*ĭ*), *c* (001, *O*); *m* (110, *I*); *u* (012, ½-*ĭ*), *e* (021, 2-*ĭ*); *w* (114, ¼), *p* (111, 1).

Angles: *mm'''* = *60° 25', *cu* = 25° 48', *bu* = *64° 12', *ce* = 62° 39', *cw* = 25° 39½', *cp* = 62° 30', *ww'* = 43° 57', *ww'''* = 25° 10'.

Twins[2]: tw. pl. *m*. Form prismatic, *m*, *b*, with *u*, *w*, resembling an hexagonal prism with low terminal pyramid. Also massive, compact.

Fracture subconchoidal. H. = 2·5–3. G. = 6·15–6·3. Luster metallic. Color and streak dark steel-gray. Opaque.

**Comp.**—Sulphide of silver and copper, $(Ag,Cu)_2S$, or $Ag_2S.Cu_2S$ = Sulphur 15·8, silver 53·1, copper 31·1 = 100. The ratio of Ag : Cu often varies slightly from 1 : 1; most analyses show a little iron.

**Anal.**—1, Stromeyer, Schw. J., **19**, 325, 1817. 2, Sander, Pogg., **40**, 313, 1837. 3, Slewert, Min. Mitth., 251, 1873. 4, G. A. Koenig, Proc. Ac. Philad., 281, 1886.

| | | | S | Ag | Cu | |
|---|---|---|---|---|---|---|
| 1. Siberia | *mass.* | G. = 6·26 | 15·78 | 52·27 | 30·48 | Fe 0·33 = 98·86 |
| 2. Rudelstadt | *cryst.* | | 15·92 | 52·71 | 30·95 | Fe 0·24 = 99·82 |
| 3. Argentine Republic | | G. = 6·17 | 14·38 | 52·60 | 31·61 | insol. 1·07 = 99·66 |
| 4. Zacatecas | | G. = 6·230 | 15·81 | 50·18 | 33·69 | insol. 0·26 = 99·94 |

**Pyr., etc.**—Fuses, but gives no sublimate in the closed tube. In the open tube sulphurous fumes. B.B. on charcoal in O.F. fuses to a semi-malleable globule, which, treated with the fluxes, reacts strongly for copper, and cupelled with lead gives a silver globule. Soluble in nitric acid.

**Obs.**—Found associated with chalcopyrite at the Zmeinogorsk mine, near Kolyvan in Siberia; at Rudelstadt, Silesia; also in Chili; at Combavalla in Peru; on the Hoyada, province of Catamarca, Argentine Republic, with chalcopyrite and galena; Zacatecas, Mexico; at the Heintzelman mine in Arizona. Reported from the Black Prince mine, Summit Co., Colorado, and the Yankee Girl mine, Ouray Co.; cf. also p. 58.

Named after Fr. Stromeyer (1776–1835), Professor of Chemistry at Göttingen, who first analyzed and established the species.

**Ref.**—[1] Pogg., **28**, 427, 1833. [2] Min., p. 158, 1852; Rose says twins as with chalcocite.

**56. STERNBERGITE.** *Haidinger*, Trans. Roy. Soc., Ed., **11**, 1, 1827, and Ed. J. Sc., **7**, 242, 1827. Silberkies *Breith.*, Schw. J., **68**, 289, 1833. Argyropyrrhotin *Blomstrand*, Öfv. Ak. Stockh., **27**, 26, 1870. Frieseite *Vrba*, Zs. Kr., **2**, 153, 1878.

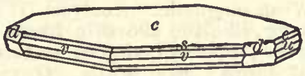
Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}5832 : 1 : 0{\cdot}8391$ Haidinger[1].

$100 \wedge 110 = {}^*30° 15'$, $001 \wedge 101 = {}^*55° 12'$, $001 \wedge 011 = 40° 0'$.

**Forms**[1]: *b* (010), *c* (001, *O*); *m* (110, *I*) tw. pl.; *w* (301, 3-ī); *e* (021, 2-ĭ), *u* (0·10·1, 10-ĭ); *s* (111, 1), *v* (221, 2), *d* (121, 2-2̆).

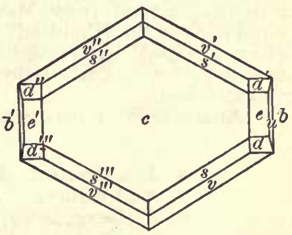
| | | | |
|---|---|---|---|
| *mm'''* = 60° 30′ | *cs* = 59° 1′ | *ss'* = 95° 34′ | *ss'''* = 51° 11′ |
| *ww'* = 153° 55′ | *cv* = 73° 17′ | *vv'* = 111° 39′ | *vv'''* = 57° 42′ |
| *ee'* = 118° 25′ | *cd* = 65° 40′ | *dd'* = 72° 45′ | *dd'''* = 87° 32′ |
| *uu'* = 166° 24′ | | | |

1.



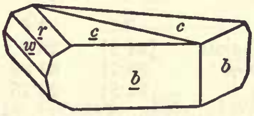
Sternbergite, Haid.

2.



Sternbergite, Haid.

3.



Frieseite, Vrba.

Twins: tw. pl. *m*. Crystals tabular ‖ *c*. Faces *c* striated ‖ edge *c*/*w*; pyramids striated ‖ intersection with *c*. Commonly in implanted crystals, forming rose-like or fan-like aggregations.

Cleavage: *c*, highly perfect. Thin laminæ flexible, like tin-foil. Leaves a trace on paper like graphite. H. = 1–1·5. G. = 4·215 Haid., 4·101 Breith. Luster metallic, of *c* most brilliant. Color pinchbeck-brown, occasionally a violet-blue tarnish on some faces. Streak black. Opaque.

For FRIESEITE, axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}5970 : 1 : 0{\cdot}7352$ approx. Vrba[2].

$100 \wedge 110 = 30° 50\frac{1}{6}'$, $001 \wedge 101 = 50° 55\frac{1}{3}'$, $001 \wedge 011 = 36° 19\frac{1}{3}'$. Observed forms: *b*, *c*, *w*; also *r* (102, ½-ī), *y* (101, 1-ī), *q* (032, $\frac{3}{2}$-ĭ) ?, *t* (131, 3-3̆).

Angles: *bb̲* = *61° 40⅓′, *rr'* = 63° 15′, *yy'* = 101° 51′, *ww'* = 149° 43′, *cw* = *74° 51⅓′, *qq'* = 95° 36′, *ct* = 68° 24′, *tt'* = 53° 54½′, *tt'''* = 108° 33′.

Twins: tw. pl. *m*. Crystals thick tabular ‖ *c*; faces *c* striated ‖ edge *c*/*r*, a feather-like striation on twins. Cleavage: *c*, perfect. Laminæ flexible. H. = 2·5. G. = 4·212–4·220. In very thin plates dark greenish gray, translucent.

**Comp., Var.**—Sulphides of silver and iron.

1. *Sternbergite.* $AgFe_2S_3$ or $Ag_2S.Fe_4S_6$ = Sulphur 30·4, silver 34·2, iron 35·4 = 100.

2. *Frieseite.* Physical characters as above; analyses 4, 5 below, corresponding to $Ag_2Fe_5S_8$ = Sulphur 34·1, silver 28·7, iron 37·2 = 100.

**Anal.**—1, Zippe, Pogg., **27**, 690, 1833. 2, Rg., Min. Ch., 66, 1875. 3, Janovsky, Zs. Kr., **3**, 187, 1878. 4, 5, Preis, ibid.

| | | S | Ag | Fe | |
|---|---|---|---|---|---|
| 1. Joachimsthal, | *Sternbergite* | 30·0 | 33·2 | 36·0 | = 99·2 |
| 2. " | " | 29·10 | 35·27 | 35·97 | = 100·34 |
| 3. " | " | 33·87 | 30·69 | 35·44 | = 100 |
| 4. " | *Frieseite* | 33·0 | 29·1 | 37·4 | = 99·5 |
| 5. " | " | 33·9 | 27·6 | 37·3 | = 98·8 |

**Pyr., etc.**—In the open tube sulphurous fumes. B.B. on charcoal gives off sulphur and fuses to a magnetic globule, the surface of which shows separated metallic silver. The washed mineral, treated with the fluxes, gives reactions for iron; on charcoal yields a globule of metallic silver. Soluble in aqua-regia with separation of sulphur and silver chloride.

**Obs.**—*Sternbergite* occurs with ores of silver, particularly pyrargyrite and stephanite, at Joachimsthal in Bohemia, and Johanngeorgenstadt in Saxony, also at Schneeberg (Breith.). Named after Count Caspar Sternberg of Prague.

The *Flexible silver ore* (*Argent sulfuré flexible* Bourn., *biegsamer Silberglanz* Germ.) from the Himmelsfürst mine, near Freiberg, is referred here.

*Frieseite* occurs with dolomite, proustite, and pseudomorphs of "Silberkies" (see below, Tsch.) on massive marcasite at Joachimsthal; the crystals of frieseite and "Silberkies" sometimes in parallel position.

**Ref.**—[1] Min., p. 180, 1852; see earlier Haid., l. c., or Pogg., **11**, 483, 1827. [2] L. c. and Zs. Kr., **5**, 426, 1881; for *q* the symbol (043) and angle given do not agree, viz., *cq* = 47° 28′ meas.

ARGENTOPYRITE. Silberkies *S. v. Waltershausen*, Nachr. Ges. Gött., **9**, 66, 1866.

Described as monoclinic; in six-sided twin crystals. No cleavage Fracture uneven. Brittle. H. = 3·5–4. G. = 6·47(?). Luster metallic. Color steel-gray to tin-white; tarnishing. Analysis (6) below. From Joachimsthal.

Tschermak[1] later described pseudomorphs in small hexagonal crystals consisting of argentite, marcasite, pyrrhotite and pyrargyrite, which he regarded as being the argentopyrite of v. Waltershausen. Schrauf[2], however, sustained the latter species making it orthorhombic, but pseudo-hexagonal by repeated twinning.

Axes $\breve{a} : \bar{b} : \acute{c}$ = 0·5812 : 1 : 0·2749, or near that of sternbergite if $\acute{c}$ be multiplied by 3. Forms: *b*, *c*, *m*, *n* (130), *y* (011), *x* (021), *p* (111), *π* (421). Angles: *mm‴* = *60° 20′, *cy* = 15° 22′, *bx* = *61° 12′, *cp* = 28° 45′ (= *c* ∧ 113 sternbergite). Silver = 22·3 p. c.

Streng[3] has also described a "SILBERKIES" from Andreasberg, occurring in prismatic crystals, pseudo-hexagonal by twinning, with the planes *m*, *n*, *x* (as above). No cleavage. Fracture uneven. Rather brittle. H. = 3·5–4. G. = 4·18. Luster metallic, brilliant. Color bronze-yellow, tarnishing on surface. Weak magnetic. Analysis (7) below. Weisbach[4] has described a similar mineral from Marienberg, like the above in form. Brittle. G. = 4·06–4·12. Also another from the Himmelsfürst mine, Freiberg, similar in form but with cleavage ∥ *c*; crystals often grouped in hemispherical forms. Not brittle. G. = 4·206. Color on fresh fracture bronze-yellow. Analysis by Winkler (8) below. To these varieties the name ARGYROPYRITE was attached.

**Anal.**—6, Waltershausen, l. c. 7, Streng, l. c. 8, Winkler, Jb. Min., 908, 1877.

| | S | Ag | Fe |
|---|---|---|---|
| 6. Joachimsthal, *Argentopyrite* | [34·2] | 26·5 | 39·3 = 100 |
| 7. Andreasberg, "*Silberkies*" | 30·71 | 32·89 | 35·89 Cu 0·19 = 99·68 |
| 8. Freiberg, *Argyropyrite* | 32·81 | 29·75 | 36·28 = 98·84 |

The relations of the above minerals are yet uncertain. It seems probable that there may be two independent species: 1, *Sternbergite* (including frieseite) usually in tabular crystals, cleavable, soft, flexible; and 2, *Argentopyrite* usually in prismatic, pseudo-hexagonal forms, without cleavage, harder, brittle. The fact that the two forms occur together seems to point to this. The "argyropyrite" from Freiberg seems to be intermediate between them. The variation in composition is probably more apparent than real. Streng suggested the formula $Ag_2S + pFe_nS_{n-1}$ for the group (i.e. acanthite + pyrrhotite), but no simple numerical relation exists and pyrrhotite is yet to be shown to be other than true hexagonal in form.

**Ref.**—[1] Ber. Ak. Wien, **54** (1), 342, 1866. [2] Ib., **64** (1), 192, 1871. [3] Jb. Min., 785, 1878. [4] Ib., 906, 1877.

## 57. ACANTHITE. Akanthit *Kenng.*, Ber. Ak. Wien, **15**, 238, 1855, Pogg., **95**, 462, 1855.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c}$ = 0·6886 : 1 : 0·9944 Dauber[1].

100 ∧ 110 = 34° 33′, 001 ∧ 101 = 55° 17$\frac{5}{6}$′, 001 ∧ 011 = 44° 50$\frac{1}{3}$′.

**Forms:**
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)
*c* (001, *O*)
*τ* (210, *i*-2̄
*m* (110, *I*)
*α* (120, *i*-2̆)
*o* (101, 1-ī)
*γ* (504, $\frac{5}{4}$-ī)
*u* (201, 2-ī)
*e* (301, 3-ī)
*d* (011, 1-ĭ)
*x* (113, $\frac{1}{3}$)
*p* (111, 1)
*z* (554, $\frac{5}{4}$)
*χ* (214, $\frac{1}{2}$-2̄)
*n* (211, 2-2̄)
*l* (534, $\frac{5}{4}$-$\frac{5}{3}$)
*h* (125, $\frac{2}{5}$-2̆)
*r* (123, $\frac{2}{3}$-2̆)
*μ* (122, 1-2̆)
*k* (121, 2-2̆)
*δ* (241, 4-2̆)
*s* (131, 3-3̆)
*λ* (143, $\frac{4}{3}$-4̆)
*ω* (141, 4-4̆)[2]
*β* (152, $\frac{5}{2}$-5̆)
*π* (161, 6-6̆)[2]
*θ* (163, 2-6̆)
*ε* (183, $\frac{8}{3}$-8̆)

Also doubtful *φ* (508, $\frac{5}{8}$-ī), *t*(203, $\frac{2}{3}$-ī), *i*(506, $\frac{5}{6}$-ī), *ψ* (801, 8-ī), *y* (518, $\frac{5}{8}$-5), *σ* (14·15·13, $\frac{15}{13}$-$\frac{15}{14}$), *g* (8·20·1, 20-$\frac{5}{2}$).

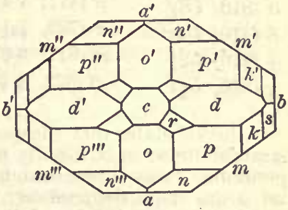
Krenner shows the close correspondence between the angles of acanthite, as given by Dauber, and those required by the isometric system, and argues from this that the crystals of acanthite are simply distorted forms of argentite. This conclusion seems plausible (cf. gold, silver, also hessite), but cannot be regarded as proved, cf. Zs. Kr., **14**, 388, 1888.

*ττ'''* = 38° 0'
*mm'''* = 69° 6'
*αα'* = 71° 58'
*oo'* = 110° 36'
*uu'* = 141° 48'
*ee'* = 154° 0'
*dd'* = 89° 41'
*cx* = 30° 18'
*cp* = 60° 18'
*cn* = 71° 52'
*cr* = 39° 20'
*ck* = 67° 52'
*pp'* = 91° 21½'
*nn'* = 127° 57'
*kk'* = 65° 57'
*ss'* = 49° 18½'
*pp'''* = 59° 2'
*nn'''* = 36° 3'
*kk'''* = 97° 6'
*ss'''* = 119° 1'

Twins: tw. plane *o*. Habit prismatic, crystals usually slender; sometimes monoclinic, in development of planes.

Cleavage indistinct. Fracture uneven. Sectile. H. = 2–2·5. G. = 7·2–7·3; 7·196, Freiberg, 7·246, Joachimsthal, Dbr. Luster metallic. Color iron-black. Opaque.

**Comp.**—Silver sulphide like argentite, $Ag_2S$ = Sulphur 12·9, silver 87·1 = 100.



Freiberg, Dbr.

**Pyr.**—As for argentite.

**Obs.**—At Joachimsthal, with pyrite, argentite, and calcite, usually on quartz; also at the Himmelsfürst and other mines, near Freiberg in Saxony, along with argentite and stephanite. A specimen found in 1860 shows brilliant crystals 22mm. long. At Schneeberg with native silver and argentite.

Named from ἄκανθα *thorn*, in allusion to the shape of the crystals.

**Ref.**—[1] Crystals from Himmelsfürst mine, Ber. Ak. Wien, **39**, 685, 1857. [2] Groth, Annaberg, crystals with marked monoclinic symmetry, Min. Samml., 51, 1878.

**Artif.**—A silver sulphide, $Ag_2S$, in acicular crystals resembling acanthite has been obtained by Weinschenk, Zs. Kr., **17**, 497, 1890.

DALEMINZITE *Breith.*, B. H. Ztg., **21**, 98, 1862, **22**, 44, 1863. Silver sulphide ($Ag_2S$) in an orthorhombic form regarded as distinct from acanthite; crystals short prisms with 010, 001, 110, 121, with *mm'''* = 64°. G. = 7·049. It may be a pseudomorph after stephanite, cf. Frenzel, Min. Lex. Sachs., 76, 1874. Found in 1858 at the Himmelfahrt mine at Freiberg with argentite.

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## 3. Sphalerite Group. RS. Isometric, tetrahedral.

| | | |
|---|---|---|
| 58. **Sphalerite** | ZnS | |
| 59. **Metacinnabarite** | HgS | |
| Guadalcazarite | (Hg,Zn)S | |
| 60. **Tiemannite** | HgSe | |
| 61. **Onofrite** | Hg(S,Se) | |
| 62. **Coloradoite** | HgTe | Massive. |
| 63. **Alabandite** | MnS | |

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| | |
|---|---|
| 64. **Oldhamite** | CaS |
| 65. **Pentlandite** | 2FeS.NiS |

58. **SPHALERITE** or BLENDE. Galena inanis, *Germ.* Blende, *Agric.*, Interpr., 465, 1546. Blände, Pseudo-galena, Zincum S, As, et Fe mineralisatum, *Wall.*, Min., 248, 1747. Zincum cum Fe, S mineralisatum *Bergm.*, Sciagr., 1782. Sulphuret of zinc. Zinc sulfuré *Fr.* Zinc Blende. Sphalerit *Glock.*, Syn., 17, 1847. Black-Jack, Mock-Lead, False Galena *Engl. Miners.* Blende or Zinkblende *Germ.* Blenda *Ital.*, *Span.* Chumbe *Span. S. A.*

Cleiophane *Nuttal.* Cramerite. Marmatite (fr. Marmato) *Boussingault*, Pogg., **17**, 399, 1829. Przibramite *Huot*, Min., 298, 1841. Marasmolite *Sheph.*, Am. J. Sc., **12**, 210, 1851. Christophit *Breith.*, B. H. Ztg., **22**, 27. Rahtite *Sheph.*, Am. J. Sc., **41**, 209, 1866.

Isometric; tetrahedral. Observed forms[1]:

$a$ (100, $i$-$i$)
$d$ (110, $i$)
$o$ (111, 1)
$o_{,}$ (1$\bar{1}$1, $-$1)
$\alpha$ (810, $i$-8)[6]
$h$ (410, $i$-4)
$e$ (210, $i$-2)
$g$ (320, $i$-$\frac{3}{2}$)

$q$ (331, 3)[7]
$c$ (661, 6)[6]
$b$ (12·1·1, 12-12)[4]
$\mu$ (411, 4-4)
$\tau$ (722, $\frac{7}{2}$-$\frac{7}{2}$)[3]
$m$ (311, 3-3)
$\beta$ (522, $\frac{5}{2}$-$\frac{5}{2}$)

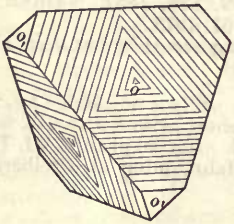
$n$ (211, 2-2)[2]
$p_{,}$ (2$\bar{2}$1, $-$ 2)
$q_{,}$ (3$\bar{3}$1, $-$ 3)
$\phi_{,}$ (5$\bar{5}$3, $-$ $\frac{5}{3}$)[6]
$\xi_{,}$ (5$\bar{5}$4, $-$ $\frac{5}{4}$)[6]
$\psi_{,}$ (8$\bar{8}$5, $-$ $\frac{8}{5}$)[6]
$\lambda_{,}$ (15·$\bar{15}$·2, $-\frac{15}{2}$)[4]
$\vartheta_{,}$ (5$\bar{1}$1, $-$ 5-5)

$\mu_{,}$ (4$\bar{1}$1, $-$ 4-4)
$\tau_{,}$ (7$\bar{2}$2, $-$ $\frac{7}{2}$-$\frac{7}{2}$)[4]
$m_{,}$ (3$\bar{1}$1, $-$ 3-3)
$\sigma_{,}$ (8$\bar{3}$3, $-$ $\frac{8}{3}$-$\frac{8}{3}$)[6]
$\beta_{,}$ (5$\bar{2}$2, $-$ $\frac{5}{2}$-$\frac{5}{2}$)
$\rho_{,}$ (9$\bar{4}$4, $-$ $\frac{9}{4}$-$\frac{9}{4}$)[6]
$n_{,}$ (2$\bar{1}$1, $-$ 2-2)
$\pi_{,}$ (7$\bar{4}$4, $-$ $\frac{7}{4}$-$\frac{7}{4}$)[6]

$\nu$ (951, 9-$\frac{9}{5}$)[6]
$s_{,}$ (3$\bar{2}$1, $-$ 3-$\frac{3}{2}$)[5]
$x_{,}$ (7$\bar{5}$3, $-$ $\frac{7}{3}$-$\frac{7}{5}$)[6]
$y_{,}$ (15·$\bar{11}$·7, $-\frac{15}{7}$-$\frac{15}{11}$)[6]
$z_{,}$ (4$\bar{3}$2, $-$ 2-$\frac{4}{3}$)[6]
$u_{,}$ (4$\bar{3}$1, $-$ 4-$\frac{4}{3}$)
$v_{,}$ (9$\bar{7}$5, $-$ $\frac{9}{5}$-$\frac{9}{7}$)[6]
$w_{,}$ (11·$\bar{10}$·1, $-$11-$\frac{11}{10}$)?[5]

Becke[1] states that the positive octants are poor in planes, the faces even, or striated with straight lines; $m$ is usually positive. In the negative octants the secondary planes are more common, faces often rounded or with vicinal elevations. The etching figures on $o$ (+ 1) and on $a$ are deep depressions; on $o_{,}$ ($-$ 1) and on $d$ they are acute elevations. In general the etching-figures developed belong to the positive octants. The size and luster of the faces does not serve to distinguish the positive and negative octants. Observations of Krenner do not entirely agree with the above[9].

1.



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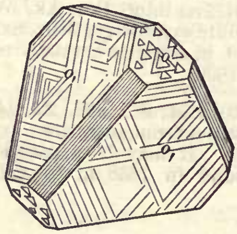

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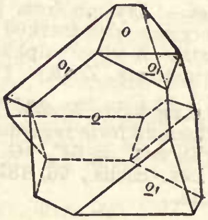

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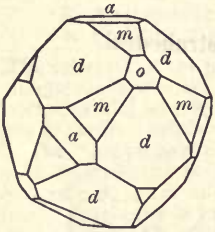

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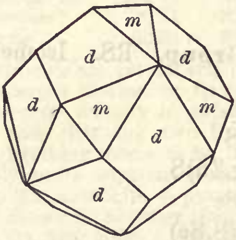

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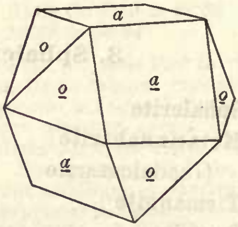


Fig. 1, Bottino, Becke. 2, St. Agnes, Id. 3, Schemnitz, Sbk. 5, Lockport. 6, Freiberg, Sbk.

Twins: tw. pl. $o$, the comp. face usually ∥ $o$, but also ⊥ $o$. Twinning often repeated, and sometimes producing narrow polysynthetic lamellæ. Crystals frequently highly complex and distorted, sometimes resembling rhombohedral forms; the faces $d$, $m$ often rounded together into a low conical form. Commonly massive cleavable, coarse to fine granular and compact; also foliated, sometimes fibrous and radiated or plumose; also botryoidal and other imitative shapes. Cryptocrystalline to amorphous, the latter sometimes as a powder.

Cleavage: dodecahedral, highly perfect. Fracture conchoidal. Brittle. H. = 3·5–4. G. = 3·9–4·1; 4·063 white, N. J. Luster resinous to adamantine. Color commonly yellow, brown, black; also red, green to white, and when pure nearly colorless. Streak brownish to light yellow and white. Transparent to translucent. Refractive indices, Ramsay[10]:

$$n_r = 2{\cdot}34165 \text{ Li} \qquad n_y = 2{\cdot}36923 \text{ Na} \qquad n_{gr} = 2{\cdot}40069 \text{ Tl}$$

Sometimes shows abnormal double refraction. Pyro-electric, polar in the direction of the trigonal axes, Friedel[11].

**Comp.**—Zinc sulphide, ZnS = Sulphur 33, zinc 67 = 100. Often containing iron and manganese, and sometimes cadmium, mercury and rarely lead and tin. Also sometimes contains traces of indium, gallium and thallium; may be argentiferous and auriferous.

**Var.**—1. *Ordinary.* Containing little or no iron; colors white to yellowish brown, sometimes black; G. = 4·0–4·1. The pure white blende of Franklin, N. J., is the *cleiophane* (anal. 1). A kind occurring at Nordmark, Sweden, in snow-white crystals, consists of pure ZnS with neither Fe nor Mn. The red or reddish brown transparent crystallized kinds are sometimes called *ruby blende* or *ruby zinc.*

The massive cleavable forms are the most common, varying from coarse to fine granular; also cryptocrystalline. *Schalenblende* (Germ., also *Leberblende*) is a closely compact variety, of a pale liver-brown color, occurring in concentric layers with reniform surface; galena and marcasite are often interstratified. The fibrous forms (*faserige Zinkblende* Germ.) are chiefly wurtzite (p 70). Rarely occurs as a soft white amorphous deposit, resembling the zinc sulphide precipitated by hydrogen sulphide in the laboratory, cf. below.

2. *Ferriferous; Marmatite.* Containing 10 p. c. or more of iron; dark-brown to black; G. = 3·9–4·05. The proportion of FeS to ZnS varies from 1 : 5 to 1 : 2, and the last ratio is that of the *christophite* of Breithaupt, a brilliant black sphalerite (anal. 11) from St. Christophe mine, at Breitenbrunn, near Johanngeorgenstadt, having G. = 3·91–3·923. A similar variety from St. Agnes, Cornwall, gave Collins 26 p. c. Fe, Min. Mag., **3**, 91, 1879.

3. *Cadmiferous; Přibramite, Przibramite.* The amount of cadmium present in any sphalerite thus far analyzed is less than 5 per cent.

4. *Mercurial.* A specimen from Aviles, Asturia, yielded Soltsien, 0·135 p. c. Hg, Jb. Min., **2**, 272 ref., 1887; other sphalerites (Sweden, Rhine) have given 0·02 p. c.

5. *Stanniferous.* Specimens of the black sphalerite from Freiberg, with 12–13·4 p. c. Fe and G. = 3·95–3·99, yielded 0 06–0·55 p. c, Sn, present as sulphide, also some cassiterite as impurity. Cf. Stelzner and Schertel, Zs. Kr., **14**, 398, 1888.

**Anal.**—1, Henry, Phil. Mag., **1**, 23, 1851. 2, 3, 7, 9, P. N. Caldwell, priv. contr. 4–6, 8, L. Sipöcz, Zs. Kr., **11**, 216, 1885. 10, Bechi, Am. J. Sc., **14**, 61, 1852. 11, Heinichen, B. H. Ztg., **22**, 27, 1863.

| | G | S | Zn | Cd | Fe | Mn | |
|---|---|---|---|---|---|---|---|
| 1. Franklin Furnace, *wh.* | 4·063 | 32·22 | 67·46 | *tr.* | — | — | = 99·68 |
| 2. Picos de Europa, *yw.* | 4·098 | 33·60 | 66·59 | — | 0·16 | — | = 100·35 |
| 3. Joplin, Mo., *yw.* | 4·098 | 32·93 | 66·69 | — | 0·42 | — | = 100·04 |
| 4. Schemnitz, *yw.* | 4·109 | 32·79 | 65·24 | 1·52 | 0·47 | — | = 100·02 |
| 5. Kapnik, *yw.-brn.* | 4·098 | 32·98 | 64·92 | 1·05 | 0·57 | 0·37 | Pb 0·05, Cu 0·06, Sb 0·04, As *tr.* = 100·04 |
| 6. Nagyág, *brn.* | 4·064 | 33·47 | 63·76 | 0·14 | 1·37 | 1·56 | Pb 0·06, Cu *tr.*, Sb 0·08, As *tr.* = 100·44 |
| 7. Roxbury Ct., *brn.* | 4·073 | 33·36 | 63·36 | — | 3·60 | — | = 100·32 |
| 8. Rodna, *blk.* | 4·002 | 33·49 | 52·10 | 1·51 | 12·19 | 0·37 | = 99·66 |
| 9. Felsobanya, *blk.* | 4·030 | 33·25 | 50·02 | 0·30 | 15·44 | — | Pb 1·01 = 100·02 |
| 10. Bottino. *Marmatite* | | 33·65 | 48·11 | *tr.* | 16·23 | — | Cu *tr.* = 97·99 |
| 11. Breitenbrunn, *Cristophite* | 3·92 | 33·57 | 44·67 | 0·28 | 18·25 | 2·66 | Sn *tr.* = 99·43 |

On the sulphides of lead and zinc which are probably to be regarded as mixtures of galena and sphalerite, see huascolite, kilmacooite, p. 51. The *brass-ore*, Messingerz *Germ.*, of early mineralogists is a mixture of sphalerite and chalcopyrite. Shepard's *marasmolite* is a partially decomposed sphalerite containing some free sulphur.

**Pyr., etc.**—In the open tube sulphurous fumes, and generally changes color. B.B. on charcoal, in R.F., some varieties give at first a reddish brown coating of cadmium oxide, and later a coating of zinc oxide, which is yellow while hot and white after cooling. With cobalt solution the zinc coating gives a green color when heated in O.F. Most varieties, after roasting, give with borax a reaction for iron. With soda on charcoal in R.F. a strong green zinc flame. Difficultly fusible.

Dissolves in hydrochloric acid with evolution of hydrogen sulphide. Some specimens phosphoresce when struck with a steel or by friction.

**Obs.**—Occurs very commonly in both crystalline and sedimentary rocks, and as a frequent associate of galena; also associated with chalcopyrite, barite, fluorite, siderite; common in silver mines. It often forms beds of considerable magnitude filling cavities in limestone. Crystals of sphalerite have been observed associated in parallel position with tetrahedrite, also with chalcopyrite (cf. Becke, Min. Mitth., **5**, 331, 1883).

Some of the chief localities for crystallized sphalerite are: Alston Moor in Cumberland, black variety; Derbyshire, St. Agnes and elsewhere in Cornwall; Oberlahnstein in Nassau, Ems, red; Andreasberg, yellow and brown; Neudorf in the Harz, Freiberg, Breitenbrunn and other localities in Saxony, black and brown; Přibram, green or yellow, and Schlackenwald in Bohemia, black; Kapnik in Hungary, green or yellow; Nagyág in Transylvania, brown; Rodna, black; the Binnenthal in Switzerland, isolated crystals of great beauty, yellow to brown in color, in cavities of dolomite; Sala in Sweden; Nordmark, black, brown and also snow-white. A beautiful transparent variety yielding large cleavage masses is brought from Picos de Europa, Province of Santander, Spain, where it occurs in a brown limestone. Fibrous varieties (see wurtzite) are obtained at Přibram, Geroldseck in Baden, Raibel; also in Cornwall. The original *Marmatite* is from Marmato near Popayan, Italy. Large beds occur at Åmmeberg on Lake Wetter in Sweden. The new element gallium was first identified in the sphalerite of the Pierrefitte mine, Vallée d'Argelès, Pyrenees, L. de Boisbandran, C. R., **81**, 493, 1875.

Abounds with the lead ore of Missouri, Wisconsin, Iowa, and Illinois. In *N. York*, Sullivan Co., near Wurtzboro', it constitutes a large part of a lead vein in millstone grit, and is occasionally in octahedrons; in St. Lawrence Co., occurs at Cooper's falls; at Mineral Point with galena, and in Fowler, on the farm of Mr. Belmont, in a vein with iron and copper pyrites traversing serpentine; at the Ancram lead mine in Columbia Co., of yellow and brown colors; in limestone at Lockport and other places, in honey and wax-yellow crystals often transparent; with galena on Flat Creek, two miles south-west of Spraker's Basin. In *Mass.*, at Sterling, of a cherry-red color, with galena; also yellowish brown at the Southampton lead mines; at Hatfield, with galena. In *N. Hamp.*, at the Eaton lead mine; at Warren, a large vein of black blende. In *Maine*, at the Lubec lead mines; also at Bingham, Dexter, and Parsonsfield. In *Conn.*, yellowish-green at Brookfield; at Berlin, of a yellow color; brownish black, sometimes finely crystallized at Roxbury, and yellowish brown at Lane's mine, Monroe. In *N. Jersey*, a *white* variety (*cleiophane* of Nuttall) at Franklin Furnace. In *Penn.*, at the Wheatley and Perkiomen lead mines, in handsome crystallizations; near Friedensville, Lehigh Co., a *white* waxy var. In *Virginia*, at Walton's gold mine, Louisa Co., and more abundantly at Austin's lead mines, Wythe Co., where it occurs crystallized, or in radiated crystallizations. In *Michigan*, at Prince vein, Lake Superior, abundant. In *Illinois*, near Rosiclare, with galena and calcite; at Marsden's diggings, near Galena, in stalactites, some 6 in. or more through, and covered with cryst. marcasite, and galena. In *Wisconsin*, at Mineral Point, in fine crystals, and many of large size (3 in. through, or so), altered to smithsonite. In *Tennessee*, at Haysboro', near Nashville. In *Missouri*, in beautiful crystallizations with galena, marcasite and calcite at Joplin and other points in the southwestern part of the state; the deposits here occur in limestone and are of great extent and value. The original sphalerite in places has been removed and redeposited as calamine or smithsonite, or again as sphalerite, usually in crystals. A variety, formed by reprecipitation, occurs as a soft white powdery mass in Galena, Cherokee Co., southeastern Kansas, adjoining the zinc region of Missouri; the deposit as first exposed extended for 30 feet with a thickness of at least 4 feet. (Am. J. Sc., **40**, 160, 1890.)

Named *blende* because, while often resembling galena, it yielded no lead, the word in German meaning *blind* or *deceiving*. *Sphalerite* is from *σφαλερός*, *treacherous*.

**Alt.**—Sphalerite by oxidation changes to the zinc sulphate, goslarite. Calamine, smithsonite, and limonite occur as pseudomorphs.

**Artif.**—Made in crystals from a solution of sulphate containing some putrifying animal matter; in an experiment by Gages, using oysters for the animal matter, the shells were turned partly into carbonate of zinc and selenite, and some sphalerite incrusted them. Also may be made by subjecting heated oxide or silicate of zinc to vapors of sulphur. Cf. further Fouqué-Lévy, Synth. Min., 297, 1882.

*Rahtite* Shepard is an impure uncrystalline sphalerite, with G. = 4·128, containing iron and copper, see 5th Ed., p. 50.

**Ref.**—[1] See Sbk., Zs. G. Ges., **21**, 620, 1869; **24**, 180, 1872; **30**, 573, 1878; also earlier Hbg., Min. Not., **1**, 28, 1856, Kapnik with *h* and *μ*; **6**, 7, 1864, Cumberland and Schemnitz; Rath, Binnenthal, with *u*, Pogg., **122**, 396, 1864. Later Becke, Min. Mitth., **5**, 457, 1883. The distinction between the planes of the + and − octants was made out by Sbk., and revised and extended by Becke on the basis of etching experiments; the results of the latter (see above) are followed here. Some planes are in doubt as between the + and − position.

[2] Klein, Kapnik, Jb. Min., 492, 1871. [3] Id. Binnenthal, ibid., 897, 1872; Klein called it 722, but Becke's etching makes the prominent tetrahedron for this locality ($1\bar{1}1$) and reverses the position taken by other authors. [4] Sbk., l. c. [5] Groth, Min. Samml., 23, 1878. [6] Becke, l. c. [7] Hintze, Striegau, Zs. Kr., **13**, 161, 1887. [8] Flink, Nordmark, Bihang, Ak. H. Stockh., **13**, (2), No. 7, 15, 1885. [9] Földt. Közl., **18**, 151, 1888.

[10] Santander, Picos de Europa, Zs. Kr., **12**, 218, 1886. On effect of change of temperature, etc., on indices of refraction, see Calderon, Zs. Kr., **4**, 504; and Voigt, ib. **5**, 113, 1880. [11] Friedel, Bull. Soc. Min., **2**, 32, 1879; Id. and Curie, **6**, 191, 1883.

On the effect of heat on molecular structure, Mld., Bull. Soc. Min., **5**, 235, 1882, cf. also Hautefeuille, C. R., **93**, 774, 1881. Experiments in hardness, Exner, Unt. Härte Kr., p. 38, 1873.

**59. METACINNABARITE.** *G. E. Moore* J. pr. Ch., **2**, 319, 1870; Am. J. Sc., **3**, **36**, 1872. Metazinnober *Germ.*

Isometric; tetrahedral. Observed forms[1]:

$o$ (111, + 1) $o_{,}$ ($1\bar{1}1$, − 1) $n$ (211, 2-2) $\beta$ (322, $\frac{3}{2}$-$\frac{3}{2}$) $v$ (975, $\frac{9}{5}$-$\frac{9}{7}$)

Twins: tw. plane *o*, common. Habit tetrahedral, faces rough and unpolished. Also massive; amorphous.

Fracture subconchoidal to uneven. Brittle. H. = 3. G. = 7·81, Pfd., cryst.; 7·701–7·748, Moore, amorphous. Luster metallic. Color grayish black. Streak black. Opaque.

**Comp.**—Mercuric sulphide, like cinnabar, $HgS$ = Sulphur 13·8, mercury 86·2 = 100.

**Anal.**—Moore, l. c.

| | S | Hg | Fe | Quartz | |
|---|---|---|---|---|---|
| 1. | 13·79 | 85·69 | 0·33 | 0·26 | = 100·07 |
| 2. | 13·84 | 85.89 | 0·45 | 0·24 | = 100·42 |

**Pyr.**—See cinnabar.

**Obs.**—From the Reddington mine, Lake county, California, with cinnabar in acicular crystals, quartz and marcasite. Also at the Baker mine near Knoxville; some tons have been found at New Idria, Fresno Co. (Becker). At Huitzuco, Mexico, in pseudomorphs of cinnabar after stibnite (Sandb.). At the mercury mines in the Palatinate. Also reported from Hermsdorf near Waldenburg, Silesia (Traube). Probably at Pakaraka, Bay of Islands, New Zealand, where Hutton in 1870 noted the occurrence of native mercury and a "black ore of mercury . . . . . a sulphide containing some iron." H. = 5, G. = 9·224(?) Trans. N. Z. Inst., **3**, 252, 1870.

Metacinnabarite is the equivalent of the black mercuric sulphide of the laboratory, also called *Æthiops mineral* (Quecksilber-Mohr *Germ.*).

**Ref.**—[1] Pfd., Am. J. Sc., **29**, 452, 1885. Melville has described crystals from New Almaden, Cal., which he regards as rhombohedral and hemimorphic, with $0001 \wedge 10\bar{1}1 = 15° 19'$, Am. J. Sc., **40**, 291 1890, and p. 1041.

GUADALCAZARITE. Schwefelselenquecksilber *Castillo* and *Burkhart*, Jb. Min., 414, 1866. Guadalcazite *Adam*, Tabl. Min., p. 59, 1869. Guadalcazarite *Petersen*, Min. Mitth., 69, 1872; *Burkhart*, ibid., 243.

Near metacinnabarite, but contains a little zinc. Occurs massive, with cinnabar, barite, quartz at Guadalcazar, Mexico. H. = 2. G. = 7·15. Castillo mentions rhombohedral forms.

**Anal.**—1, Petersen, l. c. 2, Rg., Min. Ch. p. 79, 1875.

| | | S | Se | Hg | Zn | Cd | Fe | |
|---|---|---|---|---|---|---|---|---|
| 1. | G. = 7·15 | 14·58 | 1·08 | 79·73 | 4·23 | *tr.* | *tr.* | = 99·62 |
| 2. | | 14·01 | *tr.* | 83·90 | 2·09 | — | — | = 100 |

The ratio of Hg : Zn = 6 : 1 in anal. (1), and 12 : 1 in (2).

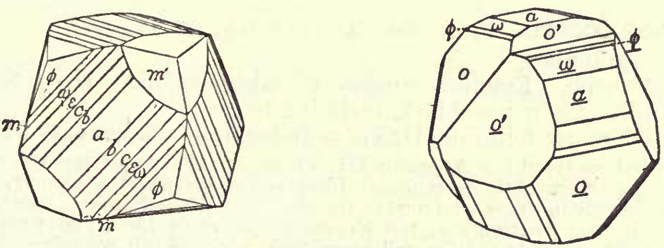
LEVIGLIANITE *D'Achiardi*, Att. Soc. Tosc., **2**, 112, 1876. Stated to be a ferriferous variety of guadalcazarite (metacinnabarite); but not fully examined. From the mercury mines of Levigliani, near Seravezza in the Apuan Alps, Italy.

**60. TIEMANNITE.** Selenquecksilber *Marx*, Schw. J. **54**, 223, 1828. Selenmercur, Tiemannit, *Naumann*, Min., 425, 1855.

Isometric; tetrahedral. Observed forms[1]:

*a* (100, *i-i*); *o* (111, 1), $o_{,}$ ($1\bar{1}1$, – 1); *ω* (511, 5·5), *m* (311, 3·3), *φ* (733, $\frac{7}{8}$-$\frac{7}{8}$); $m_{,}$ ($3\bar{1}1$, – 3-3). Also doubtful *b* (13·1·1), *c* (17·2·2), *ε* (13·2·2).

1. 2.



Utah, Penfield.

Twins: tw. pl. *o*. Crystals tetrahedral in habit, *o* usually dull, $o_{,}$ bright; zone *a b c ε ω φ* striated ‖ intersection-edges; also $m_{,}$ striated ‖ edge $m_{,}/a$. Commonly massive; compact granular.

Cleavage none. Fracture uneven to conchoidal. Brittle. H. = 2·5. G. = 8·19 Utah, cryst.; 8·30–8·47 Clausthal[2]. Luster metallic. Color steel-gray to blackish lead-gray. Streak nearly black. Opaque.

**Comp.**—Mercuric selenide, HgSe = Selenium 28·3, mercury 71·7 = 100.

**Anal.**—1, Penfield, l. c. 2, Petersen, JB. Ch., 919, 1866.

| | | Se | S | Hg | Cd | |
|---|---|---|---|---|---|---|
| 1. | Utah | 29·19 | 0·37 | 69·84 | 0·34 | insol. 0·06 = 99·80 |
| 2. | Clausthal | 24·88 | 0·20 | 75·15 | — | Pb 0·12 = 100·35 |

Earlier analyses (5th Ed., p. 56) were made on more or less impure material.

**Pyr.**—Decrepitates in the closed tube, and, when pure, entirely sublimes, giving a black sublimate, with the upper edge reddish brown; with soda a sublimate of metallic mercury. In the open tube emits the odor of selenium, and forms a black to reddish brown sublimate, with a border of white selenate of mercury, the latter sometimes fusing into drops. On charcoal volatilizes, coloring the outer flame azure-blue, and giving a lustrous metallic coating.

**Obs.**—Occurs with chalcopyrite near Zorge in the Harz; at Tilkerode; near Clausthal. In California, in the vicinity of Clear lake. Near Marysvale, Piute Co., in southern Utah, with barite, manganese oxide and calcite in a vein in limestone, the ore in part 4 feet in thickness. Cf. Becker, U. S. G. Surv., Mon. **13**, 1888. Named after the discoverer, Tiemann.

**Ref.**—[1] Pfd., Am. J. Sc., **29**, 449, 1885. [2] Ibid., p. 453; earlier determinations with G. = 7·1–7·37 were probably made on impure material.

**61. ONOFRITE.** Selenschwefelquecksilber *H. Rose*, Pogg., **46**, 315, 1839. Merkur-Glanz *Breith.*, Char., 316, 1832. Onofrite *Haid.*, Handb., 565, 1845.

Massive; fine granular.

Cleavage none. Fracture conchoidal. Brittle. H. = 2·5. G. = 7·98–8·09, Pfd.[1] Luster metallic. Color and streak blackish gray. Opaque.

**Comp.**—Sulpho-selenide of mercury, Hg(S,Se), with S : Se = 6 : 1, Brush, or 4 : 1, Rose. The first requires: Sulphur 11·5, selenium 4·7, mercury 83·8 = 100; the second: Sulphur 10·6, selenium 6·6, mercury 82·8 = 100.

**Anal.**—1, H. Rose, l. c. 2, Comstock, Am. J. Sc., **21**, 314, 1881.

| | | S | Se | Hg | Zn | Mn | |
|---|---|---|---|---|---|---|---|
| 1. | Mexico | 10·30 | 6·49 | 81·33 | — | — | = 98·12 |
| 2. | Utah | $\frac{2}{2}$ 11·68 | 4·58 | 81·93 | 0·54 | 0·69 | = 99·42 |

**Pyr.**—In the closed tube decrepitates and then gives reactions for sulphur and mercury, coating the tube grayish black and leaving a slight non-volatile residue. In the open tube gives sulphurous fumes and sublimates of mercury and sulpho-selenide of mercury. On charcoal gives copious fumes with selenium odor and a sublimate with metallic luster which touched by R.F. disappears, tingeing the flame azure-blue. Gives faint zinc and manganese reactions.

**Obs.**—Occurs with calcite and barite at San Onofre, Mexico. With the pure mercuric selenide, tiemannite, forming a seam 4 inches wide in limestone near Marysvale, southern Utah.

**Ref.**—[1] Am. J. Sc., **29**, 453, 1885.

Del Rio early called attention to a sulpho-selenide of mercury. He mentions two ores occurring in limestone at Culebras, Mexico (Phil. Mag., 4, 113, 1828), one red, the other gray. These were called *culebrite* and *riolite* (also *rionite* other authors) by Brooke, ib., 8, 261, 1836. No confidence can be placed in Del Rio's chemical determinations. Cf. native selenium, p. 10.

**62. COLORADOITE.** *F. A. Genth*, Am. Phil. Soc., **17**, 115, 1877.

Massive; granular.

Cleavage none. Fracture uneven to subconchoidal. H. = 3. G. = 8·627. Luster metallic. Color iron-black, inclining to gray.

**Comp.**—Mercuric telluride, HgTe = Tellurium 38·5, mercury 61·5 = 100.

The material analyzed (see Appendix III, 5th Ed., p. 29 for analyses) was very impure.

**Pyr.**—In the tube slightly decrepitates, fuses and yields metallic mercury as a sublimate, also tellurium dioxide in drops, and next to the assay metallic tellurium. Soluble in nitric acid.

**Obs.**—Occurs very sparingly at the Keystone, Mountain Lion, and Smuggler mines, in Colorado, with quartz, gold, native tellurium and sylvanite; it sometimes has a columnar structure due to alteration from sylvanite.

**63. ALABANDITE.** Schwarze Blende (fr. Transylvania) *Müller v. Reichenstein*, Phys. Arb. Fr. in Wien, **1**, 2nd Quart., 86, 1784; *Bindheim*, Schrift. Ges. Nat. Fr. Berl., **5**, 452, 1784 (making it comp. of Mn, S, Fe, Ag). Schwarzerz *Klapr.*, Beitr., **3**, 35, 1802. Braunsteinkies *Leonh.*, Tab., 70, 1806 Braunsteinblende [= Manganblende] *Blumenbach*, Handb., **1**, 707, 1807. Manganglanz *Karst.*, Tab., 72, 1808. Manganèse sulfuré *H.*, Tab., **3**, 1809. Schwefel-

Mangan *Germ.* Alabandine *Beud.*, Tr. **2**, 399, 1832. Blumenbachit *Breith.*, B. H. Ztg., **22**, 193, 1866.

Isometric; tetrahedral[1]. In cubes or dodecahedrons with tetrahedral planes; also *n* (211, 2-2). Twins[2]: tw. pl. *o;* sometimes repeated, consisting of five octahedrons. Usually granular massive.

Cleavage: cubic, perfect. Fracture uneven. Brittle. H.=3·5–4. G.=3·95–4·04; 4·036, Mexico. Luster submetallic. Color iron-black, tarnished brown on exposure. Streak green.

**Comp.**—Manganese sulphide, $MnS$ = Sulphur 36·9, manganese 63·1 = 100.

**Pyr.**—Unchanged in the closed tube. In the open tube sulphurous fumes. Roasted on charcoal, the assay is converted into the oxide, which, with the fluxes, gives the reactions of manganese. Soluble in dilute hydrochloric acid, with evolution of hydrogen sulphide.

**Obs.**—Occurs in veins in the gold mines of Nagyág, in Transylvania; also Kapnik and Offenbanya in Hungary, associated with tellurium, rhodochrosite, and quartz; at Gersdorf, near Freiberg, a variety containing a trace of arsenic; in Mexico, at the mine Preciosa in Puebla, with tetrahedrite. From the Morococha mines, Peru. Crystallized and massive on Snake River, Summit county, Colorado, with rhodochrosite, galena, argentite, pyrite.

Named from Alabanda in Caria, Asia Minor.

**Artif.**—Cf. Doelter, Zs. Kr., **11**, 32, 1885, and C. R., **105**, 1372, 1887; also Weinschenk, Zs. Kr., **17**, 500, 1890.

**Ref.**—[1] Peters, Jb. Min., 365, 1861. [2] Schrauf, Nagyág, Pogg., **127**, 348, 1866.

### 64. OLDHAMITE. *Maskelyne*, 1862; Phil. Trans., London, 195, 1870.

Isometric. In small, nearly round spherules, generally coated by calcium sulphate as result of alteration.

Cleavage: cubic. H. = 4. G. = 2·58. Color pale chestnut-brown, transparent when pure. Isotropic.

**Comp.**—Calcium sulphide, $CaS$ = Sulphur 44·5, Calcium 55·5 = 100.

**Anal.**—After deducting foreign matter (enstatite, etc.):

| | Oldhamite. | | Incrustation. | | | | |
|---|---|---|---|---|---|---|---|
| | $CaS$ | $MgS$ | $CaSO_4$ | $CaCO_3$ | troilite | | |
| 1. | 89·37 | 3·25 | 3·95 | 3·43 | — | = | 100 |
| 2. | 90·25 | 3·26 | 4·19 | — | 2·30 | = | 100 |

Maskelyne suggests that the $MgS$ may be considered either as a mechanically mixed ingredient, or as a constituent of the mineral.

**Pyr.**—Readily dissolved in acid with the evolution of hydrogen sulphide and deposition of sulphur.

**Obs.**—Found embedded in enstatite or augite in the Busti meteorite, and apparently also in that of Bishopville, South Carolina. Named after Dr. Oldham, Director (1862) of the Indian Geological Survey.

OSBORNITE *Maskelyne*, Phil. Trans., 198, 1870. Small golden yellow regular octahedrons occurring in oldhamite and in augite in the meteorite from Busti, India. It is supposed to be a sulphide, or an oxysulphide, of calcium and probably titanium. Named after Mr. George Osborne

### 65. PENTLANDITE. Eisen-Nickelkies *Scheerer*, Pogg., **58**, 315, 1843. Pentlandite *Dufr*, Min., **2**, 549, 1856. Nicopyrite *Shep.*, Min., 307, 1857. Lillhammerit *Weisbach*, Synops. Min., 57, 1875.

Isometric. Massive, in granular aggregates.

Cleavage octahedral. Fracture uneven. Brittle. H. = 3·5–4. G. = 4·60. Luster metallic. Color light bronze-yellow. Streak light bronze-brown. Opaque. Not magnetic.

**Comp.**—A sulphide of iron and nickel, $(Fe,Ni)S$. In part, $2FeS.NiS$ = Sulphur 36·0, iron 42·0, nickel 22·0 = 100.

**Anal.**—1, 2, Scheerer, l. c. 3, J. K. Mackenzie, priv. contr.

| | S | Fe | Ni | Cu | |
|---|---|---|---|---|---|
| 1. Lillehammer | 36·45 | 42·70 | 18·35 | 1·16 = | 98·66 |
| 2. " | 36·64 | 40·21 | 21·07 | 1·78 = | 99·70 |
| 3. Sudbury | 34·25 | 25·81 | 39·85* | 0·24 = | 100·15 |

* With Co tr

An analysis of the Sudbury nickel ore by Clarke and Catlett gave: S 40·80, Fe 15·57, Ni 41·96, Cu 0·62, $SiO_2$ 1·02 = 99·97, G. = 4·541; this corresponds to $Ni_3FeS_5$, or the general formula of polydymite (p. 75), Am. J. Sc., **37**, 372, 1889. Cf. also pyrrhotite.

**Pyr.**—In the open tube sulphurous fumes. The powdered mineral roasted on charcoal gives with the fluxes reactions for nickel and iron.

**Obs.**—Occurs with chalcopyrite in a hornblende rock near Lillehammer in southern Norway. The mineral from Sudbury, Ontario, (anal. 3) is mined extensively for nickel; it carries a little platinum (0·006 to 0·024 p. c.) probably as sperrylite, Clarke and Catlett. Pentlandite was named after Mr. Pentland.

The Sudbury mineral, examined by Penfield (priv. contr.), shows distinct octahedral cleavage (or parting) which identifies it with the original pentlandite.

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### 4. Cinnabar-Wurtzite-Millerite Group. Rhombohedral or Hexagonal.

| | | | | | |
|---|---|---|---|---|---|
| | | | | $\dot{c}$ | |
| 66. | **Cinnabar** | HgS | Trapezohedral | 1·1453 | |
| 67. | **Covellite** | CuS | | 1·1466 | |
| | | | | $\dot{c}$ | $\dot{c}$ |
| 68. | **Greenockite** | CdS | Hemimorphic | 0·8109 | or 0·9364 |
| 69. | **Wurtzite** | ZnS | " | 0·8175 | 0·9440 |
| 70. | **Millerite** | NiS | | | 0·9883 |
| 71. | **Niccolite** | NiAs | | 0·8194 | 0·9462 |
| 72. | **Breithauptite** | NiSb | | 0·8586 | 0·9915 |
| | Arite | Ni(Sb,As) | | | |
| 73. | **Troilite** | FeS | | | |
| 74. | **Pyrrhotite** | $Fe_{11}S_{12}$, etc. | | 0·8701 | 1·0047 |

If, as suggested by Groth, the prominent pyramids of wurtzite, greenockite, etc., be made pyramids of the second series (e.g., $x = 11\bar{2}2$, instead of $10\bar{1}1$), then the values of $\dot{c}$ in the second column are obtained, which correspond to millerite. The form of several of these species, however, is only imperfectly known. A rhombohedral form for greenockite has been suggested but not proved.

**66. CINNABAR.** Κιννάβαρις (fr. Spain) *Theophr.* Ἄμμιον *Dioscor.* Minium *Vitruv.*, *Plin.* Minium nativum, *Germ.* Bergzinober, *Agric.*, Interpr., 466, 1546. Cinnabarite. Zinnober, Schwefelquecksilber, Merkur-Blende *Germ.* Cinnober *Swed.* Cinabre *Fr.* Cinabro *Ital.* Cinabrio *Span.*

Rhombohedral; trapezohedral like quartz. Axis $\dot{c} = 1\cdot14526$; $0001 \wedge 10\bar{1}1 = {}^{*}52° 54' 15''$ Schabus[1].

**Forms**[2]:
$c\ (0001, O)$
$m\ (10\bar{1}0, I)$
$a\ (11\bar{2}0, i\text{-}2)^{3}$

$\mathfrak{a}\ (1\cdot0\cdot\bar{1}\cdot15, \frac{1}{15})^{7}$
$\mathfrak{b}\ (1\cdot0\cdot\bar{1}\cdot12, \frac{1}{12})^{7}$
$\mathfrak{d}\ (10\bar{1}7, \frac{1}{7})^{7}$
$\mathfrak{e}\ (10\bar{1}5, \frac{1}{5})^{7}$
$K\ (10\bar{1}4, \frac{1}{4})$
$\mathfrak{f}\ (5\cdot0\cdot\bar{5}, 14, \frac{5}{14})^{7}$
$\mathfrak{y}\ (3\cdot0\cdot\bar{3}\cdot10, \frac{3}{10})^{7}$
$d\ (10\bar{1}3, \frac{1}{3})$
$f\ (20\bar{2}5, \frac{2}{5})$
$\alpha\ (40\bar{4}9, \frac{4}{9})^{4}$
$g\ (10\bar{1}2, \frac{1}{2})$
$\mathfrak{i}\ (10\cdot0\cdot\bar{10}\cdot19, \frac{10}{19})^{7}$
$\mathfrak{w}\ (50\bar{5}9, \frac{5}{9})^{7}$

$\beta\ (30\bar{3}5, \frac{3}{5})^{4}$
$h\ (20\bar{2}3, \frac{2}{3})$
$\gamma\ (70\bar{7}9, \frac{7}{9})^{4}$
$i\ (40\bar{4}5, \frac{4}{5})^{4}$
$r\ (10\bar{1}1, R)$
$\epsilon\ (10\cdot0\cdot\bar{10}\cdot9, \frac{10}{9})^{4}$
$\eta\ (60\bar{6}5, \frac{6}{5})^{4}$
$l\ (40\bar{4}3, \frac{4}{3})^{4}$
$\nu\ (13\cdot0\cdot\bar{13}\cdot9, \frac{13}{9})^{4}$
$\chi\ (50\bar{5}3, \frac{5}{3})^{7}$
$m_{x}(16\cdot0\cdot\bar{16}\cdot9, \frac{16}{9}$
$\mathfrak{m}\ (90\bar{9}5, \frac{9}{5})^{7}$
$n\ (20\bar{2}1, 2)$
$\omega\ (30\bar{3}1, 3)^{4}$
$\vartheta\ (10\cdot0\cdot\bar{10}\cdot3, \frac{10}{3})^{4}$
$\mathfrak{n}\ (70\bar{7}2, \frac{7}{2})^{7}$
$q\ (40\bar{4}1, 4)$

$\lambda\ (50\bar{5}1, 5)^{4}$
$\pi\ (60\bar{6}1, 6)^{4}$
$\rho\ (70\bar{7}1, 7)^{4}$
$\sigma\ (10\cdot0\cdot\bar{10}\cdot1, 10)^{4}$
$\mathfrak{b}\ (16\cdot0\cdot\bar{16}\cdot1, 16)^{7}$

$\psi\ (01\bar{1}9, -\frac{1}{9})^{4}$
$b\ (01\bar{1}8, -\frac{1}{8})$
$K_{,}\ (01\bar{1}4, -\frac{1}{4})$
$e\ (03\bar{3}8, -\frac{3}{8})$
$f_{,}\ (02\bar{2}5, -\frac{2}{5})$
$g_{,}\ (01\bar{1}2, -\frac{1}{2})$
$h_{,}\ (02\bar{2}3, -\frac{2}{3})$
$i_{,}\ (04\bar{4}5, -\frac{4}{5})$
$\Delta\ (01\bar{1}1, -1)$
$k\ (05\bar{5}4, -\frac{5}{4})$
$l_{,}\ (04\bar{4}3, -\frac{4}{3})$
$m_{x,}\ (0\cdot16\cdot\bar{16}\cdot9, -\frac{16}{9})$

$n_{,}\ (02\bar{2}1, -2)$
$\phi\ (05\bar{5}2, -\frac{5}{2})^{4}$
$o\ (03\bar{3}1, -3)^{4}$
$p\ (0\cdot32\cdot\bar{32}\cdot9, -\frac{32}{9})$
$q_{,}\ (04\bar{4}1, -4)$
$\lambda_{,}\ (05\bar{5}1, -5)^{4}$
$\Pi_{,}\ (09\bar{9}2, -\frac{9}{2})$
$s\ (0\cdot16\cdot\bar{16}\cdot3, -\frac{16}{3})$
$t\ (08\bar{8}1, -8)$
$\tau\ (0\cdot11\cdot\bar{11}\cdot1, -11)^{4}$

$B\ (1\cdot1\cdot\bar{2}\cdot20, \frac{1}{10}\text{-}2)^{7}$
$C\ (11\bar{2}6, \frac{1}{3}\text{-}2)^{7}$
$N\ (11\bar{2}4, \frac{1}{2}\text{-}2\ r)^{6}$
$P\ (11\bar{2}3, \frac{2}{3}\cdot2\ r)^{6}$
$x\ (22\bar{4}5, \frac{4}{5}\text{-}2)^{4}$
$G\ (7\cdot7\cdot\bar{14}\cdot18, \frac{7}{9}\text{-}2)^{7}$
$J\ (5\cdot5\cdot\bar{10}\cdot8, \frac{5}{4}\text{-}2)^{7}$

$y\ (22\bar{4}3, \frac{4}{3}\text{-}2\ r, l)^{4}$
$u\ (11\bar{2}1, 2\text{-}2)$
$\xi\ (22\bar{4}1, 4\text{-}2)^{4}$
$E\ (5\cdot1\cdot\bar{6}\cdot13, \frac{6}{13}\text{-}\frac{6}{5})^{6}$
$D\ (21\bar{3}7, \frac{3}{7}\text{-}\frac{3}{2})^{6}$
$w\ (21\bar{3}2, \frac{3}{2}\text{-}\frac{3}{2})^{4}$
$\kappa\ (42\bar{6}3, 2\text{-}\frac{3}{2})^{5}$
$F\ (53\bar{8}5, \frac{8}{5}\text{-}\frac{8}{5})^{6}$
$T\ (23\bar{5}6, -\frac{5}{6}\text{-}\frac{5}{3})^{6}$
$L\ (6\cdot4\cdot\bar{10}\cdot23, \frac{10}{23}\text{-}\frac{5}{3})^{6}$
$Z\ (6\bar{1}\bar{5}7, \frac{6}{7}\text{-}\frac{6}{5}\ l)^{4}$
$\delta\ (8\cdot\bar{3}\cdot\bar{5}\cdot13, \frac{8}{13}\text{-}\frac{8}{5}\ l)^{4}$
$\mu\ (\bar{4}\cdot16\cdot\bar{12}\cdot17, -\frac{16}{17}\text{-}\frac{4}{3}\ r)^{4}$
$H\ (1\cdot3\cdot\bar{4}\cdot10, -\frac{2}{5}\text{-}\frac{4}{3})^{6}$
$R\ (13\bar{4}2, -2\text{-}\frac{4}{3})^{6}$
$\zeta\ (\bar{2}6\bar{4}1, -6\text{-}\frac{3}{2}\ r)^{4}$
$S\ (2\cdot8\cdot\bar{10}\ 5, -2\text{-}\frac{5}{4})^{6}$

$cK = 18° 18'$
$cd = 23° 47'$
$cf = 27° 53'$
$cg = 33° 28\frac{1}{2}'$
$ch = 41° 24'$
$ci = 46° 37'$
$cl = 60° 26\frac{1}{2}'$
$cn = 69° 17'$
$c\omega = 75° 51'$
$cq = 79° 18'$

$c\lambda = 81° 24'$
$cb = 9° 23'$
$ck = 58° 50'$
$ct = 84° 36'$

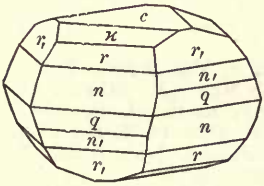
$KK' = 31° 33'$
$dd' = 40° 53\frac{1}{2}'$
$ff' = 47° 46\frac{1}{2}'$
$gg' = 57° 4'$
$hh' = 69° 53'$
$ii' = 78° 0\frac{1}{2}'$

$rr' = 87° 23'$
$ll' = 97° 45'$
$nn' = 108° 12'$
$\omega\omega' = 114° 14'$
$qq' = 116° 38'$
$\lambda\lambda' = 117° 48'$
$bb' = 16° 14'$
$kk' = 95° 38'$
$tt' = 119° 7\frac{1}{2}'$
$gg_{,} = 32° 1'$

$r\Delta = 47° 0\frac{1}{2}'$
$nn_{,} = 55° 46'$
$qq_{,} = 58° 51'$
$cu = 66° 25'$
$c\xi = 77° 41'$
$cv = 81° 43'$
$uu' = 54° 33'$
$\xi\xi' = 58° 29'$
$vv' = 59° 19'$

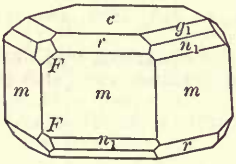
Twins: tw. axis ċ, often penetration-twins[5]; with also tw. pl. *a*, sometimes like the "Brazil twins" of quartz[6]. Crystals usually rhombohedral or thick tabular in habit, rarely showing trapezohedral planes; also acicular prismatic. In crystalline incrustations, granular, massive; sometimes as an earthy coating.

1.



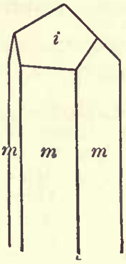
Almaden ?, Sbs.

2.



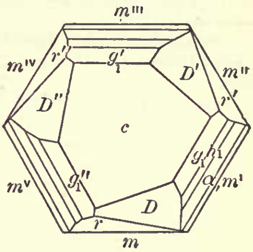
Mt. Avala, Schmidt.

3.



California.

4.



Mt. Avala, Schmidt.

Cleavage: *m* perfect. Fracture subconchoidal, uneven. Somewhat sectile. H. = 2–2·5. G. = 8·0–8·2; 8·090 G. E. Moore. Luster adamantine, inclining to metallic when dark colored, and to dull in friable varieties. Color cochineal-red, often inclining to brownish red and lead-gray. Streak scarlet. Transparent to opaque. Optically +. Indices: $\omega_r = 2{\cdot}854$, $\epsilon_r = 3{\cdot}201$, Dx[8]. Polarization circular, chiefly left handed; twins sometimes showing Airy's spirals[5].

**Var.**—1. *Ordinary:* either (*a*) *crystallized;* (*b*) *massive*, granular embedded or compact; bright red to reddish brown in color; (*c*) *earthy* and bright red.

2. *Hepatic.* Quecksilberlebererz and Quecksilberbranderz, *Germ.* Inflammable cinnabar. Of a liver-brown color, with sometimes a brownish streak, occasionally slaty in structure, though commonly granular or compact. Cinnabar mixed with an organic substance called *idrialine* (q.v.) occurs at Idria. The *corallinerz* of Idria is a curved lamellar variety of hepatic cinnabar.

**Comp.**—Mercuric sulphide, HgS = Sulphur 13·8, mercury 86·2 = 100. Usually impure from the admixture of clay, iron oxide, bitumen.

**Pyr.**—In the closed tube alone a black sublimate of mercuric sulphide, but with sodium carbonate one of metallic mercury. Carefully heated in the open tube gives sulphurous fumes and metallic mercury, which condenses in minute globules on the cold walls of the tube. B.B. on charcoal wholly volatile, but only when quite free from gangue.

**Obs.**—Occurs chiefly in veins in slate rocks and shales, and rarely in granite or porphyry[9]. It has been observed in veins, with ores of iron. The Idria mines are in the Carboniferous formation; those of New Almaden, California, in partially altered Cretaceous or Tertiary beds. It sometimes occurs in connection with hot springs as the result of solfataric action. Pyrite and marcasite, sulphides of copper, stibnite, realgar, gold, etc., are associated minerals; calcite quartz or opal, also barite, fluorite, are gangue minerals; a bituminous mineral (cf. napalite) is common.

The most important European deposits are at Almaden in Spain, and at Idria in Carniola, where it is usually massive. Considerable amounts are now obtained at Bakhmut in southern Russia, where it occurs as an impregnation of a bed of Carboniferous sandstone from 14 to 17 feet in thickness. Good crystals occur in the coal formations of Moschellandsberg and Wolfstein in the Palatinate. Also found at Reichenau in Upper Carinthia; in graywacke at Windisch Kappel; in beds traversing gneiss at Dunbrawa in Transylvania; in fine crystals at the recently reopened mines of Mt. Avala, near Belgrade, Servia; at Neumarktel in Carniola; at Ripa in Tuscany; at Schemnitz in Hungary. In the Urals and the Nerchinsk region in Transbaikal. At the mines of Kwei Chaw in China abundantly, and in Japan. In Guadalcazar, Huitzuco, San

Onofre and elsewhere in Mexico; at Huancavelica in southern Peru, abundant; in the provinces of Coquimbo and Copiapo in Chili. Also in New South Wales, New Zealand, and Transvaal, S. Africa.

In the U. S. forms extensive mines in California, in the Coast Ranges at many different points from Clear Lake in the north (near which there is a vein in a bed of sulphur) to Santa Barbara Co. in the south; important mines are at New Almaden and the vicinity, in Santa Clara Co., about 60 m. S.S.E. of San Francisco. It is now forming by solfataric action at Sulphur Bank, Cal., and Steamboat Springs, Nevada. Also occurs in southern Utah; in Idaho, but only as rolled masses. In Douglas Co., Oregon. In British Columbia, sparsely disseminated through a crystalline limestone at the Ebenezer Mine, Hector (Kicking Horse) Pass, Rocky Mts.

The name cinnabar is supposed to come from India, where it is applied to the red resin, dragon's blood. The native cinnabar of Theophrastus is true cinnabar; he speaks of its affording quicksilver. The Latin name of cinnabar, *minium*, is now given to *red lead*, a substance which was early used for adulterating cinnabar, and so got at last the name. It has been said (King on Precious Stones) that the word *mine* (miniera, *Ital.*) and *mineral* come from the Latin for quicksilver mine, *miniaria* (Fodina miniaria).

**Alt.**—Pseudomorphs after pyrite, tetrahedrite, dolomite have been described (Blum, Pseud., Nachtr., **2**, 123, 124, **3**, 262); also after stibnite (Sandb.). Heated nearly to the point of sublimation and suddenly cooled cinnabar is changed to the black sulphide, HgS; cf. metacinnabarite.

**Art.**—St. Claire Deville and Debray have obtained rhombohedral crystals of cinnabar by sublimation, see Fouqué-Lévy, Synth. Min., p. 313, 1882; also Weinschenk, Zs. Kr., **17**, 498, 1890.

**Ref.**—[1] Ber. Ak. Wien, **6**, 63, 1851; angles confirmed by Koksharov, Min. Russl., **6**, 257, 1870. [2] See Sbs., l. c. for early literature, new planes, etc.; also later Mgg., Jb. Min., **2**, 29, 1882. The distinction between + and − forms is not always surely made, cf. Schmidt[6]. [3] D'Achiardi, as a trigonal prism, tetartohedral, Ripa, Tuscany, Boll. Com. G., **2**, 163, 1871. Min. Tosc., **2**, 282, 1873. [4] Mgg., Almaden, Spain, l. c. [5] Tsch., Nikitovka, Min. Mitth., **7**, 361, 1886. [6] A. Schmidt, Mt. Avala, Servia, Földt. Közl., **17**, 555, 1887, and Zs. Kr., **13**, 433, 1887; no attempt is made to distinguish between + and − rhombohedrons, nor between *r* and *l* trapezohedrons. [7] Traube, Mt. Avala, Zs. Kr., **14**, 563, 1888. [8] Propr. Opt., **1**, 77, 1857.

[9] On the genesis of cinnabar deposits, see Phillips, Q. J. G. Soc., 1879; Christy, Am. J. Sc., **17**, 453, 1879; also LeConte, ib., **24**, 23, 1882; **25**, 424, **26**, 1, 1883; Becker., ib., **33**, 199, 1887, and Mon., **13**, U. S. G. Surv., 1888. In the latter there is given a full description of the occurrence of cinnabar, especially in California and also throughout the world. Becker concludes that the cinnabar, pyrite and gold of the quicksilver mines of the Pacific Slope reached their present position in hot solutions of double sulphides leached from the adjacent granite or the masses underlying it (p. 449).

ETHIOPSITE *Adam*, Tabl. Min., 59, 1869. Black mercurous sulphide, $Hg_2S$; it is an unstable compound, not known to occur in nature.

**67. COVELLITE.** *Freiesleben*, Geogn. Arb., **3**, 129 (fr. Sangerhausen); Kupferindig *Breith.*, in Hoffm. Min., **4**, 2, 178, 1817. Bi-solfuro di rame che formasi attualmente nel Vesuvio *Covelli* (1826), Att. Acc. Napoli, **4**, 9, 1839. Indigo-Copper; Blue Copper. Covelline, Sulfure de cuivre du Vésuve, *Beud.*, **2**, 409, 1832. Breithauptite *Chapm.*, Min. 125, 1843. Cantonite *Pratt*, Am. J. Sc., **22**, 449, 1856, **23**, 409, 1857. Cobre añilado *Span. S. A.*

Hexagonal or rhombohedral. Axis $\dot{c} = 1·1466$; $0001 \wedge 10\bar{1}1 = 52° 56\frac{1}{6}'$ Kenngott[1].

**Forms:** *c* (0001, *O*), *a* ($11\bar{2}0$, *i*-2), *x* ($11\bar{2}2$, 1-2), *y* ($22\bar{4}1$, 4-2).

Angles: $cx = 48° 54'$, $cy = 77° 42'$, $xx' = 44° 16\frac{1}{2}'$, $yy' = 58° 29'$, $yy^{vi} = {}^*24° 36'$.

Rarely in hexagonal crystals with faces *m* and *x* horizontally striated. Commonly massive or spheroidal; surface, sometimes crystalline.

Cleavage: basal, perfect. Flexible in thin leaves. H. = 1·5–2. G. = 4·590, 4·636 crystals, Zeph. Luster of crystals submetallic, inclining to resinous, a little pearly on cleavage-face; subresinous or dull when massive. Color indigo-blue or darker. Streak lead-gray to black, shining. Opaque.

**Comp.**—Cupric sulphide, CuS = Sulphur 33·6, copper 66·4 = 100. Analyses, 5th Ed., p. 84.

**Pyr.**—In the closed tube gives a sublimate of sulphur; in the open tube sulphurous fumes. B.B. on charcoal burns with a blue flame, emitting the odor of sulphur, and fuses to a globule, which reacts like chalcocite.

**Obs.**—With other copper ores near Badenweiler in Baden; at Leogang in Salzburg with chalcopyrite, sometimes in small crystals; at Kielce in Poland; Sangerhausen in Saxony; Mansfeld, Thuringia; Vesuvius, on lava; common in Chili.

Named after N. Covelli (1790–1829), the discoverer of the Vesuvian covellite.

Covellite is a result of the alteration of other ores of copper, and is often mixed with chalcocite, from which it has been derived. (See *Digenite* and *Carmenite*, p. 56.)

**Artif.**—Formed at low temperatures (to 200° C.) from CuO, while at higher temperatures, as too from $Cu_2O$, chalcocite ($Cu_2S$) results, Doelter, Zs. Kr., **11**, 34, 1885; also Weinschenk, in crystals, ib., **17**, 497, 1890.

**Ref.**—[1] Leogang, Ber. Ak. Wien, **12**, 22, 1854; the suggestion of Groth as to position is here followed, since it shows the probable relation to cinnabar.

CANTONITE is covellite from the Canton mine, Georgia, occurring in cubes, with a cubical cleavage. It is associated with *harrisite* (pseudomorphs of chalcocite after galena, see p. 56), and is regarded by Genth as a pseudomorph of covellite after the harrisite.

**68. GREENOCKITE.** Greenockite *Jameson*, Ed. N. Phil. J., 28, 390, 1840. Sulphuret of Cadmium *Connel*, ib., 392. Cadmium-Blende. Cadmium sulfuré *Fr.*

Hexagonal; hemimorphic. Axis $\dot{c}$ = 0·81091; 0001 ∧ $10\bar{1}1$ = 43° 7′ 3″ Mügge[1].

**Forms**[1]:

*c* (0001, *O*)
*m* ($10\bar{1}0$, *I*)
*a* ($11\bar{2}0$, *i*-2)
*k* ($21\bar{3}0$, *i*-$\frac{3}{2}$)

*n* ($10\bar{1}7$, $\frac{1}{7}$)
*γ* ($3{\cdot}0{\cdot}\bar{3}{\cdot}20$, $\frac{3}{20}$)
*π* ($10\bar{1}5$, $\frac{1}{5}$)
*i* ($10\bar{1}2$, $\frac{1}{2}$)
*ρ* ($20\bar{2}3$, $\frac{2}{3}$)

*l* ($30\bar{3}4$, $\frac{3}{4}$)
*x* ($10\bar{1}1$, 1)
*p* ($40\bar{4}3$, $\frac{4}{3}$)
*q* ($80\bar{8}5$, $\frac{8}{5}$)
*o* ($50\bar{5}3$, $\frac{5}{3}$)

*y* ($70\bar{7}4$, $\frac{7}{4}$)
*z* ($20\bar{2}1$, 2)
*u* ($30\bar{3}1$, 3)
*w* ($10{\cdot}0{\cdot}\bar{10}{\cdot}3$, $\frac{10}{3}$)
*v* ($40\bar{4}1$, 4)

*r* ($50\bar{5}1$, 5)
*t* (6061, 6)
*s* ($11\bar{2}1$, 2-2)

Of the above forms *γ*, *π*, *ρ* have been observed only at the lower extremity of the crystals. The form of greenockite is near that of the other hemimorphic species, iodyrite and zincite.

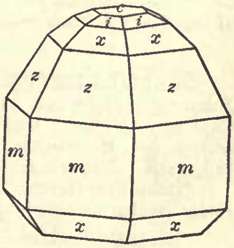
*cn* = 7° 37′
*cγ* = 8° 0′
*cπ* = 10° 36½′
*ci* = 25° 5′
*cρ* = 31° 58½′
*cl* = 35° 5′

*cp* = 51° 18′
*cq* = 56° 17′
*co* = 57° 21′
*cy* = 58° 36′
*cz* = *61° 53′ 55″
*cu* = 70° 24′

*cw* = 72° 14′
*cv* = 75° 3′
*cr* = 77° 56½′
*ct* = 79° 54½′
*cs* = 58° 20½′
*ii*′ = 24° 29′

*xx*′ = 39° 58′
*zz*′ = 52° 20½′
*vv*′ = 57° 46½′
*ss*′ = 50° 23′
*ms* = 42° 30½′
*mx*′ = 70° 1′

Crystals hemimorphic, terminated by *c*, *cx*, or *cγπρx* below, above more complex; the pyramidal faces often striated horizontally, and in oscillatory combination.



Cleavage: *a* distinct, Fdl.; *c* imperfect. Fracture conchoidal. Brittle. H. = 3–3·5. G. = 4·9–5·0. Luster adamantine to resinous. Color honey-, citron- or orange-yellow; also bronze-yellow. Streak-powder between orange-yellow and brick-red. Nearly transparent. Optically +. Double refraction weak. ω = 2·688 Mlr.

**Comp.**—Cadmium sulphide, CdS = Sulphur 22·3, cadmium 77·7 = 100.

**Pyr., etc.**—In the closed tube assumes a carmine-red color while hot, fading to the original yellow on cooling. In the open tube gives sulphurous fumes. B.B. on charcoal, either alone or with soda, gives in R.F. a reddish-brown coating. Soluble in hydrochloric acid, affording hydrogen sulphide.

**Obs.**—Occurs in short hexagonal crystals at Bishopton, in Renfrewshire, Scotland, in a porphyritic trap and amygdaloid, associated with prehnite; also at Bowling near Old Kilpatrick, and at the Boylestone quarry, Barrhead near Glasgow. At Přibram in Bohemia, as a coating especially on sphalerite; similarly elsewhere not uncommon, as at Bleiberg, Carinthia, Pierrefitte, Basses Pyrénées, Laurium, Greece; so too in the U. S. at the Ueberoth zinc mine, near Friedensville, Lehigh Co., Pa., and in the zinc region of southwestern Missouri; in Marion Co., Ark., occurs coloring smithsonite bright yellow.

Named after Lord Greenock (later Earl Cathcart). The first crystal was found about 1810 by Mr. Brown of Lanfyne, and was taken by him for sphalerite. It was over half an inch across.

**Artif.**—Obtained by Hautefeuille in hemimorphic crystals resembling the natural ones, C. R., **93**, 824, 1881. Not an uncommon furnace product.

**Ref.**—[1] Jb. Min., **2**, 18, 1882; for first description of crystals see Breith., Pogg., **51**, 507, 1840: he calls attention to the relations of the group of hexagonal (and rhombohedral) sulphides. Greg and Lettsom, and Mlr. give only *c a m i x z v*. Kk. gave in 1871, $\dot{c}$ = 0·81257, Bull. Acad. St. Pet., **15**, 219; later also $\dot{c}$ = 0·817247, Min. **8**, 125, 1881. Schüler regarded artif. cryst. examined by him as rhombohedral, Lieb. Ann., **87**, 40, 1853.

**69. WURTZITE.** *C. Friedel*, C. R., **52**, 983, 1861. Spiauterit *Breith.*, B. H. Ztg., **21**, 98, 1862, **25**, 193. Faserige Blende, Schalenblende *pt.*

Hexagonal; hemimorphic. Axis $\dot{c} = 0{\cdot}81747$; $0001 \wedge 10\bar{1}1 = 43° \ 20\frac{5}{6}'$ Friedel[1].

**Forms**[1]: *c* (0001, *O*); *m* ($10\bar{1}0$, *I*), *a* ($11\bar{2}0$, *i*-2); *x* ($40\bar{4}5$, $\frac{4}{5}$), *p* ($10\bar{1}1$, 1), *o* (2021, 2).

Angles: *cx* = 37° $3\frac{1}{2}'$, *co* = *62° 5′·4, *xx′* = 35° 4′, *pp′* = 40° 9′, *oo′* = 52° 27′.

Natural crystals quartzoids (*p*) with also *m*, both planes horizontally striated. Also fine fibrous or columnar, massive.

Cleavage: *a* easy; *c* difficult. H. = 3·5–4. G. = 3·98. Luster resinous. Color brownish black. Streak brown. Optically +. Double refraction weak.

**Var.**—1. Crystals, hemimorphic like greenockite. 2. Massive, fibrous, including the varieties of "Schalenblende" having a fine columnar structure (Noelting).

**Comp.**—Zinc sulphide, $ZnS$ = Sulphur 33, zinc 67 = 100.

**Pyr.**—Same as for sphalerite.

**Obs.**—From a silver-mine near Oruro in Bolivia. Also from Albergaria Velha in Portugal; from Quesbesita, Peru, in tabular crystals grouped and forming a crust, some of the crystals $\frac{1}{8}$ inch across. In fine pyramidal crystals with sphalerite and quartz at the "Original Butte" mine, Butte City, Montana.

The massive fibrous forms of "Schalenblende" occur at Přibram, Liskeard, etc. Other forms, from Stolberg, Wiesloch, Altenberg, are in part wurtzite, in part sphalerite.

Named after the French chemist, Adolphe Wurtz.

**Artif.**—First made by St. Claire Deville and Troost by fusing zinc sulphate with $CaF_2$ and BaS in equal parts (C. R., **52**, 920, 1861); also in crystals by a long and high heating of amorphous sphalerite (Sidot, C. R., **62**, 999, 1866); or by subliming the sphalerite in a current of sulphurous oxide, long, transparent, colorless hexagonal prisms have been formed (ib., **63**, 188, 1866). Cf. also Hautefeuille; also Noelting (Inaug. Diss., Kiel, 1887), who traces out the relations of sphalerite and wurtzite, and shows that the latter has often been produced in nature from the former.

**Ref.**—[1] On artif. cryst., C. R., **62**, 1002, 1866; Foerstner obtained $\dot{c} = 0{\cdot}8002$, Zs. Kr., **5**, 363, 1881. [2] On nat. cryst., Bolivia, only *c*, *m*, *a*, *o*, l. c.

Erythrozincite *Damour*, Bull. Soc. Min., **3**, 156, 1880. Probably a manganesian variety of wurtzite. Occurs in thin plates. Optically uniaxial, positive (Dx., ib. **4**, 40, 1881). Soft. Color red. Streak pale yellow. Translucent. Contains sulphur, zinc, manganese. In veins of lapis lazuli from Siberia.

**70. MILLERITE.** Haarkies (as a var. of Schwefelkies) *Wern.*, Bergm. J., 383, 1789 (fr. Johanng.); *Hofmann*, id., 175, 1791. Fer sulfuré capillaire (as a var. of Pyrite) *H.*, Tr., **4**, 1801. Capillary Pyrites. Gediegen Nickel *Klapr.*, Beitr., **5**, 231, 1810. Schwefelnickel *Berz.*; *Arfvedson*, Ak. H. Stockh., 427, 1822. Harkise *Beud.*, Tr., **2**, 400, 1832. Capillose *Chapman*, Min., 135, 1843. Millerit *Haid.*, Handb., 561, 1845. Trichopyrit *Glock.*, Syn., 43, 1847.

Nickelkies *Germ.* Sulphuret of Nickel. Nickel sulfuré *Fr.* Sulfuro di Nickel, Archise *Ital.* Sulfuro de niquel *Span.*

Rhombohedral. Axis $\dot{c} = 0{\cdot}9883$; $0001 \wedge 10\bar{1}1 = 48° \ 46\frac{1}{3}'$ Miller[1].

**Forms**[1]: *m* ($10\bar{1}0$, *I*), *a* ($11\bar{2}0$, *i*-2), *k* ($21\bar{3}0$, *i*-$\frac{3}{2}$); *r* ($10\bar{1}1$, *R*); also as cleavage-faces: *e* ($10\bar{1}6$, $\frac{1}{6}$), *d* ($10\bar{1}3$, $\frac{1}{3}$); *e*, ($01\bar{1}6$, $-\frac{1}{6}$), *d*, ($01\bar{1}3$, $-\frac{1}{3}$).

Angles: *ee′* = 18° $37\frac{1}{2}'$, *dd′* = *35° 52′, *rr′* = 81° 17′, *dd*, = 20° 29′.

Usually in very slender to capillary crystals, often in delicate radiating groups; sometimes interwoven like a wad of hair. Also in columnar tufted coatings, partly semi-globular and radiated.

Cleavage: *e*, *e*,, *d*, *d*,, all perfect, Mlr. Fracture uneven. Brittle; capillary crystals elastic. H. = 3–3·5. G. = 5·3–5·65; 5·65 fr. Saalfeld, Rg. Luster metallic. Color brass-yellow, inclining to bronze-yellow, with often a gray iridescent tarnish. Streak greenish black.

**Comp.**—Nickel sulphide, $NiS$ = Sulphur 35·3, nickel 64·7 = 100.

**Pyr., etc.**—In the open tube sulphurous fumes. B.B. on charcoal fuses to a globule. When roasted, gives with borax and salt of phosphorus a violet bead in O.F., becoming gray in R.F. from reduced metallic nickel. On charcoal in R.F. the roasted mineral gives a coherent metallic mass, attractable by the magnet. Most varieties also show traces of copper, cobalt, and iron with the fluxes.

**Obs.**—Occurs commonly in capillary crystals, in the cavities and among crystals of other minerals. Found at Joachimsthal in Bohemia; Johanngeorgenstadt; Přibram; Riechelsdorf;

Andreasberg; Himmelfahrt mine near Freiberg and Marienberg in Saxony; at Micheroux, Belgium; Cornwall; near Merthyr Tydvil, at Dowlais, occupies cavities in nodules of siderite.

Occurs at the Sterling mine, Antwerp, N. Y., in radiating groups of capillary crystals with ankerite in cavities in hematite; in Lancaster Co., Pa., at Gap mine, with pyrrhotite, in thin coatings of a radiated fibrous structure, often with a velvety surface of crystals, or tufts of radiated needles. With calcite, dolomite and fluorite, forming delicate tangled hair-like tufts, in geodes in limestone, often penetrating the calcite crystals, at St. Louis, Mo.; similarly near Milwaukee, Wis.

Stated to occur in considerable deposits in quartz near Benton in Saline Co., Arkansas (Min. Res. U. S , 128. 1887). Sparingly present with pyrite and marcasite at one of the cinnabar mines in Pope Valley, Mayacmas distr., Cal. With a green chromiferous garnet in Orford Township, Quebec, disseminated in grains in calcite.

Identified in the nickeliferous metallic iron of Santa Catarina, Brazil (Meunier).

**Artif.**—Obtained in groups of acicular crystals by Weinschenk, Zs. Kr , **17**, 500, 1890; also earlier by Baubigny, Fouqué-Lévy, Synth. Min., 306, 1882.

The *capillary pyrites, Haarkies,* of Werner was true millerite, from Johanngeorgenstadt, according to Hofmann, Min., **4**, 168, 1817. But capillary pyrite and marcasite have sometimes gone by the same name.

**Ref.**—[1] Phil. Mag , **6**, 104, 1835, or Pogg., **36**, 476, 1835, and Min., p. 163, 1852. Cf. Breith., Pogg., **51**, 511, 1840.

JAIPURITE. Sulphuret of Cobalt *Middleton,* Phil. Mag., **28**, 352, 1846. Syepoorite *J. Nicoll,* Min., 458, 1849. Jeypoorite *Ross,* Proc. Roy. Soc., **21**, 292, 1873. Jaipurite *F R. Mallet,* Records Geol. Surv. India, **14**, pt. 2, 190, 1880, and Min. India, 16, 1887. Ruténite *Adam,* Tabl. Min., 55, 1869. Kobaltsulfuret pt., Schwefelkobalt pt., Kobaltkies pt., Graukobalterz, Kobaltblende *Germ.*

Described as a simple cobalt sulphide (CoS), occurring massive, with G. = 5·45, and of a steel-gray color, stated to have been found at the Khetri mines, Jaipur (Syepoore, Jeypoor), Rájputána, India, and to be "used by Indian jewelers for staining gold of a delicate rose color." Mallet (l. c.) questions the existence of the mineral, he having found only cobaltite and danaite at the locality. Moreover the cobalt ore from the Khetri mines, sold to Indian enamelers under the name of "sehta," is used in enameling in different shades of blue (not red) on gold and silver.

It is to be noted here that Weinschenk describes an artificial cobalt monosulphide, CoS, in tin-white crystals resembling those obtained of the nickel sulphide, millerite. See Zs. Kr., **17**, 500, 1890.

**71. NICCOLITE.** Kupfernickel *Hiärne,* Anledn. Malm og Berg., 76, 1694. Cuprum Nicolai [mistaken trl.] *J. Woodward,* Foss., 1728. Kupfernickel, Arsenicum sulphure et cupro mineralisatum, aeris modo rubente, *Wall.*, 228, 1747. Niccolum ferro et cobalto arsenicatis et sulphuratis min. (fr. Saxony) *Cronst.* Ak. H. Stockh., 1751, 1754 (first discov. of metal); Min., 218, 1758. Cuprum min. arsen. fulvum *Linn.*, 1768. Mine de cobalt arsenicale tenant cuivre *Sage,* Min., 58, 1772; *de Lisle,* Crist., **3**, 135, 1783. Niccolum nativum *Bergm.*. Opusc., **2**, 440, 1780 Rothnickelkies, Arseniknickel, *Germ.* Copper Nickel, Arsenical Nickel. Nickeline *Beud.*, Tr., **2**, 586, 1832. Arsenischer Pyrrotin *Breith.*, J. pr. Ch., **4**, 266, 1835. Niccolite *Dana,* Niquel rojo *Span.*

Antimonarsennickel *Petersen,* Pogg., **137**, 396, 1869. Aarite *Adam,* Tabl. Min., 40, 1869. Arite *Pisani,* C. R., **76**, 239, 1873.

Hexagonal. Axis $\dot{c} = 0{\cdot}8194$; $0001 \wedge 10\bar{1}1 = {}^*43° 25'$ Breithaupt[1].

**Forms:** $c$ (0001, $O$), $m$ ($10\bar{1}0$, $I$); $x$ ($10\bar{1}1$, 1). Angle: $xx' = 40° 12'$.

Crystals rare. Usually massive, structure nearly impalpable; also reniform with a columnar structure; also reticulated and arborescent.

Fracture uneven. Brittle. H. = 5–5·5. G. = 7·33–7·67. Luster metallic. Color pale copper-red, with a gray to blackish tarnish. Streak pale brownish black. Opaque.

**Comp.**—Nickel arsenide, NiAs = Arsenic 56·1, nickel 43·9 = 100. Usually contains a little iron and cobalt, also sulphur; sometimes part of the arsenic is replaced by antimony, and then it graduates toward breithauptite. The intermediate varieties have been called *arite.*

**Anal.**—1, Petersen, Pogg., **134**, 82, 1868. 2, Winkler, Jb. Min., 818, 1872. 3, L. Sipöcz, Zs. Kr., **11**, 215, 1885. 4, Genth, Am Phil. Soc., **20**, 403, 1882. 5–7, Berthier, Ann. Mines, **4**, 467, 1819; ibid., **7**, 537, 1835. 8, Petersen, Pogg., **137**, 396, 1869. 9, Pisani, l. c.

1. *Ordinary.*

| | | As | Sb | S | Ni | Fe |
|---|---|---|---|---|---|---|
| 1. Wittichen | G. = 7·526 | 53·49 | — | 1·18 | 43·86 | 0·67 Bi 0·54 = 99·74 |
| 2. Telhadella mine, Portugal | G. = 7·33 | 50·78 | — | 3·85 | 42·41 | 1·40 $SiO_2$ 1·65 = 100·09 |
| 3. Dobsina | G. = 7·513 | 53·33 | 2·03 | 2·30 | 42·65 | 0·17 Bi 0·10 = 100·58 |
| 4. Silver Cliff, Col. | G. = 7·314 | 46·81 | 2·24 | 2·52 | 44·76 | 0·60 Cu 1·59, Co 1·70 = 100·22 |
| 2. *Antimonial.* | | | | | | |
| 5. Allemont | | 48·80 | 8·00 | 2·00 | 39·94 | *tr.* Co 0·16 = 98·90 |
| 6. Balen | | 32·3 | 28·0 | 2·5 | 34·5 | 1·4 $SiO_2$ 2·0 = 100·7 |
| 7. " | | 33·0 | [27·8] | 2.8 | 33·0 | 1·4 $SiO_2$ 2·0 = 100 |
| 8. Wolfach | G. = 7·50 | 30·06 | 28·22 | 1·77 | 39·81 | 0·96 Co *tr.* = 100·82 |
| 9. *Arite* | G. = 7·19 | 11·5 | 48·6 | 1·7 | 37·3 | Zn 2·4 = 101·5 |

**Pyr., etc.**—In the closed tube a faint white crystalline sublimate of arsenic trioxide. In the open tube a sublimate of arsenic trioxide, with a trace of sulphurous fumes, the assay becoming yellowish green. On charcoal gives arsenical fumes and fuses to a globule, which, treated with borax glass, affords, by successive oxidation, reactions for iron, cobalt, and nickel; the antimonial varieties give also reactions for antimony. Soluble in aqua regia.

**Obs.**—Accompanies cobalt, silver, and copper in the Saxon mines of Annaberg, Schneeberg, etc.; also in Thuringia, Hesse, and Styria, and at Allemont in Dauphiné; at the Ko mines in Nordmark, Sweden; at Balen in the Basses Pyrénées (*arite*); occasionally in Cornwall, as at Pengelly and Wheal Chance; formerly at the Hilderstone Hills, Scotland; at Chañarcillo, near Copiapo, and at Huasco, Chili; abundant at Mina de la Rioja, Oriocha, in the Argentine Republic.

Found at Chatham, Conn., in gneiss, associated with smaltite; sparingly at Franklin Furnace, N. J. (Koenig); Silver Cliff, Colorado; Tilt Cove, Newfoundland.

Named from the contained metal. The name of the species should be formed from the Latin word for nickel, *niccolum*, proposed by Cronstedt, and hence should be written *niccoline*, or better *niccolite*, in place of Beudant's *nickeline*.

**Ref.**—[1] L. c., Pogg., **51**, 515, 1840.

**72. BREITHAUPTITE.** Antimonnickel *Stromeyer & Hausm.*, Gel. Anz. Gött., 2001, 1833. Antimonial Nickel. Hartmannite *Chapman*, Min., 1843. Breithauptit *Haid.*, Handb., 559, 1845.

Hexagonal: Axis $\dot{c} = 0{\cdot}8586$; $0001 \wedge 10\bar{1}1 = 44° 45\frac{1}{6}'$ Breithaupt[1].

**Forms:** *c* (0001, *O*), *m* ($10\bar{1}0$, *I*); *i* ($10\bar{1}2$, $\frac{1}{2}$), *w* ($30\bar{3}2$, $\frac{3}{2}$), *v* ($20\bar{2}1$, 2)[2].

Angles: *ci* = 26° 22′, *cw* = *56° 5′, *cv* = 63° 14′, *ii′* = 25° 40′, *ww′* = 49° 2′.

Crystals thin tabular, rare; also hexagonal prisms (artif.[2]). Arborescent and disseminated, massive.

Fracture uneven to small subconchoidal. Brittle. H. = 5·5. G. = 7·541 Breith. Luster metallic, splendent. Color on the fresh fracture light copper-red, inclining strongly to violet. Streak reddish brown. Opaque.

**Comp.**—Nickel antimonide, NiSb = Antimony 67·2, nickel 32·8 = 100. Arsenic is sometimes present; compare analyses 5–9 under niccolite.

**Pyr.**—In the open tube white antimonial fumes. On charcoal fuses in R.F.; gives off antimonial fumes, and coats the coal white; if lead is present, a yellow coating near the assay; treated with soda the odor of arsenic may be distinguished in most specimens.

**Obs.**—Found in the Harz at Andreasberg, with calcite, galena, and smaltite. Has been observed as a furnace product, crystallized, cf. ref.[2] below.

Named after the Saxon mineralogist, J. F. A. Breithaupt (1791–1873).

**Ref.**—[1] Pogg., **51**, 512, 1840. [2] Brand, on artif. cryst., Zs. Kr., **12**, 234, 1886.

**73. TROILITE.** Pyrrhotite pt. Troilit *Haid.*, Ber. Ak. Wien, **47** (2), 283, 1863.

Usually massive.

H. = 4·0. G. = 4·75–4·82. Color tomback-brown. Streak black.

**Comp.**—Iron sulphide, usually accepted as FeS = Sulphur 36·4, iron 63·6 = 100; it may, however, be identical with pyrrhotite, as urged by Meunier.

**Anal.**—1, J. L. Smith, Am. J. Sc., **19**, 156, 1855. 2, Id., C. R., **81**, 976, 1875, also Rg., l. c. 3, Rg., Min. Ch., 53, 1875, cf. also Pogg., **74**, 443, 1848, **122**, 365, 1864. 4, E. Geinitz, Jb. Min., 608, 1876. 5, 6, Meunier, Ann. Ch. Phys., **17**, 36, 1869.

| | | | S | Fe | Ni | |
|---|---|---|---|---|---|---|
| 1. | Tazewell Co., Tenn. | | 35·67 | 62·38 | 0·32 | Cu *tr.* $SiO_2$, CaO 0·64 = 99·01 |
| 2. | Sevier Co., Tenn. | G. = 4·813 | 36·21 | 63·48 | — | = 99·69 |
| 3. | Seeläsgen | G. = 4·787 | 35·91 | 63·35 | — | = 99·26 |
| 4. | Nenntmannsdorf | | 37·36 | 63·82 | — | = 101·18 |
| 5. | Toluca | G. = 4·799 | 40·03 | 59·01 | 0·14 | Cu *tr.* = 99·18 |
| 6. | Charcas | G. = 4·780 | 39·21 | 56·29 | 3·10 | = 98·60 |

**Pyr.**, etc.—Same as for pyrrhotite.

**Obs.**—Common in iron meteorites in nodules disseminated more or less sparingly through the mass, also in narrow veins usually separated from the iron by a thin layer of graphite.

It is assumed by Rose that the iron sulphide of meteoric iron is troilite, that of meteoric stones (sometimes crystallized) is pyrrhotite, but as remarked above, they may be both pyrrhotite.

Named after Dominico Troili, who, in 1766, described a meteorite that fell that year at Albareto in Modena, which contains this species.

**Artif.**—The simple iron monosulphide is a common laboratory product. Weinschenk has obtained it in crystals, small hexagonal tables, showing the basal plane and pyramids (or rhombohedrons), Zs. Kr., **17**, 499, 1890.

**74. PYRRHOTITE.** Vattenkies, Pyrites fusca, Minera hepatica, pt., *Wall.*, Min., 209, 212, 1747. Pyrites en prismes hexagonales *Forst.*, Cat., 1772; *Bourn.*, de Lisle's Crist., **3**, 243, 1783. Magnetischer-Kies *Wern.*, Bergm. J., 383, 1789. Magnetic Pyrites *Kirwan*, 1796. Magnetic Sulphuret of Iron. Magnetkies *Germ.* Fer sulfuré magnétique *Fr.* Leberkies pt. *Germ.* Leberkies *Leonh.*, Handb., 665, 1826. Leberkise *Beud.*, Tr., **2**, 404, 1832. Magnetopyrite *Glocker*, Grundr., 1839. Pyrrotin pt., Magnetischer Pyrrotin, *Breith.*, J. pr. Ch., **4**, 265, 1835. Magnetkis *Swed.* Pirrotina *Ital.* Pirita magnética *Span.*

Hexagonal. Axis $\dot{c} = 0·8701$; $0001 \wedge 10\bar{1}1 = 45° \ 7\tfrac{5}{6}'$ Rose[1].

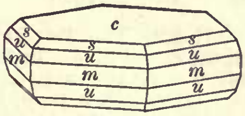
**Forms**[2]: *c* (0001, *O*), *m* ($10\bar{1}0$, *I*), *a* ($11\bar{2}0$, *i*-2), *s* ($10\bar{1}1$, 1), *z* ($20\bar{2}1$, 2), *u* ($40\bar{4}1$, 4), *w* ($60\bar{6}1$, 6)[3]? *y* ($20·0·\overline{20}·3$, $\tfrac{20}{3}$)[4]; *v* ($11\bar{2}1$, 2-2).

*cs* = 45° 8′ *cw* = 80° 35′ *ss′* = 41° 30½′ *vv′* = 51° 22′
*cz* = 63° 32′ *cy* = 81° 30½′ *zz′* = *53° 11′ *av* = 41° 20′
*cu* = 76° 0′ *cv* = 60° 7′ *uu′* = 58° 3′ *ms′* = 69° 15′

Twins: tw. pl. *s*, with vertical axes nearly at right angles (f. 2). Distinct crystals rare, commonly tabular; also acute pyramidal with faces striated horizontally. Usually massive, with granular structure.

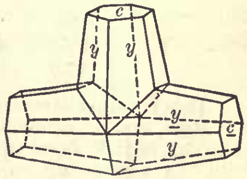
Parting: *c* sometimes distinct; *a* less so. Fracture uneven to subconchoidal. Brittle. H. = 3·5–4·5. G. = 4·58–4·64. Luster metallic. Color between bronze-yellow and copper-red, and subject to speedy tarnish. Streak dark grayish black. Magnetic, but varying much in intensity; sometimes possessing polarity.

1.



Cyclopean Is., Slg.

2.



Elizabethtown[4].

**Comp.**—A sulphide of iron, often containing also nickel; formula chiefly $Fe_{11}S_{12}$, which is also the composition of the artificial compound (Doelter). Analyses, however, vary from $Fe_5S_6$ up to $Fe_{16}S_{17}$, while conforming to the general formula $Fe_nS_{n+1}$. Percentage composition $Fe_{11}S_{12}$ = Sulphur 38·4, iron 61·6 = 100; $Fe_7S_8$ = Sulphur 39·6, iron 60·4 = 100; $Fe_8S_9$ = Sulphur 39·2, iron 60·8 = 100.

The analyses collected and tabulated by Lindström, and later with additions by Habermehl, show a variation from Fe : S = 1 : 1·1902, corresponding to $Fe_5S_6$, to 1 : 1·0610 or $Fe_{16}S_{17}$. The material may not in all cases have been homogeneous. Habermehl obtained from the Bodenmais pyrrhotite, Fe = 60·57, as the mean of 14 determinations, ten of them essentially identical, on portions separated successively from the fine powder suspended in water by a strong magnet; the material was thus proved to be homogeneous and to conform closely to $Fe_7S_8$. On the other hand Bodewig and also Doelter have obtained $Fe_{11}S_{12}$. The FeS of anal. 4 needs confirmation.

For a discussion of the composition see Rg., Pogg., **121**, 337, 1864; Lindström, Öfv. Ak. Stockh., **32**, No. 2, 25, 1875; Habermehl, Ber. Oberhess. Ges., **18**, 83, 1879; Bodewig, Zs. Kr., **7**, 174, 1882; Doelter, Min. Mitth., **7**, 535, 1886.

**Anal.**—1–3, Bodewig, l. c. 4, Gutknecht, Jb. Min., **1**, 164, 1880. 5, Doelter, l. c. 6–11. Lindström, l. c. 12, Nilsson, Öfv. Ak. Stockh., **41**, No. 9, 39, 1884. 13–15, 17, J. F. Mackenzie, priv. contr. 16, Harrington, Am. J. Sc., **11**, 387, 1876. 18, 19, Rg., l. c. 20, Funaro, Att. Soc. Tosc., 172, 1881. 21, Mutschler, Lieb. Ann., **185**, 208, 1877.

1. *Ordinary.*

| | | | S | Fe | |
|---|---|---|---|---|---|
| 1. | Schreibershau | | 38·56 | 61·33 | Co 0·29 = 100·18 |
| 2. | Pallanza | | 38·75 | 60·59 | Co 0·63 = 99·97 |
| 3. | Bodenmais | | 38·45 | 61·53 | = 99·98 |
| 4. | Tavetschthal | G. = 4·62 | 36·35 | 63·15 | = 99·50 |
| 5. | Schneeberg | | 39·10 | 61·77 | Co *tr.* = 100·87 |
| 6. | Freiberg | G. = 4·642 | 38·88 | 60·18 | Cu *tr.*, $SiO_2$ 0·57, $CaCO_3$ 0·30 = 99·93 |
| 7. | Utö | G. = 4·627 | 38·22 | 60·91 | Cu *tr.*, $SiO_2$, etc., 0·97 = 100·10 |
| 8. | Kongsberg | G. = 4·584 | 38·89 | 60·20 | $SiO_2$ 0·98 = 100·07 |
| 9. | Tammela | | 39·74 | 59·76 | Ni 0·09, Cu 0·12, $SiO_2$ 0·45 = 100·16 |
| 10. | Smörvik | | 38·77 | 59·40 | Ni 0·51, Cu *tr.*, $SiO_2$ 1·22 = 99·90 |
| 11. | Adolfsgrufva | | 37·77 | 60·85 | Ni 0·04, Cu *tr.*, $SiO_2$ 1·91 = 100·57 |
| 12. | Vestr. Silfberg | G. = 4·35 | 37·76 | 61·60 | = 99·36 |
| 13. | Monroe, Conn. | | 38·22 | 61·65 | = 99·87 |
| 14. | Brewster, N.Y. | G. = 4·66 | 37·98 | 61·84 | Ni 0·25 = 100·07 |
| 15. | Fort Montgomery, Putnam Co., N. Y. | G. = 4·64 | 39·28 | 60·03 | Ni 0·78 = 100·09 |
| 15*a*. | “ pt., *magnetic* | | 38·99 | 60·04 | Ni 1·02 = 100·05 |
| 15*b*. | “ pt., *non-magnetic* | | 39·85 | 58·73 | Ni 1·53 = 100·11 |
| 16. | Elizabethtown | G. = 4·622 | 39·02 | 60·56 | Ni 0·11, Co,Mn,Cu 0·31 = 100 |

2. *Nickeliferous.*

| | | | S | Fe | Ni | |
|---|---|---|---|---|---|---|
| 17. | Sudbury | G. = 4·51 | 38·91 | 56·39 | 4·66 | = 99·96 |
| 18. | Hilsen | G. = 4·577 | [40·27] | 56·57 | 3·16 | = 100 |
| 19. | Gap Mine, Pa. | G. = 4·543 | [38·59] | 55·82 | 5·59 | = 100 |
| 20. | Frigido | | 37·59 | 55·16 | 2·06 | Cu *tr.*, $SiO_2$ 5·90 = 100·71 |
| 21. | Todtmoos | G. = 4·12–4·20 | 40·46 | 56·58 | 1·82 | Cu 0·54, Co 0·48 = 99·88 |

Forbes (Phil. Mag., **35**, 174, 180, 1868) has described a sulphide of iron and nickel from Scotland, which seems to lie between pyrrhotite and pentlandite. Massive, strongly magnetic. Occurs near Inverary Castle, Argyleshire, anal. 1, after deducting impurities; also from the Craigmuir mine, eight miles below Inverary, anal. 2. In both the ratio of Fe : Ni = 5 : 1 nearly.

| | G. | S | Fe | Ni | |
|---|---|---|---|---|---|
| 1. | 4·50 | 38·01 | 50·66 | 11·33 | Co, Cu *tr.* = 100 |
| 2. | 4·60 | 37·99 | 50·87 | 10·01 | Co 1·02, As 0·04, Cu *tr.* = 99·93 |

This is called *inverarite* by Heddle, Enc. Brit., **16**, 392, 1883.

**Pyr., etc.**—Unchanged in the closed tube. In the open tube gives sulphurous fumes. On charcoal in R.F. fuses to a black magnetic mass; in O.F. is converted into red oxide, which with fluxes gives only an iron reaction when pure, but many varieties yield small amounts of nickel and cobalt. Decomposed by hydrochloric acid, with evolution of hydrogen sulphide.

**Obs.**—Occurs at Kongsberg, Modum, Snarum, Hilsen, in Norway; Klefva and Fahlun in Sweden; Andreasberg and Treseburg, Harz; Bodenmais in Bavaria; Breitenbrunn, Saxony; Joachimsthal, Bohemia; Nizhni Tagilsk; Minas Geraes in Brazil, in large tabular crystals; the lavas of Vesuvius; Cornwall; Appin in Argyleshire.

In N. America in *Maine*, at Standish in crystals with andalusite; in *Vermont*, at Stafford, Corinth, and Shrewsbury. In many parts of *Massachusetts*. In *Connecticut*, at Trumbull with topaz, in Monroe, and elsewhere. In *N. York*, 1½ m. N. of Port Henry, Essex Co.; near Natural Bridge in Diana, Lewis Co.; at O'Neil mine and elsewhere in Orange Co. In *N. Jersey*, Morris Co., at Hurdstown, cleavable massive. In *Pennsylvania*, at the Gap mine, Lancaster Co., niccoliferous. In *Tennessee*, at Ducktown mines, abundant. In Canada, in large veins at St. Jérôme, Elizabethtown, Ontario; at Sudbury (anal. 17), etc.

Pyrrhotite is often present in disseminated particles or crystals in meteoric stones; the iron sulphide of meteoric irons (p. 29) is generally referred to troilite (Rose, l. c., cf. troilite).

Named from *πυῤῥότης, reddish.*

**Alt.**—Occurs altered to pyrite (G. Rose, ZS. G. Ges., **10**, 98, 1858); also to limonite and siderite.

**Ref.**—[1] Crystals from the Juvinas meteorite, which fell June 15, 1821, Pogg., **4**, 180, 1825. Other determinations: Kenng., Kongsberg, $zz' = 53° 22'$, Ber. Ak. Wien, **9**, 1852; Slg., Cyclopean Is. on analcite, $cu = 75° 18'$ and $uu' = 57° 51'$, whence $\dot{c} = 1·6502$, Zs. Kr., **11**, 343, 1886 An orthorhombic form for pyrrhotite has been suggested but not confirmed, cf. Streng. Jb. Min., 799, 1878, **1**, 183, 1882.

[2] Rose observed *c, a, m, s, z, v*; Bournon early gave figures and measurements from which Rose deduces 2021 and 1122 (cf. Ph., Min., 213, 1837). Slg. gives *c, m, s, u.* [3] D'Achiardi, Bottino, Att. Soc. Tosc., **2**, 114, 1876. [4] E. S. D., Elizabethtown, Ontario, Am. J. Sc., **11**, 386, 1876; *w* and *y* may be identical, the measured angles given are 80½° and 81½° respectively.

KRŒBERITE *D. Forbes*, Phil. Mag., **29**, 9, 1865. Krœberite is a strongly magnetic mineral, in copper-colored crystals, not yet analyzed, which Forbes says "appears to be principally a subsulphide of iron." The reasons for this opinion are not stated. Named after P. Krœber. It is from between La Paz and Yungas, on the eastern slope of the Andes.

HORBACHITE, *Knop*, Jb. Min., 521, 1873. In crystalline masses, showing an imperfect cleavage direction. H. = 4·5. G. = 4·43. Color resembling pyrrhotite but darker, pinchbeck-brown to steel-gray. Streak black. Analysis, Wagner, l. c.

S $\frac{4}{4}$ 45·87 Fe 41·96 Ni 11·98 = 99·81

This corresponds pretty nearly to $4Fe_2S_3.Ni_2S_3$. If confirmed, it would belong in the following section. An earlier analysis by Rg. gave different results, viz.: S 40·03, Fe 55·96, Ni 3·86 = 99·85, G. = 4·7; the latter called it simply pyrrhotite. Pogg., **121**, 361, 1864.

Decomposed rather easily under the influence of air and water, forming iron and nickel vitriol. Occurs with chalcopyrite in irregular masses in the serpentinized gneiss at Horbach near St. Blasien, in the Black Forest.

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## C. Intermediate Division.

### Group 1.

75. **Polydymite** $Ni_4S_5$ Isometric
76. **Beyrichite** $Ni_3S_4$

Polydymite and Beyrichite may prove to be the same species.

77. **Melonite** $Ni_2Te_3$

**75. POLYDYMITE** *H. Laspeyres*, J. pr. Ch., **14**, 397, 1876.

Isometric. In octahedrons; frequently in polysynthetic twins with tw. pl. *o*; often tabular.

Cleavage: cubic, imperfect. H. = 4·5. G. = 4·54–4·81. Luster metallic, brilliant on the fresh fracture. Color light gray to steel-gray; easily tarnished. Opaque.

**Comp.**—A nickel sulphide, perhaps $Ni_4S_5$ = Sulphur 40·6, nickel 59·4 = 100.

**Anal.**—1, 2, Laspeyres, on 0·28 and 0·2 gr.

| | | S | Ni | Co | Fe | Sb | As | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Grünau | G. = 4·81 | 40·27 | 53·51 | 0·61 | 3·84 | 0·51 | 1·04 | = | 99·78 |
| 2. " | | 39·20 | 53·13 | | 4·12 | 1·15 | 2·30 | = | 99·90 |

After deducting impurities (gersdorffite, ullmannite 5 p. c.), anal. 1 becomes: S 41·09, Ni 54·30, Co 0·63, Fe 3·98 = 100.

**Pyr., etc.**—Insoluble in hydrochloric, soluble in nitric, acid, with separation of sulphur. B.B. decrepitates, in the closed tube gives a sulphur sublimate and fuses to a dark-green magnetic bead.

**Obs.**—Occurs intimately mixed with gersdorffite, ullmannite, millerite, siderite, quartz, sphalerite, galena, bismuthinite, and other minerals, at Grünau, in Sayn-Altenkirchen, Westphalia.

A nickel ore from Sudbury, Ontario, analyzed by Clarke and Catlett (Am. J. Sc., **37**, 372, 1889, cf. p. 65) corresponds to $Ni_3FeS_5$, conforming to the general formula of polydymite; another Sudbury ore agrees with pentlandite (cf. p. 65), and still another is a nickeliferous pyrrhotite (p. 74).

Named from πολύς *many*, δίδυμος *twin*, because observed in polysynthetic twinned forms.

GRÜNAUITE. Nickelwismuthglanz *Kbl*, J. pr. Ch., **6**, 332, 1835. Bismuth Nickel. Grünauite *Nicol.*, Min., 458, 1849. Saynit *Kbl.*, Taf., 13, 1853. Wismuthnickelkies, Wismuthnickelkobaltkies *Germ.*

Described as isometric, with octahedral cleavage. H. = 4·5. G. = 5·13. Luster metallic. Color light steel-gray to silver-white, often tarnished. Streak dark gray. Analyses: 1, Kobell, l. c. 2, 3, Schnabel, Rg., Min. Ch., 108, 1860.

| | S | Bi | Ni | Fe | Co | Cu | Pb | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 38·46 | 14·11 | 40·65 | 3·48 | 0·28 | 1·68 | 1·58 | = | 100·24 |
| 2. | 31·99 | 10·49 | 22·03 | 5·55 | 11·24 | 11·59 | 7·11 | = | 100 |
| 3. | 33·10 | 10·41 | 22·78 | 6·06 | 11·73 | 11·56 | 4·36 | = | 100 |

Found at Grünau, in Sayn-Altenkirchen, with quartz and chalcopyrite. According to Laspeyres this supposed species is a polydymite, impure through the admixture of bismuthinite, also chalcopyrite, and galena.

**76. BEYRICHITE.** *Ferber; K. Th. Liebe*, Jb. Min., 840, 1871.

In complex prismatic crystals longitudinally striated, grouped radially or twisted screw-like. Terminated by a single plane (cleavage) with another plane inclined 81° to vertical axis, and a third 36° to this.

H. = 3–3·5. G. = 4·7. Luster metallic. Color lead-gray.

**Comp.**—Perhaps $Ni_3S_4$ or $2NiS.NiS_2$ = Sulphur 42·1, nickel 57·9 = 100.

**Analysis.**—Liebe, l. c.

S 42·86 Fe 2·79 Ni 54·23 = 99·88

**Pyr., etc.**—B.B. in the closed tube decrepitates and gives a sublimate of sulphur, on charcoal fuses to a brass-yellow magnetic globule. Soluble in aqua regia, yielding an emerald-green solution.

**Obs.**—From Lommerichskaul mine in Westerwald, where it is associated with millerite, and into which it is believed to change readily.

**Artif.**—An artificial nickel sulphide, having the composition $Ni_3S_4$, has been obtained by Sénarmont, Ann. Ch. Phys., **32**, 165, 1851.

**77. MELONITE.** *Genth*, Am. J. Sc., **45**, 313, 1868. Tellurnickel *Rg.*, Min. Ch., 17, 1875.

Hexagonal, with eminent basal cleavage. Generally in indistinct granular and foliated particles.

Luster metallic. Color reddish white, rarely tarnished brown. Streak dark gray.

**Comp.**—A nickel telluride, perhaps $Ni_2Te_3$ = Tellurium 76·2, nickel 23·8 = 100.

**Anal.**—Genth, l. c., after deducting 22·2 p. c. quartz and 3·26 gold:

Te 73·43 Ni 20·98 (Co *tr.*) Ag 4·08 Pb 0·72 = 99·21

Genth considers the analysis to correspond to 6·60 p. c. hessite, 1·17 altaite, 2·29 native tellurium, and 89·25 melonite.

**Pyr., etc.**—B.B. in the open tube gives a sublimate fusing to colorless drops, leaving a gray mass; on charcoal burns with a bluish flame, giving a white volatile coating, and a greenish gray residue; in R.F. with soda a gray powder of magnetic metallic nickel. Soluble in nitric acid, giving a green color, and on evaporation yielding a white crystalline powder of tellurium dioxide.

**Obs.**—Found with other tellurium minerals at the Stanislaus mine, California. Probably also at the Forlorn Hope mine, Boulder Co., Colorado (Hillebrand).

### Group 2.

The species here included are sometimes regarded as Sulpho-salts: Sulphoferrites, etc. Cf. Groth, Tab. Ueb., 25, 1889.

| | | | |
|---|---|---|---|
| 78. | **Bornite** | $3Cu_2S.Fe_2S_3$ | Isometric |

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| | | | |
|---|---|---|---|
| 79. | **Linnæite** | $CoS.Co_2S_3$ | Isometric |
| 80. | **Daubreelite** | $FeS.Cr_2S_3$ | Massive |
| 81. | **Cubanite** | $CuS.Fe_2S_3$ | Massive |
| 82. | **Carrollite** | $CuS.Co_2S_3$ | Isometric |

---

| | | | | $\dot{c}$ |
|---|---|---|---|---|
| 83. | **Chalcopyrite**<br>Barnhardtite | $Cu_2S.Fe_2S_3$ | Tetragonal | 0·9853 |

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| | | | |
|---|---|---|---|
| 84. | **Stannite** | $Cu_2S.FeS.SnS_2$ | Massive |

**78. BORNITE.** Kupferkies pt., Kupfer-Lazul *Henckel*, Pyrit., 1725. Lefverslag, Brun Kopparmalm, Minera Cupri Hepatica. Cuprum sulfure et ferro mineralisatum, *Wall.*, 283, 1747. Cuivre vitreuse violette *Fr. Trl.* Wall., 1753. Koppar-Lazur, Minera Cupri Lazurea, *Cronst.*, 175, 1758. Buntkupfererz *Wern.* Purple Copper Ore *Kirw.* Variegated Copper Ore. Cuivre pyriteux hepatique, *H.* Cuivre panaché *Fr.* Phillipsite *Beud.*, Tr., **2**, 411, 1832. Pyrites erubescens *Dana*, Min., 408, 1837; Poikilopyrites *Glock.*, Grundr.. 328, 1839. Bornit *Haid.*, Handb., 562, 1845. Poikilit *Breith.* Erubescite *Dana*, Min., 510, 1850. Cobre abigarrado, Cobre panaceo, Pecho de paloma, *Span. S. A.* Peacock ore pt. *Eng. Miners.* Brokig koppar-malm *Swed.* Chalcomiklit *Blomstrand*, Öfv. Ak. Stockh., **27**, 24, 1870.

Isometric. Observed forms:

*a* (100, *i-i*) *d* (110, *i*) *o* (111, 1) *n* (211, 2-2)

Twins: tw. pl. *o*, often penetration-twins, hexagonal in form. Habit cubic, faces often rough or curved. Massive, structure granular or compact.

Cleavage: *o* in traces. Fracture small conchoidal, uneven. Brittle. H. = 3. G. = 4·9–5·4. Luster metallic. Color between copper-red and pinchbeck-brown on fresh fracture, speedily iridescent from tarnish. Streak pale grayish black. Opaque.

**Comp., Var.**—A sulphide of copper and iron, but varying in the proportions of these metals. The crystallized mineral agrees with $Cu_3FeS_3$ = Sulphur 28·1, copper 55·5, iron 16·4 = 100; this may be written $3Cu_2S.Fe_2S_3$ (Groth) or $Cu_2S.CuS.FeS$ (Rg.).

Analyses of massive varieties give from 50 to 70 p. c. of copper and 15 to 6·5 p. c. of iron. The variation is due, in part at least, to mechanical admixture, chiefly of chalcocite; this commonly accepted view has been confirmed by Baumhauer by microscopic examination. Zs. Kr., **10**, 447. 1885.

**Anal.**—1. Plattner, Pogg., **47**, 351, 1839; also other analyses. 2, Chodnev. Pogg., **61**, 395, 1844. 3, Bechi, Am. J. Sc., **14**, 61, 1852. 4, Collier, Dana Min., p. 45, 1868. 5, Ch. Staaf, Öfv. Ak. Stockh., **5**, 66, 1848, deducting 4·09 gangue. 6, Hisinger, Afh. Phys., **4**, 359. 1815. 7–14, quoted by Cleve, G. För. Förh., **2**, 526, 1875. 7, A. Euren. 8, S. R. Paijkull. 9, G. Ekman. 10, F. Svenonius. 11, 12, N. Engström. 13, Hj. Björklund. 14, A. Ekelund. 15, Katzer, Min. Mitth., **9**, 404, 1887. 16, 17, Plattner, l. c.

| *Crystallized.* | | S | Cu | Fe | |
|---|---|---|---|---|---|
| 1. Condurra Mine, Cornwall | | 28·24 | 56·76 | 14·84 | = 99·84 |
| 2. Redruth " | | 26·84 | 57·89 | 14·94 | gangue 0·04 = 99·71 |
| *Massive.* | | | | | |
| 3. Mte. Catini | | 24·93 | 55·88 | 18·03 | = 98·84 |
| 4. Bristol, Ct. | | 25·83 | 61·79 | 11·77 | Ag *tr.* = 99·39 |
| 5. Norberg | | 25·49 | 63·73 | 10·78 | = 100 |
| 6. Vestanfors | | 24·70 | 63·33 | 11·80 | = 98·83 |
| 7. Tunaberg | G. = 5·071 | 25·87 | 62·84 | 11·46 | = 100·17 |
| 8. Nummedal | G. = 4·988 | 25·34 | 62·76 | 11·64 | = 99·74 |
| 9. Dålsland | G. = 5·060 | 25·55 | 62·90 | 11·14 | = 99·59 |
| 10. Svappavaara | G. = 4·99 | 26·08 | 62·40 | 11·77 | = 100·25 |
| 11. Ranavaara | G. = 5·05 | 25·79 | 62·34 | 12·18 | = 100·31 |
| 12. Falun | G. = 4·81 | 26·03 | 61·04 | 12·81 | = 99·88 |
| 13. Ragisvaara | G. = 5·248 | 24·16 | 67·14 | 8·43 | = 99·73 |
| 14. Aardal | G. = 5·425 | 23·37 | 68·75 | 8·60 | = 100·72 |
| 15. Woderad | G. = 4·91 | 23·76 | 59·85 | 15·62 | insol. 1·23 = 100·46 |
| 16. Sangerhausen | | 22·58 | 71·00 | 6·41 | = 99·99 |
| 17. Eisleben | | 22·65 | 69·72 | 7·54 | = 99·91 |

Many analyses of the massive mineral, as urged by Cleve, agree closely with $Cu_5FeS_4$ or $5Cu_2S.Fe_2S_3$ = Sulphur 25·5, copper 63·3, iron 11·2. Other analyses deviate more widely from the above formula, cf. 5th Ed., p. 45.

**Pyr., etc.**—In the closed tube gives a faint sublimate of sulphur. In the open tube yields sulphurous fumes, but no sublimate. B.B. on charcoal fuses in R.F. to a brittle magnetic globule. The roasted mineral gives with the fluxes the reactions of iron and copper, and with soda a metallic globule. Soluble in nitric acid with separation of sulphur.

**Obs.**—Occurs with other copper ores, and is a valuable ore of copper. Crystalline varieties are found in Cornwall, and mostly in the mines of Tincroft and Dolcoath near Redruth, where it is called by the miners "horse-flesh ore." Other foreign localities of massive varieties are at Ross Island, Killarney. in Ireland; at Monte Catini, Tuscany; in cupriferous shale in the Mansfeld district, Germany; in the Ardennes; in Norway, Sweden (see above anal. 5 to 15), Siberia, Silesia, and Hungary. It is the principal copper ore at some Chilian mines, especially those of Tamaya and Sapos; also common in Peru, Bolivia, and Mexico.

At the copper mine in Bristol, Conn., abundant, and often in fine crystallizations. At Cheshire, sparingly in cubes, with barite, malachite, and chalcocite. Massive at Mahoopeny, near Wilkesbarre, Penn., and in other parts of the same State, in cupriferous shale, associated in small quantities with chalcocite; also in granite at Chesterfield, Mass.; in New Jersey. A common ore in Canada, at the Acton and other mines, along a belt of 15–20 m., between L. Memphremagog and Quebec. Howe Inlet, Br. Columbia.

Named after Ignatius von Born, a distinguished mineralogist of the last century (1742–1791). The name phillipsite has a prior use for another species.

**Artif.**—Cf. Doelter, Zs. Kr., **11**, 36, 1885.

CASTILLITE *Rg.*, Zs. G. Ges., **18**, 23, 1866. A massive mineral from Guanasevi, Mexico, resembling bornite in color and tarnish. H. = 3. G. = 5·19–5·24. Analysis, Rg.:

S 25·65  Cu 41·11  Zn 12·09  Pb 10·04  Ag 4·64  Fe 6·49 = 100·02

Rammelsberg writes the formula $(Cu,Ag)^2S.2(Cu,Pb,Zn,Fe)S$, but it can hardly be regarded as other than a mixture, probably an impure bornite.

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**79. LINNÆITE.** Kobolt med Jern och Svafelsyra (fr. Bastnaes) *G. Brandt*, Ak. H. Stockh., 119, 1746. Kobolt med förvswafladt Järn, Cobaltum Ferro Sulphurato mineralisatum, *Cronst.*, 213, 1758. Cobaltum pyriticosum *Linn.*, 1768; *de Born*, Lithoph., **1**, 144, 1772. Mine de Cobalt sulfureuse *de Lisle*, **3**, 134, 1783. Kobalt-Glanz pt. *Wern.*, *Kirwan*, *etc.* Svafelbunden Kobolt *Hisinger*, Afh., **3**, 316, 1810. Kobaltkies *Hausm.*, Handb., 158, 1813. Schwefelkobalt. Sulphuret of Cobalt; Cobalt Pyrites. Cobalt sulfuré *Fr.* Koboldine *Beud.*, Tr., **2**, 417, 1832. Linneit *Haid.*, Handb., 560, 1845. Kobaltnickelkies [not Kobaltkies] *Rg.* Siegenite (fr. Müsen) *Dana*, Min., 687, 1850. Koboltkis *Swed.*

Isometric. Commonly in octahedrons. Twins: tw. pl. octahedral. Also massive, granular to compact.

Cleavage: cubic, imperfect. Fracture uneven to subconchoidal. Brittle. Etching figures similar to those of magnetite[1]. H. = 5·5. G. = 4·8–5. Luster metallic. Color pale steel-gray, tarnishing copper-red. Streak blackish gray.

**Comp., Var.**—A sulphide of cobalt, $Co_3S_4 = CoS.Co_2S_3$ analogous to the spinel group. This requires: Sulphur 42·1, cobalt 57·9 = 100. The cobalt is replaced by nickel and to some extent by iron and copper in very varying proportions.

The niccoliferous variety has been called *siegenite*, Dana, Min., p. 687, 1850. The name *linnæite*, after Linnæus, was given by Haidinger to the Bastnaes mineral.

**Anal.**—1, Wernekinck, Schw. J., **39**, 306, 1823. 2, Schnabel, Rg. Min. Ch., 110, 1860. 3, Ebbinghaus, ib. 4, Rg., J. pr. Ch., **86**, 340, 1862. 5–7, Genth, Am. J. Sc., **23**, 419, 1857. 8, 9, P. T. Cleve, G. För. Förh., **1**, 125, 1872.

| | | S | Co | Ni | Fe | Cu | |
|---|---|---|---|---|---|---|---|
| 1. Müsen | | 41·00 | 43·86 | — | 5·31 | 4·10 | gangue 0·67 = 94·94 |
| 2. " *Sieg.* | G. = 4·8 | 41·98 | 22·09 | 33·64 | 2·29 | — | = 100 |
| 3. " *Sieg.* | G. = 5·0 | 42·30 | 11·00 | 42·64 | 4·69 | — | = 100·63 |
| 4. " | | 43·04 | 40·77 | 14·60 | — | 0·49 | = 98·90 |
| 5. Mineral Hill, *Sieg.* | | 39·70[a] | 25·69 | 29·56 | 1·96 | 2·23 | insol. 0·45 = 99·59 |
| 6. " *Sieg.* | | 41·15 | [50·76] | | 3·20 | 3·63 | insol. 1·26 = 100 |
| 7. Missouri, *Sieg.* | | 41·54 | 21·34 | 30·53 | 3·37 | *tr.* | Pb 0·39, Sb *tr.*, insol. 1·07 [= 98·24 |
| 8. Bastnaes | G. = 4·755 | 41·83 | 44·92 | 0·19 | 4·19 | 8·22 | = 99·35 |
| 9. Gladhammar | G. = 4·825 | 42·19 | 39·33 | 12·33 | 4·29 | 2·28 | = 100·42 |

[a] A portion lost.

Hisinger obtained 14·4 p. c. Cu in the Bastnaes mineral, but it is not certain that it all belonged to the pure linnæite.

**Pyr., etc.**—The variety from Müsen gives, in the closed tube, a sulphur sublimate; in the open tube, sulphurous fumes, with a faint sublimate of arsenic trioxide. B.B. on charcoal gives sulphurous (and arsenical) odors, and fuses to a magnetic globule. The roasted mineral gives with the fluxes reactions for nickel, cobalt, and iron. Soluble in nitric acid, with separation of sulphur.

**Obs.**—In gneiss, with chalcopyrite, at Bastnaes, near Riddarhyttan, Sweden, also at Gladhammar; at Müsen, near Siegen, in Prussia, with barite and siderite; at Siegen (*siegenite*), in octahedrons; at Mine la Motte, in Missouri, mostly massive, sometimes octahedral and cubo-octahedral crystals; and at Mineral Hill, in Maryland, in a vein in chlorite slate, with chalcopyrite, bornite, sphalerite, pyrite, etc.

**Alt.**—Occurs altered to yellow earthy cobalt so-called (*gelb Erdkobalt*), which is a mixture of erythrite and pitticite.

**Ref.**—[1] Becke, Min. Mitth., **7**, 225, 1885.

**80. DAUBREELITE** *J. L. Smith*, Am. J. Sc., **12**, 109, 1876; **16**, 270, 1878.

Massive; somewhat scaly, structure crystalline.

Cleavage in one direction. Brittle. Fracture uneven. G. = 5·01. Luster metallic, brilliant. Color black. Streak black. Not magnetic.

**Comp.**—$FeS.Cr_2S_3$ = Sulphur 44·3, chromium 36·3, iron 19·4 = 100.

**Anal.**—Smith, l. c. $\frac{3}{3}$ S 42·69 Cr 35·91 Fe 20·10 = 98·70

**Pyr.**—B.B. infusible, loses luster and (R.F.) becomes magnetic. With borax reacts for chromium. Not attacked by cold nor by hot hydrochloric acid, but completely dissolved in nitric acid, without the liberation of free sulphur.

**Obs.**—Occurs associated with troilite, on the borders of troilite nodules, or as minute veins running across them, in the meteoric irons from Cohahuila, Mexico. Also identified in the irons of Toluca, Mexico, of Sevier, Tenn., and of Cranbourne, Australia. Named after M. Daubrée, of Paris

The name *schreibersite* was given by Shepard to a supposed chromium sesquisulphide, occurring in the Bishopville meteorite (Am. J. Sc., **2**, 383, 1846). It is not contained in Shepard's list of meteoric minerals (ibid., **43**, 28), published in 1867.

**81. CUBANITE** Weisskupfererz *pt.* Cuban *Breith.*, Pogg., **59**, 325, 1843. Cubanite *Chapman.*

Isometric. Massive.

Cleavage: cubic, and rather more distinct than in ordinary pyrite, Breith. Color between bronze- and brass-yellow. Streak dark reddish bronze, black. H. = 4. G. = 4·026–4·042 Br.; 4·169 Booth.

**Comp.**—$CuFe_2S_4$ = $CuS.Fe_2S_3$ = Sulphur 35·4, copper 23·3, iron 41·3 = 100.

**Anal.**—1, Eastwick, Dana, Min., p. 68, 1854. 2, Magee, ib. 3, Stevens, ib. 4, Scheidhauer, Pogg., **64**, 280, 1845. 5, J. L. Smith, Am. J. Sc., **18**, 381, 1854. 6, 7, 8, Carlin, Brodin, Lindström, G. För. Förh., **1**, 105, 1873.

| | | S | Cu | Fe | $SiO_2$ |
|---|---|---|---|---|---|
| 1. Cuba | | 39·01 | 19·80 | 38·01 | 2·30 = 99·12 |
| 2. " | | 39·35 | 21·05 | 38·80 | 1·90 = 101·10 |
| 3. " | | 39·05 | 20·12 | 38·29 | 2·85 = 100·31 |
| 4. " | | 34·78 | 22·96 | 42·51 | Pb *tr.* = 100·25 |
| 5. " | G. = 4·180 | 39·57 | 18·23 | 37·10 | $SiO_2Fe_2O_3$ 4·23 = 99·13 |
| 6. Tunaberg | G. = 4·03 | 35·86 | 23·32 | 40·04 | = 99·22 |
| 7. " | | 34·77 | 24·68 | 40·26 | = 99·71 |
| 8. Kafveltorp | | 34·62 | 22·69 | 40·71 | Zn 1·11, insol. 0·38 = 99·51 |

**Pyr.**—In the closed tube a sulphur sublimate; in the open tube sulphur dioxide. B.B. on charcoal gives sulphur fumes and fuses to a magnetic globule. The roasted ore reacts for copper and iron with the fluxes; with soda on charcoal gives a globule of metallic iron with copper.

**Obs.**—From Barracanao, Cuba; Tunaberg and Kafveltorp, Sweden.

CHALCOPYRRHOTITE. Chalkopyrrhotin *Blomstrand*, Öfv. Ak. Stockh., **27**, 23, 1870. Massive. Color like that of pyrite with a tinge of brown. H. = 3·5–4. G. = 4·28. Analysis: $\frac{2}{2}$ S 38·16, Fe 48·22, Cu 12·98, residue 0·74 = 100·10, which gives the formula $Fe_4CuS_6$. Occurs at Nya Kopparberg, Sweden, in small imbedded portions with magnetite, sphalerite, calcite, and chondrodite.

A "Weisskupfererz" (cf. p. 96) from Halzbrücke, near Freiberg, gave Frenzel: S 44·83, Fe 40·47, Cu 10·75, Co 2·61 = 98·66. Jb. Min., 785, 1873.

**82. CARROLLITE.** *Faber*, Am. J. Sc., **13**, 418, 1852.

Isometric. Rarely in octahedrons. Massive.

Fracture subconchoidal or uneven. H. = 5·5. G. = 4·85. Luster metallic. Color light steel-gray, with a faint reddish hue.

**Comp.**—A sulphide of copper and cobalt, $CuCo_2S_4$ or $CuS.Co_2S_3$ = Sulphur 41·5, cobalt 38·0, copper 20·5 = 100.

**Anal.**—1–3, Smith and Brush, Am. J. Sc., **16**, 367, 1853. 4, Genth, ib., **23**, 418, 1857.

| | S | Co | Ni | Fe | Cu | As |
|---|---|---|---|---|---|---|
| 1. Patapsco mine | 41·93 | 37·25 | 1·54 | 1·26 | 17·48 | *tr.* = 99·46 |
| 2. " | 40·94 | 38·21 | 1·54 | 1·55 | 17·79 | *tr.* = 100·04 |
| 3. " | 40·99 | 37·65 | 1·54 | 1·40 | 19·18 | *tr.* = 100·76 |
| 4. " | 41·71 | 38·70 | 1·70 | 0·46 | 17·55, | quartz 0·07 = 100·19 |

**Pyr.**—Like siegenite, except that the roasted mineral reacts for copper with the fluxes.

**Obs.**—In Carroll Co., Maryland, at the Patapsco mine, near Finksburg; and also at the Springfield mine, associated and mixed with chalcopyrite and chalcocite.

**83. CHALCOPYRITE.** ? *Χαλκῖτις* (fr. Cyprus) *Aristotle.* ? *Χαλκῖτις*, *Πυρίτης* pt., *Dioscor.*, ? Chalcites pt., Pyrites pt., *Plin.* Pyrites ærosus pt., Pyrites aureo colore, *Germ.* Geelkis o. Kupferkis *Agric.*, 212, Interpr., 467, 1546. Pyrites pt., *Germ.* Kupferkies, *Gesner*, Foss., 1565. Pyrites flavus, Chalcopyrites, *Henckel*, Pyrit., 1725. Gul Kopparmalm. Cuprum sulphure et ferro mineralisatum, Chalcopyrites, *Wall.*, 284, 1747. Cuivre jaune, Pyrite cuivreuse, *Fr. Trl.* Wall., 2, 514, 1753. Copper Pyrites. Pyritous Copper. Chalcopyrite, Beud., 2, 412. 1832. Towanite *B. & M.* Min., 182, 1852.

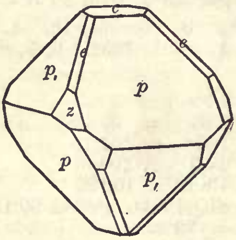
Kupferkies *Germ.* Cuivre pyriteux *Fr.* Kopparkis *Swed.* Kobberkis *Dan.* Calcopirite, Rame giallo, Pirite di rame *Ital.* Cobre amarillo, Bronze amarillo, Bronze de cuivre *Span.* Peacock ore *pt.* (when tarnished).

Tetragonal: sphenoidal. Axis $\dot{c} = 0{\cdot}98525$; $001 \wedge 101 = 44°\ 34\tfrac{1}{2}'$ Haidinger[1].

| | | | | | |
|---|---|---|---|---|---|
| **Forms**[2]: | *g* (203, $\tfrac{2}{3}$-*i*) | *p* (111, 1) | $r_{,}$ (3$\bar{3}$2, − $\tfrac{3}{2}$) | *k* (511, 5·5) | *ω* (576, $\tfrac{7}{6}$-$\tfrac{7}{5}$)[7] ? |
| *c* (001, *O*) | *e* (1-*i*, 101) | *r* (332, $\tfrac{3}{2}$) | $t_{,}$ (2$\bar{2}$1, − 2) | *ξ* (825, $\tfrac{8}{5}$-4)[6] | $v_{,}$ (3$\bar{1}$6, − $\tfrac{1}{2}$-3) |
| *a* (100, *i*-*i*) | *h* (302, $\tfrac{3}{2}$-*i*) | *t* (221, 2) | $u_{,}$ (4$\bar{4}$1, − 4)[3] | *y* (313, 1-3)[3] | $U_{,}$ (4$\bar{2}$3, − $\tfrac{4}{3}$-2)[4] |
| *m* (110, *I*) | *z* (201, 2-*i*) | $d_{,}$ (1$\bar{1}$4, − $\tfrac{1}{4}$) | *l* (20·1·40, $\tfrac{1}{2}$-20)[3] | *i* (6·3·16, $\tfrac{3}{8}$-2)[3] | $q_{,}$ (6$\bar{4}$7, − $\tfrac{6}{7}$-$\tfrac{3}{2}$)[4] |
| *w* (310, *i*-3) | *d* (114, $\tfrac{1}{4}$) | $x_{,}$ (1$\bar{1}$3, − $\tfrac{1}{3}$) | *B* (22·4·5, $\tfrac{22}{5}$-$\tfrac{11}{2}$)[4] | *q* (647, $\tfrac{6}{7}$-$\tfrac{3}{2}$)[4] | $\psi_{,}$ (10·$\bar{8}$·11, − $\tfrac{10}{11}$-$\tfrac{5}{4}$)[4] |
| | *n* (112, $\tfrac{1}{2}$) | $p_{,}$ (1$\bar{1}$1, − 1) | *s* (513, $\tfrac{5}{3}$-5)[3] | *β* (323, 1-$\tfrac{3}{2}$)?[5] | |

Also *φ* (772, $\tfrac{7}{2}$)[7] and *χ* (122, 1-2)[7] doubtful (f. 10), the former probably due to the oscillation of a prism, the latter perhaps of a pyramid of the second order.

1.



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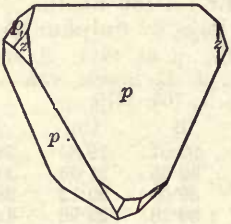

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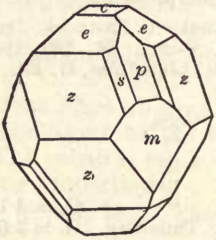

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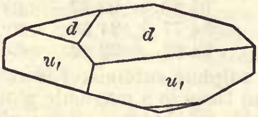

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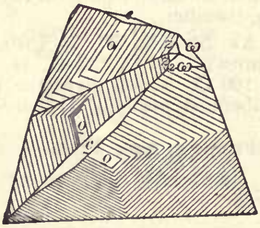

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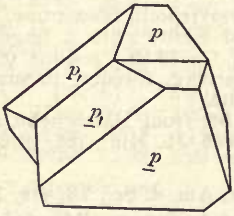

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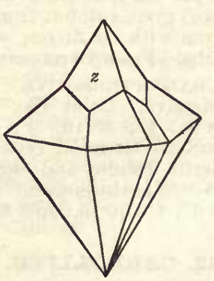


1, Freiberg, Haid. 3, Ramberg, Daaden, Sbk. 4, Ellenville, Id. 5, Cornwall, Fletcher (*o* = *p*, *ω* = $p_{,}$). 7, Neudorf, Sbk.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *gg′* | = 45° 41′ | $dd_{,}$ | = 26° 54′ | $x_{,}x_{,}'$ | = 49° 49½′ | *at* | = 48° 16½′ |
| *ee′* | = 59° 30½′ | $pp_{,}$ | = 70° 7½′ | $u_{,}u_{,}'$ | = 159° 39′ | *ak* | = 15° 54′ |
| *hh′* | = 71° 42′ | $rr_{,}$ | = 79° 16′ | | | *as* | = 32° 39½′ |
| *zz′* | = 78° 11′ | $tt_{,}$ | = 83° 27′ | *cs* | = 59° 9′ | *ay* | = 46° 53½′ |
| | | | | *ck* | = 78° 44½′ | *av* | = 64° 4½′ |
| *gg″* | = 66° 36′ | *dd′* | = 38° 25′ | *cy* | = 46° 5′ | | |
| *ee″* | = 89° 9′ | *nn′* | = 69° 44′ | $cv_{,}$ | = 27° 26½′ | *kk′* | = 65° 55′ |
| *hh″* | = 111° 50′ | *pp′* | = *108° 40′ | | | *ss′* | = 56° 53′ |
| *zz″* | = 126° 11′ | *rr′* | = 128° 52′ | *an* | = 66° 9½′ | *yy′* | = 37° 35′ |
| | | *tt′* | = 140° 31′ | *ap* | = 54° 56′ | $v_{,}v_{,}'$ | = 23° 47′ |
| | | | | *ar* | = 50° 22′ | | |

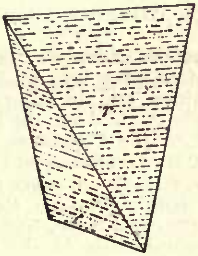
Twins[8]: (1) tw. pl. *p* (111), comp.-face usually *p*, f. 6, and f. 15 a penetration-twin, also $\perp$ *p*; sometimes repeated as a fiveling, f. 7. (2) Tw. pl. and comp.-face *e*, f. 5, often in repeated twins. (3) Tw. pl. *m*, tw. axis *c*, complementary penetration-twins. Rarely by twinning (f. 13) pseudo-rhombohedral in symmetry.

Crystals commonly tetrahedral in aspect, the sphenoidal faces *p* large, dull in luster or oxidized, and diagonally striated; while *p*, are small, brilliant, not oxidized, not striated; scalenohedral faces often prominent and often striated ‖ intersection with *p*. Sphenoidal and other faces also striated as in figs 8–15 Often massive, compact.

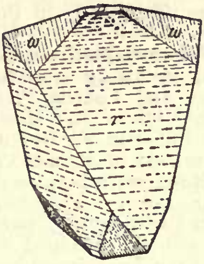
Cleavage: *z*, sometimes distinct; *c*, indistinct. Fracture uneven. Brittle. H. = 3·5–4. G. = 4·1–4·3. Luster metallic. Color brass-yellow; often tarnished or iridescent. Streak greenish black. Opaque.

**Comp.**—A sulphide of copper and iron, $CuFeS_2$ or $Cu_2S.Fe_2S_3$ = Sulphur 35·0, copper 34·5, iron 30·5 = 100. Analyses often show variation from this formula due in most cases certainly to mechanical admixture of pyrite.

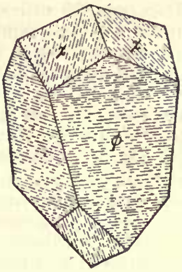
8.



9.



10.



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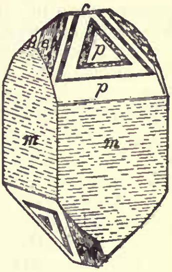

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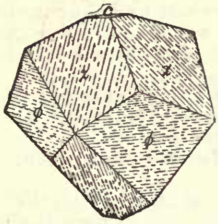
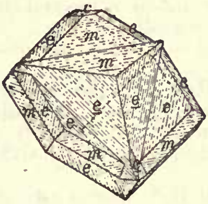
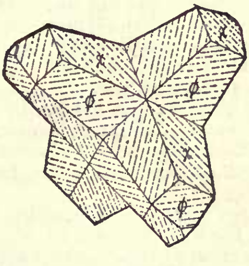


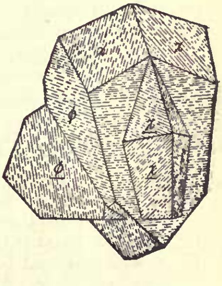
13.



14.



15.



Figs. 8–15, French Creek, Penn., Penfield.

Sometimes auriferous and argentiferous (*Gualda* Span. S. A.). Traces of selenium have been noticed by Kersten in an ore from Reinsberg near Freiberg; and that from Rammelsberg near Goslar must contain the same, it being one of the furnace products (Rg., Min. Ch., 120, 1860). Thallium is also present in some kinds, and more frequently present in this ore than in pyrite.

**Pyr., etc.**—In the closed tube decrepitates, and gives a sulphur sublimate, in the open tube sulphurous fumes. On charcoal fuses to a magnetic globule; with soda the roasted mineral gives a globule of copper containing iron. The roasted mineral reacts for copper and iron with the fluxes. Dissolves in nitric acid, excepting the sulphur, and forms a green solution; ammonia in excess changes the green color to a deep blue, and precipitates red ferric hydroxide.

**Obs.**—A widely disseminated mineral in metallic veins and nests in gneiss and crystalline schists, also in serpentine rocks; often intimately associated with pyrite, also with siderite, tetrahedrite, etc., sometimes with nickel and cobalt sulphides, pyrrhotite, etc. Observed coated with tetrahedrite crystals in parallel position, also as a coating over the latter.

Chalcopyrite is the principal ore of copper at the Cornwall mines; it is there associated with cassiterite, galena, bornite, chalcocite, tetrahedrite, sphalerite. The copper beds of Falun in Sweden are composed principally of this ore, which occurs in large masses surrounded by a coating of serpentine, and embedded in gneiss. At Rammelsberg, near Goslar in the Harz, it forms a bed in argillaceous schist, and is associated with pyrite, galena, sphalerite, and minute portions of silver and gold; associated with nickel and cobalt ores in the Kupferschiefer of Mansfeld. The Kurprinz mine at Freiberg affords well-defined crystals; also Horhausen, Dillenburg, Neudorf, Müsen; Schlackenwald in Bohemia. It occurs also in the Banat, Hungary, and Thuringia; in Scotland in Kirkcudbrightshire, Perthshire and elsewhere; at Mte. Catini in Tuscany: at New South Wales; in South Australia. Extensively worked in Namaqualand, S. Africa; in fine crystals at Cerro Blanco, near Copiapo, Chili, and elsewhere in large deposits.

In *Maine*, at the Lubec lead mines; at Dexter. In *N. Hamp.*, at Franconia, in gneiss; at Unity, on the estate of Jas. Neal; Warren, on Davis's farm; at Eaton, 2 m. N.E. of Atkins's tavern; Lyme, E. of E. Village; Haverhill, etc. In *Vermont*, at Stafford, Corinth, Waterbury. Shrewsbury. In *Mass.*, at the Southampton lead mines; at Turner's falls on the Connecticut, near Deerfield, and at Hatfield and Sterling. In *Connecticut*, at Bristol and Middletown, sometimes in crystals. In *New York*, at the Ancram lead mine; five miles from Rossie, beyond De Long's mills at the Rossie lead mines, in crystals; in crystals and massive near Wurtzboro', Sullivan Co.; very large crystals (f. 4) and massive at Ellenville, Ulster Co. In *Pennsylvania*, at Phenixville; at the French Creek mines, Chester Co., with pyrite, magnetite, byssolite, calcite, etc., sometimes in large skeleton sphenoidal crystals formed by parallel grouping; also in small isolated crystals embedded in chlorite (figs. 8–15). In *Maryland*, in the Catoctin Mts.; between Newmarket and Taneytown; near Finksbury, Carroll Co., abundant (Patapsco and other mines), with bornite, carrollite, and malachite. In *Virginia*, at the Phenix copper mines, Fauquier Co., and the Walton gold mine, Louisa Co. In *N. Carolina*, near Greensboro', abundant massive (Fenress or North Carolina, and Macculloch mines), along with siderite in a quartz gangue. In *Tennessee*, 30 miles from Cleveland, in Polk Co. (Hiwassee mines). In *Missouri*, with sphalerite at Joplin, Jasper Co.

In *Cal.*, in different mines along a belt between Mariposa Co. and Del Norte Co., on west side of, and parallel to, the chief gold belt; occurring massive in Calaveras Co., at Union, Keystone, Empire, Napoleon, Campo Seco, and Lancha Plana mines, and in crystals on Domingo Creek; in Mariposa Co., at the La Victoire and Haskell claims, and on the Chowchillas river; in Amador Co., at the Newton mine; in El Dorado Co., at the Cosumnes, Hope Valley, Bunker Hill, El Dorado, Excelsior mines; in Plumas Co., at the Genesee and Cosmopolitan mines. Abundant in *Montana*, near Butte, with bornite, pyrite, etc., also at other points, and often argentiferous and auriferous. In *Colorado* abundant in Gilpin, Boulder, Chaffee, Gunnison Counties, etc.; commonly associated with pyrite, tetrahedrite, sphalerite, and often highly argentiferous; well crystallized and sometimes coated with tetrahedrite in the mines near Central City. Also mined in Arizona, Utah, but in most cases chiefly for silver and gold. Grant Co., New Mexico.

In *Canada*, in Perth and near Sherbrooke and at many points in the eastern part of the province of Quebec; in the Nipissing distr., Ontario, at various points; extensively mined at Sudbury; at the Bruce mines, on Lake Huron; at Point-au-Mines and elsewhere on Lake Superior.

**Alt.**—Changes on exposure with moisture, especially if heated, to a sulphate. Malachite, covellite, chrysocolla, melaconite, chalcocite, and iron oxide are other forms into which it is sometimes altered; also to tetrahedrite.

Named from *χαλκός*, *brass*, and *pyrites*, by Henckel, who observes in his Pyritology (1725) that chalcopyrite is a good distinctive name for the ore. Aristotle calls the copper ore of Cyprus *chalcitis;* and Dioscorides uses the same word; but what ore was intended is doubtful. There is no question that copper-pyrites was included by Greek and Latin authors under the name *pyrites* (q.v., p. 86).

**Artif.**—Obtained in crystals by the action of $H_2S$ upon a mixture of $2CuO,Fe_2O_3$ slightly heated in a glass tube, Doelter, Zs. Kr., **13**, 35, 1885. Has been observed as a furnace-product. Occurs as a recent formation at Bourbonne-les-Bains (Daubrée).

**Ref.**—[1] Mem. Wern. Soc., **4**, 1, 1822, also Ed. J. Sc., **3**, 66, 1825. Haidinger first correctly determined the system to which the crystals belong, gave accurate measurements (confirmed by Sbk., and Kk., Min. Russl., **6**, 277), and described the three twinning laws.

[2] Mlr. Min., p. 182, 1852; Sbk., monograph, Zs. G. Ges., **20**, 595, 1868. [3] Sbk., l. c. [4] Schimper, Min.-Samml. Strassburg, 53, 1878. [5] Rath, Anxbach, Ber. nied. Ges., Jan. 9, 1882. [6] Mayer, Holzheim, Zs Kr., **13**, 47, 1887. [7] Pfd., Am. J. Sc., **40**, 207, 1890. [8] Cf. Fletcher, Phil. Mag., **14**, 276, 1882; Zs. Kr., **7**, 321, 1882.

**BARNHARDTITE** *Genth*, Am. J. Sc., **19**, 17, 1855; **28**, 247, 1859. Compact massive. Fracture conchoidal, uneven. Brittle. H. = 3·5. G. = 4·521. Luster metallic. Color bronze-yellow. Streak grayish black, slightly shining. Tarnishes easily, giving pavonine tints, or becoming pinchbeck-brown.

**Anal.**—1, W. J. Taylor, Am. J. Sc., **19**, 18, 1855. 2, F. A. Genth, ibid. 3, P. Keyser, ibid. 4, Higgins, ibid., **45**, 319, 1868.

| | S | Fe | Cu | |
|---|---|---|---|---|
| 1. Barnhardt's Land | 29·40 | 22·23 | 47·61 | Ag *tr.* = 99·24 |
| 2. Pioneer Mills | 29·76 | 22·41 | 46·69 | = 98·86 |
| 3. " " | 30·50 | 21·08 | 48·40 | = 99·98 |
| 4. Bill Williams' Fork | 28·96 | 20·44 | 50·41 | = 99·81 |

Occurs in N. Carolina with other copper ores, on Dan Barnhardt's land, Pioneer Mills, Phenix mine, and Vanderburg mine, in Cabarrus Co.; also near Charlotte, Mecklenburg Co.;

at Bill Williams' Fork, in California, with chalcopyrite, etc. It may be a chalcopyrite, partly altered to chalcocite, as would be inferred from Genth's later observations.

HOMICHLIN *Breithaupt*, B. H. Ztg., **17**, 385, 424, 1858; **18**, 65, 321, 1859. Closely related to the preceding, and may be chalcopyrite partly altered to bornite. Occurs in tetragonal octahedral crystals, but mostly massive; H. = 4–5; G. = 4·472–4·480; color more bronze-like than in chalcopyrite; streak black. Analysis by Richter, ibid., **18**, 321:

S 30·21 Fe 25·81 Cu 43·76 = 99·78

Occurs with malachite and other copper ores at Plauen in Voigtland; also said to occur, by Breithaupt, in Bavaria, Hesse and Nassau, Silesia, the Harz, at Rheinbreitbach on the Rhine, in Algeria, in Chili at Remolinos and Tocopilla, and in Japan.

DUCKTOWNITE *Shepard*. A blackish copper ore from Ducktown, Tenn. G. J. Brush has shown that it is not homogeneous, and only a mixture, grains of pyrite being visible through the mass, and also a softer gray mineral, which is probably chalcocite. See Rep. on Mt. Pisgah Copper Mine, N. Haven, 1859, and Am. J. Sc., **28**, 129, 1859.

**84. STANNITE.** Geschwefeltes Zinn (fr. Cornwall) *Klapr.*, Schriften Nat. Fr. Berlin, **7**, 169, 1787, Beitr., **2**, 257, 1797, **5**, 228, 1810. Zinnkies *Wern.*, Bergm. J., 1789. 385, 397. Tin Pyrites *Kirw.*, **2**, 300, 1796. Bell Metal Ore. Etain sulfuré *Fr.* Stannine *Beud.*, Tr., **2**, 416, 1832.

Massive, granular, and disseminated[1].

Cleavage: cubic, indistinct. Fracture uneven. Brittle. H. = 4. G. = 4·3–4·522; 4·506, Zinnwald, Rg. Luster metallic. Streak blackish. Color steel-gray to iron-black, the former when pure; sometimes a bluish tarnish; often yellowish from the presence of chalcopyrite. Opaque.

**Comp.**—A sulphide of tin, copper, iron and sometimes zinc, perhaps $Cu_2S.FeS.SnS_2$ = Sulphur 29·9, tin 27·5, copper 29·5, iron 13·1 = 100.

**Anal.**—1, Kudernatsch, Pogg., **39**, 146, 1836. 2, Mallet, Am. J. Sc., **17**, 33, 1854. 3, Rg., Pogg., **88**, 607, 1853. 4*a*, Adger, Ch. News, **25**, 259, 1872. 4*b*, deducting insol. Also Klaproth, 1810; Johnson, 1839; see 5th Ed., p. 68.

| | | | S | Sn | Cu | Fe | Zn | |
|---|---|---|---|---|---|---|---|---|
| 1. | Wheal Rock | | 29·64 | 25·55 | 29·39 | 12·44 | 1·77 | gangue 1·02 = 99·81 |
| 2. | St. Michael's Mt. | G. = 4·522 | 29·46 | 26·85 | 29·18 | 6·73 | 7·26 | gangue 0·16 = 99·64 |
| 3. | Zinnwald | | 29·05 | 25·65 | 29·38 | 6·24 | 9·68 | = 100 |
| 4*a*. | Cornwall | G. = 4·46 | 27·94 | 22·04 | 27·77 | 12·75 | 3·62 | insol. 6·39 = 100·51 |
| 4*b*. | " | | 29·68 | 23·42 | 29·50 | 13·55 | 3·85 | = 100 |

**Pyr., etc.**—In the closed tube decrepitates, and gives a faint sublimate; in the open tube sulphurous fumes. B.B. on charcoal fuses to a globule, which in O.F. gives off sulphur, and coats the coal with tin dioxide; the roasted mineral treated with borax gives reactions for iron and copper.

Decomposed by nitric acid, affording a blue solution, with separation of sulphur and tin dioxide.

**Obs.**—Formerly found at Wheal Rock, Cornwall, and at Carn Brea, where it constituted a considerable vein, and was accompanied by pyrite, sphalerite, and other minerals; more recently in considerable quantity in granite at St. Michael's Mount; also at Stenna Gwynn, St. Stevens, and at Wheal Primrose, Wheal Scorrier, and occasionally at Botallack mine, St. Just; also at the Cronebane mine, Co. Wicklow, in Ireland; Zinnwald, in the Erzgebirge, with sphalerite and galena. It frequently has the appearance of bronze or bell metal, and hence the name *bell-metal ore*.

**Ref.**—[1] Usually accepted as tetrahedral upon the authority of Breithaupt; this, however, is stated by Weisbach (priv. contrib.) to be a mistake, the observations having been made upon a specimen of tetrahedrite from South America, not upon stannite.

## D. Disulphides, Diarsenides, etc.

### 1. Pyrite Group. $RS_2,RAs_2,RSb_2$. Isometric, pyritohedral.

85. **Pyrite** $FeS_2$
86. **Hauerite** $MnS_2$
87. **Smaltite** $CoAs_2$
88. **Chloanthite** $NiAs_2$

Species 87, 88 are united by many intermediate compounds, $(Co,Ni)As_2$ and $(Ni,Co)As_2$

89. **Cobaltite** $CoS_2.CoAs_2$
90. **Gersdorffite** $NiS_2.NiAs_2$
91. **Corynite** $NiS_2.Ni(As,Sb)_2$
92. **Ullmannite** $NiS_2.NiSb_2$

Also in part, tetrahedral.

93. **Sperrylite** $PtAs_2$
94. **Laurite** $RuS_2$?

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95. **Skutterudite** $CoAs_3$ Isometric, pyritohedral.

**85. PYRITE.** Σπῖνος *Theophr.* Πυριτης pt. *Dioscor.*, E. **143**. Pyrites pt. *Plin.*, **36** 30. Pyrites pt., *Arab.* Marchasita, *Germ.* Kis, *Agric.*, 334, 431, 467, 1529, 1546. Pyrites pt., Marchasita (= cryst. Pyr.) *Henckel*, Pyrit., 1725. Kies pt., Svafelkies pt., Pyrites pt. (= mass and nodular Pyr.), Marchasita (= cryst. Pyr.), *Wall.*, 208, 211, 1747. Pyrites pt. (= glob. var., etc.); Marcasite (= cryst. Pyr.), Mundic (= massive var.) *Hill*, Foss., 324–332, 1771. Xanthopyrites *Glock.*, Handb., 314. 1839.

Schwefelkies, Eisenkies, *Germ.* Svafvelkis *Swed.* Svovlkis *Dan.* Iron Pyrites. Bisulphuret of iron. Fer sulfuré *Fr.* Pirite *Ital.* Pirita, Pirita amarilla, Bronce *Span.* and *Span.*, *S. A.*

Isometric; pyritohedral. Observed forms[1]:

$a$ (100, $i$-$i$)
$d$ (110, $i$)
$o$ (111, 1)

$b$ (910, $i$-9)[4]
$c$ (710, $i$-7)?
$\delta$ (610, $i$-6)[7, 11]
$\alpha$ (920, $i$-$\frac{9}{2}$)
$h$ (410, $i$-4)
$\gamma$ (720, $i$-$\frac{7}{2}$)
$\epsilon$ (10·3·0, $i$-$\frac{10}{3}$)
$f$ (310, $i$-3)
$\zeta$ (11·4·0, $i$-$\frac{11}{4}$)
$k$ (520, $i$-$\frac{5}{2}$)
$\eta$ (940, $i$-$\frac{9}{4}$)
$e$ (210, $i$-2)
$\varDelta$ (12·7·0, $i$-$\frac{12}{7}$)
$l$ (530, $i$-$\frac{5}{3}$)

$g$ (320, $i$-$\frac{3}{2}$)
$\varGamma$ (750, $i$-$\frac{7}{5}$)?
$\Xi$ (19·14·0, $i$-$\frac{19}{14}$)[8]
$\vartheta$ (430, $i$-$\frac{4}{3}$)
$D$ (540, $i$-$\frac{5}{4}$)
$\lambda$ (11·9·0, $i$-$\frac{11}{9}$)
$\nu$ (650, $i$-$\frac{6}{5}$)

$\varLambda_,$ (10·11·0, $-i$-$\frac{11}{10}$)[6]?
$\xi_,$ (890, $-i$-$\frac{9}{8}$)[6]?
$\pi_,$ (780, $-i$-$\frac{8}{7}$)
$\rho_,$ (13·15·0, $-i$-$\frac{15}{13}$)[6]?
$\sigma_,$ (670, $-i$-$\frac{7}{6}$)
$\nu_,$ (560, $-i$-$\frac{6}{5}$)
$\kappa_,$ (450, $-i$-$\frac{5}{4}$)
$\vartheta_,$ (340, $-i$-$\frac{4}{3}$)
$g_,$ (230, $-i$-$\frac{3}{2}$)
$U_,$ (470, $-i$-$\frac{7}{4}$)[9]

$e_,$ (120, $-i$-2)[12]
$k_,$ (250, $-i$-$\frac{5}{2}$)
$h_,$ (140, $-i$-4)[13]
$B_,$ (180, $-i$-8)[3]

$r$ (332, $\frac{3}{2}$)
$\tau$ (885, $\frac{8}{5}$)[5]
$p$ (221, 2)
$q$ (331, 3)
$\varTheta$ (661, 6)[8]

$\phi$ (911, 9-9)
$E$ (511, 5-5)[10]
$\mu$ (411, 4-4)
$m$ (311, 3-3)
$\omega$ (522, $\frac{5}{2}$-$\frac{5}{2}$)
$\psi$ (944, $\frac{9}{4}$-$\frac{9}{4}$)
$\varPhi$ (11·5·5, $\frac{11}{5}$-$\frac{11}{5}$)
$n$ (211, 2-2)

$\beta$ (322, $\frac{3}{2}$-$\frac{3}{2}$)[3]
$\chi$ (433, $\frac{4}{3}$-$\frac{4}{3}$)[2, 3]
$\varPi$ (655, $\frac{6}{5}$-$\frac{6}{5}$)[2]?

$x$ (721, 7-$\frac{7}{2}$)[4]
$F$ (621, 6-3)[10]
$y$ (932, $\frac{9}{2}$-3)
$z$ (16·6·3, $\frac{16}{3}$-$\frac{8}{3}$)
$\varOmega$ (15·6·5, 3-$\frac{5}{2}$)[4]
$\varPsi$ (942, $\frac{9}{2}$-$\frac{9}{4}$)[4]
$X$ (11·5·2, $\frac{11}{2}$-$\frac{11}{5}$)
$v$ (12·6·5, $\frac{12}{5}$-2)?
$u$ (632, 3-2)
$t$ (421, 4-2)
$w$ (841, 8-2)
$T$ (10·5·1, 10-2)
$S$ (12·6·1, 12-2)[4]
$R$ (742, $\frac{7}{2}$-$\frac{7}{4}$)[3]

$Q$ (13·7·3, $\frac{13}{3}$-$\frac{13}{7}$)[3]
$\Sigma$ (532, $\frac{5}{2}$-$\frac{5}{3}$)[3]
$Z$ (531, 5-$\frac{5}{3}$)
$Y$ (10·6·1, 10-$\frac{5}{3}$)
$W$ (851, 8-$\frac{8}{5}$)
$V$ (22·14·7, $\frac{22}{7}$-$\frac{11}{7}$)[4]
$s$ (321, 3-$\frac{3}{2}$)
$P$ (13·9·6, $\frac{13}{6}$-$\frac{13}{9}$)[3]
$N$ (751, 7-$\frac{7}{5}$)[4]
$M$ (432, 2-$\frac{4}{3}$)
$L$ (10·8·7, $\frac{10}{7}$-$\frac{5}{4}$)
$K$ (14·11·10, $\frac{14}{10}$-$\frac{14}{11}$)[4]

$G_,$ (453, $-\frac{5}{3}$-$\frac{5}{4}$)
$M_,$ (342, $-2$-$\frac{4}{3}$)
$H_,$ (341, $-4$-$\frac{4}{3}$)
$s_,$ (231, $-3$-$\frac{3}{2}$)
$t_,$ (241, $-4$-2)

Twins: tw. ax *a*, usually penetration-twins (f. 11) with parallel axes; rarely contact-twins. Cube and the pyritohedron *e* (210) most common forms, the faces of both often striated in one direction ‖ edge *a*/*e*, the striation due to oscillatory combination of these forms and tending to produce rounded faces (f. 5); pyritohedral faces also striated ⊥ to this edge; octahedron also common. Crystals sometimes acicular by elongation in direction of a cubic axis; also abnormally developed with tetragonal or orthorhombic symmetry (f. 7, 8).[14] Also frequently massive, fine granular; sometimes subfibrous radiated; reniform, globular, stalactitic.

Cleavage: *a*, *o* indistinct. Fracture conchoidal to uneven. Brittle. H. = 6–6·5.

G. = 4·95–5·10; 4·967 Traversella, 5·027 Elba, Rg. Luster metallic, splendent to glistening. Color a pale brass-yellow, nearly uniform. Streak greenish black or brownish black. Opaque. Shows both + and − varieties thermo-electrically[15]. Paramagnetic.

**Comp., Var.**—Iron disulphide, $FeS_2$ = Sulphur 53·4, iron 46·6 = 100.

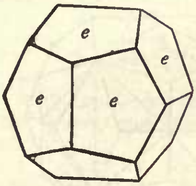
Nickel, cobalt, and thallium, and also copper in very small quantities, sometimes replace part of the iron, or else occur as mixtures. Gold is sometimes present, distributed invisibly through it, auriferous pyrite being an important source of gold. Thallium occurs in traces in much pyrite, showing its presence often in the chimneys of furnaces where pyrite, or ores containing it, are roasted. A variety from near Ribadeo in Galicia, from which tin and zinc were obtained, has been called *ballesterosite*, after Lopez Ballesteros, Schulz and Paillette, Bull. G. Fr. **7**, 16, 1849. Pyrite sometimes contains traces of selenium.

Arsenic is rarely present, a variety in octahedral crystals from French Creek, Penn., gave Hamburger (cf. Genth, Am. J. Sc., **40**, 114, 1890):

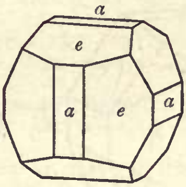
S 54·08 As 0·20 Fe 44·24 Co 1·75 Ni 0·18 Cu 0·05 = 100·50

For analyses of pyrite, see Mène, C. R., **64**, 867, 1867, also Girard and Morin, Ann. Ch. Phys., **7**, 229, 1876.

1.



2.



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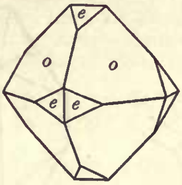

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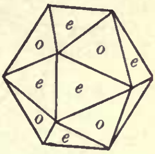

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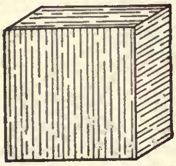

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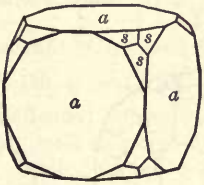

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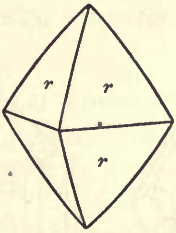

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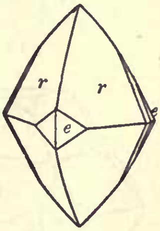


Figs. 1–6, Simple forms. 7, 8, French Creek, Pfd.[14]

**Pyr., etc.**—In the closed tube a sublimate of sulphur and a magnetic residue. B.B. on charcoal gives off sulphur, burning with a blue flame, leaving a residue which reacts like pyrrhotite. Insoluble in hydrochloric, but decomposed by nitric acid.

**Obs.**—Pyrite occurs abundantly in rocks of all ages, from the oldest crystalline to the most recent alluvial deposits. It usually occurs in small cubes, pyritohedrons, or in more highly modified forms; also in irregular spheroidal nodules and in veins, in clay slate, argillaceous sandstones, the coal formation, etc.

Crystals have been observed associated in parallel position with those of marcasite, also with arsenopyrite.

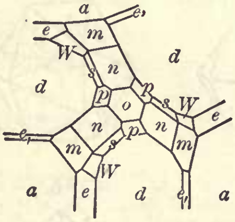
Cubes of gigantic dimensions have been found in some of the Cornish mines; pyritohedrons and other forms in great variety occur with hematite on the island of Elba, sometimes five to six inches in diameter; also with magnetite at Traversella in Piedmont, and at Brosso in fine crystals. Other localities for crystals are Müsen near Siegen; Freiberg, Saxony; Schneeberg; Waldenstein in Carinthia; Příbram, Bohemia; Schemnitz, Hungary; large octahedral crystals are found at Persberg in Sweden. Magnificent crystals come from Peru. Alston-Moor, Derbyshire, Falun and Långban in Sweden, Kongsberg in Norway, are well-known localities The clay at Vlotho near Minden, Westphalia, and the chalk at Lewes in Surrey, have afforded some remarkable compound crystals. It has also been met with in the Vesuvian lavas.

In *Maine*, at Corinna, Peru, Waterville, and Farmington, in crystals; at Bingham (sawmills), Brooksville, and Jewell's Id., massive. In *N. Hampshire*, at Unity, massive. In *Mass.*, at Heath, in cryst.; at Rowe, Hawley and Hubbardston, massive. In *Vermont*, at Shoreham, in limestone, crystals abundant; Hartford, in cubes 2–4 in. In *Conn.*, at Lane's mine, Monroe, in octahedrons; Orange and Milford, in cubes in chlorite slate; Middletown lead mine, sometimes acicular; Roxbury, finely crystallized; at Stafford, in mica slate; massive at Colchester, Ashford, Tolland, Stafford, and Union. In *N. York*, at Rossie, fine crystals (dodecahedral, f. 14) occur at the lead mine in green shale; at Schoharie, a mile west of the court-house, in single and compound crystals, often highly polished and abundant; in interesting crystals at Johnsburgh and Chester, Warren Co.; in gneiss near Yonkers; in Orange Co., at Warwick and Deerpark; in Jefferson Co., in Champion and near Oxbow on the banks of Vrooman's lake, in modified octahedrons; massive in Franklin, Putnam, and Orange Cos., etc. In *Pennsylvania*, in crystals at Little Britain, Lancaster Co.; at Chester, Delaware Co.; in Carbon and York Cos.; at Knauertown, Chester Co.; at French Creek mines, octahedrons and other forms, sometimes tetragonal or orthorhombic in symmetry. In Cornwall, Lebanon Co., in lustrous cubo-octahedrons. with a steel tarnish; in *N. Car.*, near Greensboro', Guilford Co., in crystals. In *Colorado* in fine complex crystals in mines near Central City, Gilpin Co., and elsewhere. Auriferous pyrite is common at the mines of Colorado, and many of those of California, as well as in Virginia and the States south.

In *Canada*, 2 miles N. W. of Brockville, Ontario, a cobaltiferous var., in the Laurentian; on the river Assumption, seignory of Daillebout, and at Escott, a niccoliferous var., containing also some cobalt.

Large quantities of massive pyrite are mined at the Rio Tinto and other mines in Spain, also in Portugal. Among important deposits in the U. S. are those at Rowe, Mass.; Herman, St. Lawrence Co., and Ellenville, Ulster Co., N. Y.; Tolersville, Louisa Co., Va.; Dallas, Paulding Co., Ga.

9.



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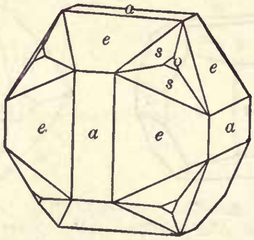

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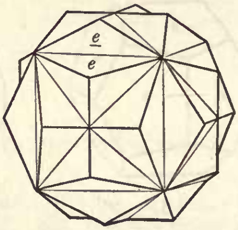

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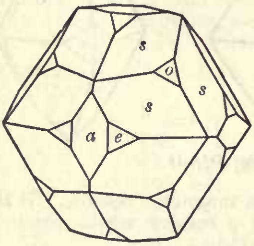

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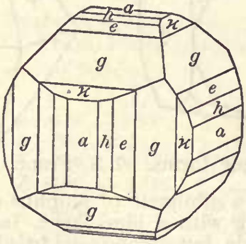

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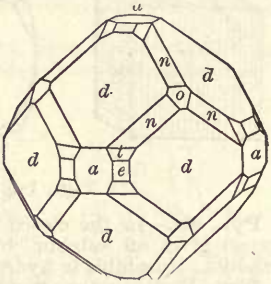


), 13, Gilpin Co., Col , Ayres. 10, Elba. 11, Vlotho. Westphalia, Sbk. 12. Elba, Svr. 14, Rossie.

The name *pyrite* is derived from πῦρ, *fire*, and alludes to the sparks from friction. Pliny nentions several things as included under the name (36, 30): (1) a stone used for grindstones; (2) a kind which so readily fires punk or sulphur that he distinguishes it as *pyrites vivus*, and which may have been flint or a related variety of quartz, as has been supposed, but more probably was *emery*, since he describes it as the heaviest of all; (3) a kind resembling brass or copper; (4) a porous stone, perhaps a sandstone or buhrstone. The brassy kind was in all probability our pyrite. But with it were confounded copper pyrites (chalcopyrite), besides marcasite and pyrrhotite, although these three kinds of pyrites fail of the scintillations. In fact, Dioscorides calls pyrite an ore of copper, yet in the next sentence admits that some kinds contain no copper; and, moreover, he states that the mineral gives sparks. This confounding of iron and copper pyrites is apparent also in the descriptions of the vitriols (sulphates of iron and copper) by Pliny and other ancient writers, and equally so in the mineralogy of the world for more than fifteen centuries after Pliny, as is even now apparent in the principal languages of Europe; *Kupferwasser* (copper-water) of the Germans being the copperas of the English and couperose of the French. It is quite probable that *copperas* and *couperose* are in fact corruptions of the German word, instead of derivatives from *cuprosa* or *cuprirosa*, as usually stated, for the Latin *u* would not have become *ou* in French.

Under the name *marcasite* or *marchasite*, of Spanish or Arabic origin, the older mineralogists Henckel, Wallerius, Linnæus, etc., included distinctively crystallized pyrite, the cubic preëminently; the nodular and other varieties being called *pyrites*, and the less yellow or brownish and softer kinds, *wasserkies*, this last including our *marcasite* and *pyrrhotite*, and some *true pyrite*. Werner first made *pyrrhotite* a distinct species. The "marcasite" used for personal ornaments in the last century was pyrite.

**Alt.**—Pyrite readily changes to an iron sulphate by oxidation, some sulphur being set free. Also to limonite on its surface, and afterward throughout, by the action of a solution of bicarbonate of lime carrying off the sulphuric acid as change proceeds, and from limonite to red iron oxide. Green vitriol, limonite, göthite, hematite, quartz, graphite, ochreous clay, occur as pseudomorphs after pyrite. Cf. also marcasite on the relative stability of the two compounds.

**Artif.**—May be made by the slow reduction of ferric sulphate in presence of some carbonate. Also by heating together iron sesquioxide, sulphur, and sal ammoniac (Wöhler), the crystals obtained seemed to have a *tetrahedral* form; cf. Weinschenk, Zs. Kr., **17**, 487, 1890. See further Fouqué-Lévy, Synth. Min., 321, 1882, and Doelter, Zs. Kr., **11**, 30, 1885.

Pyrite has been observed as a recent formation at Bourbonne-les-Bains, Daubrée, C. R., **80**, 605, 1875.

**Ref.**—[1] See Strüver, Mem. Acc. Torino, **26**, 1869, and Att. Acc. Torino, **6**, 374, 1871, for list of planes with early authorities, and many new forms; also Helmhacker, Min. Mitth., 13, 1876. Koksharov adds (962) from A. Nordenskiöld, whose 3-$\frac{2}{3}$ is, however, an obvious misprint for 3-$\frac{3}{2}$.

[2] Zeph., Lölling, Ber. Ak. Wien, **60** (1), 814, 1869. [3] Hkr., Waldenstein, l. c. [4] Groth, Min.-Samml., 31, 1878. [5] Zeph., Böckstein, Salzburg, Lotos, 1878. [6] Websky, Zs. G. Ges., **31**, 222, 1879; these forms are uncertain. [7] Vrba, Přibram, Zs. Kr., **4**, 357, 1880. [8] Brugnatelli, Brosso, Piedmont, Att. Acc. Torino, **20**, 808, 1885. [9] Jackson, Calaveras Co., Cal., Cal. Acad., No. 4, p. 365, 1886. [10] Flink, Långban, Ak. H. Stockh., Bih., **13**, (2), No. 7, 5, 1888. [11] Hoefer, Rötzgraben, Styria, Min. Mitth., **10**, 157, 1888. [12] E. F. Ayres, Colorado, Am. J. Sc., **37**, 236, 1889. [13] Cathrein, Monzoni, Min. Mitth., **10**, 395, 1889. [14] Pfd., French Creek, Am. J. Sc. **37**, 209, 1889.

[15] Thermo-electrical character, *Friedel*, Ann. Ch. Phys., **17**, 79, 1868; *Rose*, Pogg., **142**, 1, 1871; *Schrauf* and *Dana*, Ber. Ak. Wien, **69** (1), 145, 157, 1874; Curie, Bull. Soc. Min., **8**, 127, 1885.

On elasticity, Voigt, Nachr. Ges. Göttingen, 310, 1888. On etching experiments see Becke, Min. Mitth., **8**, 239, 1886, **9**, 2, 1887.

**86. HAUERITE.** Hauerit *Haid.*, Nat. Abh. Wien, **1**, 101, 107, 1846, or Pogg., **70**, 148, 1847.

Isometric; pyritohedral. Observed forms:

*a* (100, *i-i*) *d* (110, *i*) *o* (111, 1) *f* (310, *i*-3) *e* (210 *i*-2) *s* (321, 3-$\frac{3}{2}$)

Commonly in octahedrons; sometimes in globular clusters.

Cleavage: cubic, imperfect. Fracture uneven to subconchoidal. Brittle. H. = 4. G. = 3·463. Luster metallic-adamantine. Color reddish brown, brownish black. Streak brownish red.

**Comp.**—Manganese disulphide, $MnS_2$ = Sulphur 53·9, manganese 46·1 = 100.

**Anal.**—1, Patera, quoted by Haid. 2, E. Scacchi, Rend. Accad. Napoli, April 1890.

| | | S | Mn | Fe | |
|---|---|---|---|---|---|
| 1. Kalinka | | 53·64 | 42·97 | 1·30 | $SiO_2$ 1·20 = 99·11 |
| 2. Sicily | G. = 3·366–3·411 | 53·76 | 46·05 | — | = 99·81 |

**Pyr.**—In the closed tube a sublimate of sulphur; in the open tube sulphurous fumes, and becomes green. On charcoal sulphurous fumes; the roasted mineral reacts for manganese with the fluxes.

**Obs.**—From Kalinka, Hungary, in clay with gypsum, sulphur, and realgar in a region like a solfatara: trachytic, and other eruptive rocks decomposing and adding to the clay, and the sulphur given off at the same time making depositions of sulphur and sulphides. One crystal found measured 1¼ inches through. The hauerite crystals are sometimes coated with pyrite; an unknown flesh-red or greenish mineral also accompanies it. Also in the crystalline schists of the Wakalipu district, New Zealand (Cox, Trans. N. Z. Inst., **14**, 426, 1881). At Raddusa, Catania, Sicily, in octahedral crystals at a depth of 50 meters embedded in a clay carrying layers of sulphur, gypsum and calcite.

**Artif.**—Synthetic experiments partially successful, Doelter, Zs. Kr., **11**, 32, 1885.

**87, 88. SMALTITE-CHLOANTHITE.**

**Smaltite.** ?Cobaltum cineraceum *Agric.*, 459, 1529. Koboltmalm, Koboltglants, Minera Cobalti cinerea, Cobaltum arsenico mineralisatum, pt. (Cobaltite here included), *Wall.*, 231, 1747. ?Cobaltum Ferro et Arsenico mineralisatum, Glants-Cobalt (fr. Schneeberg), *Cronst.*, 212, 1758. Mine de Cobalt grise *De Lisle*, Crist., 333, 1772; Mine de Cobalt arsenicale *De Lisle*, **3**, 123, 1783. Weisser Speisskobold, Grauer Speisskobold, *Wern.* Gray Cobalt ore *Kirw.*, 1796. Tin-white cobalt. Speiskobalt *Hausm.*, Handb., 155, 1813. Smaltine *Beud.*, *Tr.*, **2**, 584, 1852.

**Chloanthite** *Breith.*, Pogg., **64**, 184, 1845. Weissnickelkies, Weissnickelerz pt. Weisser Kupfernickel, Arsenikuickel, *Rg.* Rammelsbergit *Haid.*, Handb., 560, 1845. Chathamite *Shepard*, Min., 158, 1844; Am. J. Sc., **47**, 351, 1844.

Isometric; pyritohedral, Groth[1]. Observed forms[1]:

*a* (100, *i-i*); *d* (110, *i*); *o* (111, 1); *n* (211, 2-2); ϵ (10·1·0, *i*-10), δ (510, *i*-5), *f* (310, *i*-3); *x* (831, 8-$\frac{8}{3}$)?

Penetration-twins[2]: tw. pl. *o*, comp.-face 211, normal to *o*; often in complex and distorted forms. Also massive, and in reticulated and other imitative shapes.

Cleavage: *o* distinct; *a* in traces. Fracture granular and uneven. Brittle. H. = 5·5–6. G. = 6·4 to 6·6. Luster metallic. Color tin-white, inclining, when massive, to steel-gray, sometimes iridescent, or grayish from tarnish. Streak grayish black. Opaque. Shows both + and − varieties thermo-electrically.

**Comp.**—SMALTITE is essentially cobalt diarsenide, $CoAs_2$ = Arsenic 71·8, cobalt 28·2 = 100. CHLOANTHITE is nickel diarsenide, $NiAs_2$ = Arsenic 71·9, nickel 28·1 = 100.

Cobalt and nickel are usually both present, and thus these two species graduate into each other, and no sharp line can be drawn between them. Iron is also present in varying amount; the variety of chloanthite containing much iron has been called *chathamite*, a name given by Shepard to the mineral from Chatham, Conn. Further sulphur is usually present, but only in small quantities. Sometimes argentiferous, anal. 20.

Many analyses do not conform even approximately to the formula $RAs_2$, the ratio rising from less than 1 : 2 to 1 : 2·5 and nearly 1 : 3, thus showing a tendency toward skutterudite ($RAs_3$), perhaps due to either molecular or mechanical mixture. Part of the variation is due to want of homogeneity in the substances analyzed. Baumhauer has shown that even the crystals often have a zonal structure, Zs. Kr., **12**, 18, 1886. Moreover, Volkhardt has analyzed such crystals, and shown that, after being acted upon by hydrochloric acid and potassium chlorate, a part containing less arsenic went into solution, and the residue was richer in arsenic than the original (76·19 p. c. and 73·46 in one case). Similarly the same author found skutterudite ($RAs_3$) to be more difficultly soluble than smaltite and chloanthite. Zs. Kr., **14**, 407, 1888.

Much that has been called smaltite (speiskobalt) is shown by the high specific gravity to belong to the species safflorite, p. 100. Without the determination of either the form or specific gravity the classification is uncertain.

**Anal.**—1, McCay, Inaug. Diss., p. 44, 1883, deducting 10·62 p. c. quartz and 1·44 Bi. 2, Id., ib., p. 31, see below. 3. Petersen, Pogg., **134**, 70, 1868. 4, van Gerichten, Ber. Ak. München, 137, 1873. 5, Rg., Zs. G. Ges., **25**, 284, 1873. 6, Smith, Gillis Exped., **2**, 102. 7, Iles, Am. J. Sc., **23**, 380, 1882.

8, Booth, Am. J. Sc., **29**, 241, 1836. 9, Rg., Min. Ch., 23, 1860. 10, 11, Bull, Rose, Kr.-Ch. Syst., 52, 1852. 12, 13, McCay, l. c., pp. 39, 40. 14, Berthier, Ann. Mines, **11**, 504, 1837. 15, Rg., J. pr. Ch., **55**, 486, 1852. 16, Id., Zs. G. Ges., **25**, 283, 1873. 17, Koenig, Proc. Ac. Philad., 184, 1889. 18, Genth, Dana Min., 512, 1854. 19, Kbl., Ber. Ak. München, 402, 1868. 20, Hillebrand, Proc. Col. Sc. Soc., **3**, 46, 1888. See further 5th Ed., pp. 70, 71.

| | G. | As | S | Co | Ni | Fe | Cu | |
|---|---|---|---|---|---|---|---|---|
| 1. *Smaltite.* | | | | | | | | |
| 1. Schneeberg | 6·11 | 71·53 | 1·38 | 18·07 | 1·02 | 7·31 | 0·01 | = 99·32 |
| 2. " *Cheleutite* | 6·30 | $\frac{2}{2}$ 76·00 | 1·32 | 12·61 | 3·05 | 5·22 | 1·60 | = 99·80 |
| 3. Wittichen | 6·272 | 69·70 | 4·71 | 10·11 | 8·52 | 5·05 | 0·94 | Bi 0·97, Sb *tr.* = 100·00 |
| 4. Bieber | | 74·84 | 1·70 | 8·28 | 8·50 | 4·45 | 3·24 | = 101·01 |
| 5. Usseglio | 6·498 | 76 55 | 0·75 | 7·31 | 4·37 | 7·84 | 0·22 | Sb 0·32, Zn 4·11 |
| 6. Atacama | | 70·85 | 0·08 | 24·13 | 1·23 | 4·05 | 0·41 | = 100·75 [= 101·47 |
| 7. Gunnison Co., Col. | | 63·82 | 1·55 | 11·59 | *tr.* | 15·99 | 0·16 | Pb 2·05, Bi 1·13, |
| | | | | | | | | $SiO_2$ 2·60, Ag *tr.* = 98·89 |
| 2. *Chloanthite.* | | | | | | | | |
| 8. Riechelsdorf | 6·6 | 72·64 | — | 3·37 | 20·74 | 3·25 | — | = 100 |
| 9. " | 6·374 | 60·42 | 2·11 | 10·80 | 25·87 | 0·80 | — | = 100 |
| 10. " | | 76·09 | — | 4·56 | 12·25 | 6·82 | — | = 99·72 |
| 11. Schneeberg, *Stängelkobalt* | 6·537 | 75·85 | — | 3·32 | 12·04 | 6·52 | 0·94 | = 98.67 |
| 12. " " | 6·54 | 75·40 | 0·73 | 3·42 | 11·90 | 7·50 | 0·39 | = 99·34 |
| 13. " | 6·45 | 68·40 | 1·06 | 4·20 | 24·95 | 0 69 | — | Bi 0·21 = 99·51 |
| 14. Val d'Anniviers | | [65·02] | 2·90 | 3·93 | 26·75 | 1·40 | — | = 100 |
| 15. Allemont | 6·411 | 71·11 | 2·29 | *tr.* | 18·71 | 6 82 | — | = 98 93 |
| 16. Annaberg | | [76·38] | 0·11 | 1·60 | 18·96 | 2·30 | — | Sb 0·31, Bi 0·34 = 100 |
| 17. Franklin Furnace | 6·83 | 70·66 | 1·54 | 6·37 | 18·63 | 2·31 | — | Zn *tr.*, $CaCO_3$ 0·89 |
| 18. Chatham, *Chathamite* | | 70·11 | 4·78 | 3·82 | 9·44 | 11·85 | — | = 100 [= 100·40 |
| 19. Andreasberg | 6·6 | 72·00 | 0·43 | 1·94 | 7·00 | 17·39 | — | = 98·76 |
| 20. Grant Co., N. M. | 6·644 | 74·04 | 0 13 | 19·52[a] | | 0·44 | 0·04 | Ag 4·78, Pb 0·03 = 98·98 |

[a] Ni : Co = 3 : 1 approx.

Analysis 2 by McCay is of the Schneeberg ore called *Wismuthkobalterz* by Kersten (Schw. J., **47**, 265, 1826), and from which he obtained: ($\frac{4}{4}$) As 77·96, S 1·02, Co 9·89, Ni 1·11, Fe 4·77, Cu 1·30, Bi 3·89 = 99·94. Breithaupt called it cheleutite (cf. McCay, p. 25). It is isometric, with cubic habit and cleavage; H. = 5; color slate-gray. McCay shows that the bismuth, of which he obtained 0·78 p. c., is an impurity; the ratio of R : As = 1 : 2·80, which with the cubic cleavage shows it to be closely allied to skutterudite.

**Pyr., etc.**—In the closed tube gives a sublimate of metallic arsenic; in the open tube a white sublimate of arsenic trioxide, and sometimes traces of sulphur dioxide. B.B. on charcoal gives an arsenical odor, and fuses to a globule, which, treated with successive portions of borax-glass, affords reactions for iron, cobalt, and nickel.

**Obs.**—Usually occurs in veins, accompanying ores of cobalt or nickel, and ores of silver and copper; also, in some instances, with niccolite and arsenopyrite; often having a coating of annabergite.

Occurs with silver and copper at Freiberg, Annaberg, and particularly Schneeberg in Saxony; at Joachimsthal in Bohemia, the reticulated varieties frequently found embedded in calcite; also at Wheal Sparnon in Cornwall; at Riechelsdorf in Hesse, in veins in the copper schist; at Tunaberg in Sweden; Allemont in Dauphiné; at the silver mines of Tres Puntas and others in Chili, but only in small quantities.

At Chatham, Conn., the chloanthite (*chathamite*) occurs in mica slate, associated generally with arsenopyrite and sometimes with niccolite. At Franklin Furnace, N. J., at the Trotter zinc mine in octahedral crystals (anal. 17) with traces of a pyritohedron (20·1·0)?.

**Alt.**—Occurs altered to erythrite (arsenate of cobalt), a change due to the oxidation of the arsenic and cobalt on exposure to moisture.

**Ref.**—[1] Groth, Pogg., **152**, 249, 1874; Min.-Samml. Strassburg, p. 43, 1878; Naumann, Pogg., **7**, 337, 1826, **31**, 537, 1834. [2] Rath, Zs. Kr., **1**, 8, 1877; cf. Groth, Min.-Samml., p. 44.

**89. COBALTITE.** Cobaltum cum ferro sulfurato et arsenicato mineralisatum, Glants-Kobolt pt. (fr. Tunaberg), *Cronst.*, 213, 1758. Mine de Cobalt blanche *de Lisle*, Crist, 334, 1772. Mine de Cobalt arsenico-sulfureuse *de Lisle*, Crist., **3**, 129, 1783. Glanz-Kobold *Wern.* Kobalt-Glanz *Germ.* Cobalt gris pt. *H.* Glance Cobalt; Bright-White Cobalt. Glanzkobaltkies *Glock.*, Grundr., 1831. Cobaltine *Beud.*, Tr. **2**, 450, 1832. Koboltglans *Swed.* Sehta *Indian jewelers.*

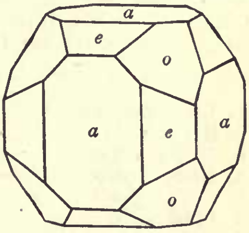
Isometric; pyritohedral. Observed forms[1]:

*a* (100, *i-i*) *o* (111, 1) *e* (210, *i*-2) *ω* (522, $\frac{5}{2}$-$\frac{5}{2}$) *s* (321, 3-$\frac{3}{2}$)
*d* (110, *i*) *h* (410, *i*-4) *p* (221, 2) *χ* (433, $\frac{4}{3}$-$\frac{4}{3}$) *y* (432, 2-$\frac{4}{3}$)

Commonly in cubes, *a*, or pyritohedrons, *e*, or combinations of these, with faces striated as in pyrite (cf. f. 1–5, p. 85); also with *o*. Also lamellar, granular massive to compact.

Cleavage: cubic, rather perfect. Fracture uneven. Brittle. H. = 5·5. G. = 6–6·3. Luster metallic. Color silver-white, inclined to red; also steel-gray, with a violet tinge, or grayish black when containing much iron. Streak grayish black. Shows both + and – varieties thermo-electrically.[2]

**Comp.**—Sulph-arsenide of cobalt, CoAsS or $CoS_2.CoAs_2$ = Sulphur 19·3, arsenic 45·2, cobalt 35·5 = 100.



India, Mallet.

Iron is present, and in the variety *ferrocobaltite* in large amount; this is the so-called *Stahlkobalt*, Rg. 4th Suppl., 116, 5th, 148, 1853; ferrocobaltine, Dana Min., 58, 1854.

**Anal.**—1, Stromeyer, Schw. J., **19**, 336, 1817. 2–5, Schnabel, Rg. Min. Ch., 60, 1860. 6, McCay, Inaug. Diss, p. 41. 7, Flink, Ak. H. Stockh., Bihang **12** (2), No. 2, 5, 1886. 8, Mallet. Rec. G. Surv. India, **14**, 190, 1880.

| | | As | S | Co | Fe |
|---|---|---|---|---|---|
| 1. Skutterud | G. = 6·231 | 43·46 | 20 08 | 33·10 | 3·23 = 99·87 |
| 2. Siegen, *massive* | | 45·31 | 19·35 | 33·71 | 1·63 = 100 |
| 3. " " | | 44·75 | 19·10 | 29·77 | 6·38 = 100 |
| 4. " *plumose* | | 42·53 | 19·98 | 8·67 | 25·98 Sb 2·84 = 100 |
| 5. " " | | 42·94 | 20 86 | 8·92 | 28·03 = 100·75 |
| 6. Schladming | G. = 5·722 | 43·12 | 18·73 | 29·20 | 5·30 Ni 3·20 = 99·55 |
| 7. Nordmark | | 44·77 | 20·23 | 29·17 | 4·72 Ni 1·68 = 100·57 |
| 8. Khetri, India | G. = 6·00 | 43·87 | 19·46 | 28·30 | 7·83 Ni, Sb. *tr.* gangue 0·80 = 100·26 |

The mineral analyzed by McCay had H. = 5, and gave in the closed tube a distinct sublimate of arsenic sulphide and metallic arsenic, like arsenopyrite.

**Pyr., etc.**—Unaltered in the closed tube. In the open tube gives sulphurous fumes, and a crystalline sublimate of arsenic trioxide. B.B. on charcoal gives off sulphur and arsenic, and fuses to a magnetic globule; with borax a cobalt-blue color. Soluble in warm nitric acid, with the separation of sulphur.

**Obs.**—Occurs at Tunaberg, Riddarhyttan, and Hakansbö, in Sweden, in large, splendent, well-defined crystals; at the Ko and Bjelke mines of Nordmark; also at Skutterud in Norway. Other localities are at Querbach in Silesia; Schladming, Styria; Siegen in Westphalia (from the Hamberg mine the *ferrocobaltite*); Botallack mine, near St. Just, in Cornwall; Khetri mines, Rajputana, India, called *sehta* by the Indian jewelers, who use it for giving a blue color to gold ornaments, cf. p. 71.

**Ref.**—[1] See Phillips, Min. 278, 1823, also Naumann, Pogg., **16**, 486, 1829, Groth, Min.-Samml., 41. 1878; Zs. G. Ges., **23**, 661, 1871. [2] Cf. references under pyrite, p. 87.

**90. GERSDORFFITE.** Niccolum Ferro et Cobalto Arsenicatis et Sulphuratis mineralisatum, Kupfernickel, pt. (*white*, var. fr. Loos), *Cronst.*, 218, 1758, Ak. H. Stockh., 1751, 1754. [The species later taken for Kupfernickel and Cobalt ore, until 1818.] Nickelglanz, Weisses Nickelerz, *Pfaff*, Schw. J., **22**, 260, 1818; *Berz.*, Ak. H. Stockh., 251, 1820. Sulfo-arséniure de nickel *Beud.*, 1824. Nickelarsenikglanz, Nickelarsenikkies, Arseniknickelglanz, *Germ.* Nickel Glance. Disomose *Beud.*, Tr., **2**, 448, 1832. Tombazite pt. *Breith.*, J. pr. Ch., **15**, 330, 1838. Gersdorffit (fr. Schladming) pt. *Löwe*, Pogg., **55**, 503, 1842. Amoibit pt. *Kbl.*, J. pr. Ch., **33**, 402, 1844. Dobschauite (fr. Dobschau).

Isometric; pyritohedral. Observed forms:

*a* (100, *i-i*) *o* (111, 1) *e* (210, *i*-2)

Also lamellar and granular massive.

Cleavage: cubic, rather perfect. Fracture uneven. Brittle. H. = 5·5. G. = 5·6–6·2. Luster metallic. Color silver-white to steel-gray, often tarnished gray or grayish black. Streak grayish black. Opaque.

**Comp.**—Essentially a sulph-arsenide of nickel, NiAsS or $NiS_2.NiAs_2$ = Sulphur 19·3, arsenic 45·3, nickel 35·4 = 100. Iron replaces the nickel, often to considerable amount; also sometimes cobalt.

With normal gersdorffite are classed a number of minerals, in part doubtless mixtures, which have yielded different results, many of them approximating toward chloanthite. The analyses below include some of these; see further 5th Ed., p. 73. Anal. 9 corresponds to $NiS_2.2NiAs_2$, the mineral had cubic cleavage.

**Anal.**—1, Berzelius, l. c. 2, Rg , Pogg., **68**, 511, 1846. 3, Schnabel, Rg., Min. Ch., 62, 1860. 4, Id., Vh. Ver. Rheinl., **8**, 307, 1851. 5, Bergemann, J. pr. Ch., **75**, 244, 1858. 6, Heidingsfeld, Rg., Min. Ch., 62, 1860. 7, 9, Sipöcz, Zs. Kr., **11**, 213, 214, 1885. 8, Genth, Am. Ch. J., **1**, 324, 1879. 10, Löwe, Pogg., **55**, 505, 1842. 11, 12, Pless, Lieb. Ann., **51**, 250, 1844. 13, Kobell, l. c. 14, 15, Forbes, Phil. Mag., **35**, 181, 1868.

| | G | As | S | Ni | Fe | Co | |
|---|---|---|---|---|---|---|---|
| 1. Loos, Sweden | 6·13 | 45·37 | 19·34 | 29·94 | 4·11 | 0·92[a] | $SiO_2$ 0·90 = 100·58 |
| 2. Harzgerode | 5·65 | 44·01 | 18·83 | 30·30 | 6·00 | — | Sb 0·86 = 100 |
| 3. Müsen, *cryst.* | | 46·02 | 18·94 | 32·66 | 2·38 | — | = 100 |
| 4. Ems, *massive* | | 38·92 | 17·82 | 35·27 | 4·97 | 2·23 | Cu 2·75 = 101·96 |
| 5. " *cryst.* | | 45·02 | 19·04 | 34·18 | 1·02 | 0·27 | Sb 0·61 = 100·14 |
| 6. Lobenstein | 5·954 | 46·12 | 18·96 | 33·04 | 1·81 | 0·60 | Cu 0·11, Sb 0·33 = **100·97** |
| 7. Orawitza | 6·20 | 44·35 | 18·20 | 29·22 | 0·99 | 6·75 | Bi 0·11 = 99·62 |
| 8. Benahanis | 5·856 | 39·71 | 22·01 | 24·83 | 1·12 | 12·54 | Cu 0·25 = 100·46 |
| 9. Dobsina | 6·514 | 56·83 | 10·93 | 29·54 | 1·75 | 2·14 | = 101·19 |
| 10. Schladming | 6·7–6·9 | ⅔ 42·52 | 14·22 | 38·42 | 2·09 | *tr.* | $SiO_2$ 1·87 = 99·12 |
| 11. " | 6·64 | 39·04 | 16·35 | 19·59 | 11·13 | 14·12 | = 100·23 |
| 12. " *Plessite* | | 39·88 | 16·11 | 27·90 | 14·97 | 0·83 | = 99·69 |
| | | [39·40] | 16·91 | 28·62 | 12·19 | 2·88 | = 100 |
| 13. Lichtenberg, *Amoibite* | 6·08 | [45·34] | 14·00 | 37·34 | 2·50 | *tr.* | Pb 0·82 = 100 |
| 14. Loch Fyne | 5·49–5·65 | 34·45 | 20·01 | 21·59 | 13·12 | 6·32 | Mn 0·33, Mg 0·66, insol. [2·71 = **99·19** |
| 15. " " | | 35·84 | 19·75 | 23·16 | 11·02 | 6·64 | Mn 0·33, Mg 0·66, insol. [2·60 = **100** |

**Pyr., etc.**—In the closed tube decrepitates, and gives a yellowish brown sublimate of arsenic trisulphide. In the open tube yields sulphurous fumes, and a white sublimate of arsenic trioxide. B.B. on charcoal gives sulphurous and garlic fumes and fuses to a globule, which, with borax-glass gives at first an iron reaction, and, by treatment with fresh portions of the flux, cobalt and nickel are successively oxidized.

Decomposed by warm nitric acid, forming a green solution, with the separation of sulphur.

**Obs.**—Occurs at Loos in Helsingland, Sweden; Lempälä, Finland; in the Albertine mine, near Harzgerode in the Harz, with chalcopyrite, galena, calcite, fluorite, and quartz; at

Schladming in Styria; Kamsdorf in Lower Thuringia; Haueisen, near Lobenstein, Voigtland; at the quicksilver mine and at Pfingstwiese, near Ems. At the Craigmuir mine, Loch Fyne, Scotland. Also found as an incrustation of cubes, on decomposed galena and sphalerite, at Phenixville, Pa.

Sommarugaite is stated to be an auriferous gersdorffite from Rezbanya, Hungary. Bull. Soc. Min., **1**, 143, 1878.

Tombazite, according to Zerrenner, is pyrite, from Lobenstein.

**91. CORYNITE.** Korynit *v. Zepharovich,* Ber. Ak. Wien, **51** (1), 117, 1865. Arsenantimonnickelglanz pt. *Germ.*

Isometric. In octahedrons, with convex faces. Also in globular groups.

Fracture uneven. H. = 4·5–5. G. = 5·994; 5·95–6·029 Zeph. Luster metallic. Color silver-white, inclined to steel-gray on fresh fracture. Streak black. Opaque.

**Comp.**—Essentially a sulph-arsenide of nickel like gersdorffite, but with antimony replacing part of the arsenic, and thus connecting it with the arsenical varieties of ullmannite; formula $Ni(As,Sb)S$.

**Anal.**—Payer, l. c.:

| | As | Sb | S | Ni | Fe |
|---|---|---|---|---|---|
| G. = 5·994 | 37·83 | 13·45 | 17·19 | 28·86 | 1·98 = 99·31 |

**Pyr., etc.**—In the open tube affords sulphurous fumes and a crystalline white sublimate of arsenic trioxide. In the closed tube also finally a narrow yellowish-red and a broader yellow zone. B.B. on charcoal fuses easily at surface, yielding sulphurous and arsenical fumes. With borax-glass reactions for iron, cobalt, and finally nickel, with an arsenical odor.

**Obs.**—From Olsa, in Carinthia, with bournonite; crystals about 2½ mm. through.

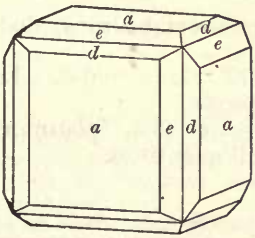
Named from *κορύνη, a club.*

**92. ULLMANNITE.** Nickelspiesglaserz (fr. Siegen) *Ullmann* (his discov. in 1803), Syst.-Tab., 166, 379, 1814. Nickelspiessglanzerz *Hausm.*, Handb., 192, 1813. Antimonnickelglanz, Nickelantimonglanz, Antimon-Arseniknickelglanz, Arsenantimonnickelglanz pt. *Germ.* Nickel Stibine; Nickeliferous Gray Antimony. Antimoine sulfuré nickelifère *H.*, 1822. Ullmannit *Fröbel*, 1843.

Isometric: pyritohedral,[1] Klein; tetrahedral, Zeph.[2] Observed forms:

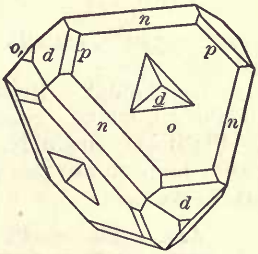
*a* (100, *i-i*), *d* (110, *i*), *o* (111, 1), *e* (210, *i*-2), *p* (221, 2), *q* (331, 3), *ξ* (881, 8), *n* (211, 2-2).

1.



Sarrabus, Klein

2.



Lölling. Zeph.

In crystals from Sarrabus[1] with *a, d, e* and rarely *q* with pyritohedral striations on *a* (f. 1). Also from the Lölling[2] in tetrahedral crystals with *d, o, o,, n, n,, p, ξ*; also in tetrahedrite-like twins with parallel axes (f. 2). These two varieties have the same composition (anal. 4, 5) and their relation is somewhat uncertain, cf. Klein[3]. It may be noted that artificial crystals of pyrite, of apparent tetrahedral form, have been described.

Also massive, structure granular.

Cleavage: cubic, perfect. Fracture uneven. Brittle. H. = 5–5·5. G. = 6·2–6·7. Luster metallic. Color steel-gray inclining to silver-white. Streak grayish black.

**Comp.**—Sulph-antimonide of nickel, $NiSbS$ or $NiS_2.NiSb_2$ = Sulphur 15·2, antimony 57·0, nickel 27·8 = 100. Arsenic is usually present in small amount.

**Anal.**—1, H. Rose, Pogg., **15**, 588, 1829. 2, Rg., Pogg., **64**, 189, 1845. 3, Lill, Vh. G. Reichs., 131, 1871. 4, 5, Jannasch, Jb. Min., **2**, 169, 1887; also earlier, ibid., **1**, 186, 1883. 6, Gintl, Ber. Ak. Wien, **60** (1), 812, 1869. 7, Behrendt, Rg., Min. Ch., 41, 1875. 8, Ullik Ber. Ak. Wien, **61** (1), 17, 1870; also other analyses on less pure material.

| | | Sb | As | S | Ni | |
|---|---|---|---|---|---|---|
| 1. Siegen | | 55·76 | — | 15·98 | 27·36 | = 99·10 |
| 2. Harzgerode | G. = 6·506 | 50·84 | 2·65 | 17·38 | 29·43 | Fe 1·83 = 102·13 |
| 3. Rinkenberg | G. = 6·63 | 56·07 | 0·94 | 15·28 | 27·50 | Co *tr.* = 99·79 |
| 4. Sarrabus, *pyrit.* | G. = 6·733 | 55·73 | 0·75 | 14·64 | 28·17 | Co *tr.*, Fe 0·17, insol. 0·11 = 99·57 |
| 5. Lölling, *tetrahed.* | G. = 6·625 | 55·71 | 1·38 | 14·69 | 28·13 | Co 0·25, Fe 0·09, insol. 0·27 = 100·52 |
| 6. " " | G. = 6·74 | 52·56 | 3·23 | 15·73 | 28·48 | = 100 |
| 7. Nassau | | 50·56 | 5·08 | 16·00 | 26·05 | Co 1·06, Fe 0·43, Cu 0·40 = 99·58 |
| 8. Waldenstein | G. = 6·53–6·56 | 56·01 | — | 14·81 | 28·85 | Pb 0·61 = 100·28 |

An alteration-product of the Waldenstein crystals gave Ullik (l. c., p. 19). after deducting impurities. Sb 52·44, O 16·15, CaO 13·52, NiO 3·27, FeO 3·13, MgO 0·21, $H_2O$ 11·26 = 99·98. For this the formula $3CaO.2Sb_2O_5.6H_2O$ is calculated.

**Pyr., etc.**—In the closed tube gives a faint white sublimate. In the open tube sulphurous and antimonial fumes, the latter condensing on the walls of the tube as a white non-volatile sublimate. B.B. on charcoal fuses to a globule, boils, and emits antimonial vapors, which coat the coal white; treated with borax-glass, reacts like gersdorffite. Some varieties contain arsenic.

Decomposed by nitric acid, forming a green solution, with separation of sulphur and antimony trioxide.

**Obs.**—Occurs in the Duchy of Nassau, in the mines of Freusburg, with galena and chalcopyrite; in Siegen, Prussia; at Harzgerode and Lobenstein; also Lölling and Waldenstein in Carinthia; Montenarba, Sarrabus, Sardinia. Named after J. C. Ullmann (1771–1821).

**Ref.**—[1] Klein, Jb. Min., **1**, 180, 1883. [2] Zeph., Ber. Ak. Wien, **60** (1), 809, 1869. [3] Klein, Jb. Min., **2**, 169, 1887. See p. 1051. *Kallilite*, p. 1039, is NiBiS.

Rammelsberg calls an ore from Wolfsberg in the Harz *bournonit-nickelglanz.* It occurs in cubes; H. = 4·5. G. = 5·635–5·706. Analysis, Pogg., **77**, 254, 1849:

As 28·00 Sb 19·53 S 16·86 Ni 27·04 Co 1·60 Pb 5·13 Cu 1·33 Fe 0·51 = 100

Heusler describes a massive light to dark steel-gray ore from Gosenbach near Siegen. Analysis gave: Sb 32·90, As 5·27, S 34·40, Ni 27·43, Pb,Zn *tr.* = 100.

This corresponds to $3\ NiS.\left.\begin{matrix}\frac{1}{5}\,As\\ \frac{4}{5}\,Sb\end{matrix}\right\}S_3$. Ber. nied. Ges., p. 67, 1887.

### 93. SPERRYLITE. *Horace L. Wells*, Am. J. Sc., **37**, 67, 1889; S. L. Penfield, ib., p. 71.

Isometric; pyritohedral. Observed forms:

*a* (100, *i-i*) *d* (110, *i*) *o* (111, 1) *e* (210, *i*-2)

In minute crystals, usually in cubes, or cubo-octahedrons; dodecahedral and pyritohedral faces rare.

Fracture conchoidal. Brittle. H. = 6–7. G. = 10·602. Luster metallic, brilliant. Color tin-white. Streak black. Opaque.

**Comp.**—Platinum arsenide, $PtAs_2$ = Arsenic 43·5, platinum 56·5 = 100. Antimony and rhodium are also present in small quantities.

**Anal.**—H. L. Wells:

| | As | Sb | Pt | Rh | Pd | Fe | |
|---|---|---|---|---|---|---|---|
| $\frac{2}{2}$ | 40·98 | 0·50 | 52·57 | 0·72 | *tr.* | 0·07 | $SnO_2$ 4·62 = 99·46 |

**Pyr.**—B.B. decrepitates slightly. In the closed tube remains unchanged at the fusing point of glass. In the open tube gives readily a sublimate of arsenic trioxide and does not fuse if slowly roasted, but if rapidly heated it melts very easily after losing a part of the arsenic. When dropped on a red-hot platinum foil, instantly melts, gives off white fumes of arsenic trioxide having little or no odor, and porous excrescences are formed on the platinum which do not differ in color from the untouched foil.

**Obs.**—Found at the gold quartz Vermillion mine, district of Algoma, 22 miles west of Sudbury, Ontario, Canada; occurs with pyrite, chalcopyrite, and cassiterite as a loose material occupying small pockets in the decomposed ore. Also probably present in small amount disseminated through a nickel-iron sulphide, cf. p. 66.

Named after F. L. Sperry of Sudbury, Ontario, who first called attention to the mineral.

**Artif.**—The artificial $PtAs_2$ has long been known.

**94. LAURITE.** *F. Wöhler* Nachr. Ges. Göttingen, 155, 1866; 327, 1869.

Isometric. Observed forms:

*a* (100, *i-i*) *o* (111, 1) *e* (210, *i*-2) *m* (311, 3-3) *n* (211, 2-2)? *s* (321, 3-$\frac{3}{2}$)?

Commonly in minute octahedrons; faces often rounded like the diamond; also in spherical forms and grains.

Cleavage: *o* distinct. Fracture subconchoidal. Very brittle. H. = 7·5. G. = 6·99. Luster metallic, bright. Color dark iron-black; powder dark gray.

**Comp.**—Sulphide of ruthenium and osmium, probably essentially $RuS_2$ (cf. below).

**Anal.**—Wöhler, l. c., on 0·3 gr.

S 31·79 Ru 65·18[a] Os [3·03] = 100

[a] Containing some osmium.

**Pyr., etc.**—Heated it decrepitates. B.B. infusible, giving first sulphurous and then osmic fumes. Not acted upon by aqua regia, nor by heating with potassium disulphate.

**Obs.**—From the platinum washings of Borneo. Found among fine-grained platinum which had been brought from Borneo. Also reported as occurring with the platinum of Oregon.

Named by Wöhler as a compliment to the wife of a personal friend.

**Artif.**—St. Claire Deville and Debray have made artificially a ruthenium sulphide ($RuS_2$ = S 38·1, Ru 61·9 = 100) in isometric crystals, octahedrons, and cubes. Bull. Soc. Min., **2**, 185, 1879.

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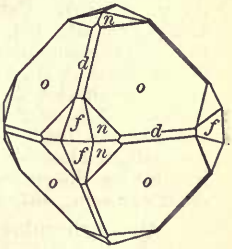
**95. SKUTTERUDITE.** Tesseral-Kies, Hartkobaltkies, *Breith.*, Pogg., **9**, 115, 1827. Arsenikkobaltkies *Scheerer*, Pogg., **42**, 553, 1837. Hartkobalterz, *Hausm.*, Handb., 69, 1847. Skutterudit *Haid.*, Handb., 560, 1845. Modumite *Nicol*, Min., 457, 1849.

Isometric; pyritohedral[3]. Observed forms[1]:

*a* (100, *i-i*), *d* (110, *i*), *o* (111, 1), *f* (130, − *i*-3)[2], *r* (332, $\frac{3}{2}$)[2], *n* (211, 2-2), *s* (321, 3-$\frac{3}{2}$)[3], *y* (643, 2-$\frac{3}{2}$)[2].



Skutterud, Fletcher.

Also massive granular.

Cleavage: *a* distinct; *d* in traces. Fracture uneven. Brittle. H. = 6. G. = 6·72–6·86. Luster bright metallic. Color between tin-white and pale lead-gray, sometimes iridescent. Shows both + and − varieties thermo-electrically[4].

**Comp.**—Cobalt arsenide, $CoAs_3$ = Arsenic 79·3, cobalt, 20·7 = 100.

**Anal.**—1, Scheerer, l. c. 2, 3, Wöhler, Pogg., **43**, 591, 1838.

| | | As | Co | Fe | |
|---|---|---|---|---|---|
| 1. | G. = 6·78 | 77·84 | 20·01 | 1·51 | S 0·69, Cu *tr.* = 100·05 |
| 2. *Cryst.* | | 79·2 | 18·5 | 1·3 | = 99·0 |
| 3. *Mass.* | | 79·0 | 19·5 | 1·4 | = 99·9 |

A "chloanthite" from Markirch in Alsace gave Vollkardt: As 77·94, Ni 12·01, Co 3·69, Fe 5·07; corresponding to $RAs_3$; it was in crystals (100, 111) with G. = 6·32. Other crystals are stated to have conformed to $RAs_2$. Zs. Kr., **14**, 408, 1888.

**Pyr.**—Reactions like those of smaltite, but gives a more copious sublimate of metallic arsenic in the closed tube.

**Obs.**—From Skutterud, near Modum, in Norway, in a hornblendic gangue in gneiss, with titanite and cobaltite, the crystals sometimes implanted on those of cobaltite.

**Ref.**—[1] Scheerer, l. c. [2] Rath, Pogg., **115**, 480, 1862. [3] Fletcher, Phil. Mag., **13**, 474, 1882, or Zs. Kr., **7**, 20, 1882; cf. also Rath, Zs. Kr., **14**, 257, 1888. [4] Schrauf and Dana, Ber. Ak Wien, **69** (1). 153, 1874.

A mineral from an unknown source in small crystals (not measured) in quartz has been analyzed by Ramsay (J. Ch. Soc., **29**, 153, 1876) and called a bismuth-skutterudite, but its homogeneity may well be questioned, the corrected results (after deducting $SiO,FeS_2$) are:

G. = 7·55 As 46·10 Bi 37·64 Co 10·18 Ni 5·66 Fe 0·55 = 100·13

## 2. Marcasite Group. $RS_2$, $RAs_2$, etc. Orthorhombic.

The species falling in this group are closely parallel to those of the Pyrite group, p. 84.

| | | | $\breve{a} : \bar{b} : \grave{c}$ |
|---|---|---|---|
| 96. | **Marcasite** | $FeS_2$ | 0·7662 : 1 : 1·2342 |
| 97. | **Löllingite** | $FeAs_2$ | 0·6689 : 1 : 1·2331 |
| | Leucopyrite | $Fe_3As_4$ | |
| 98. | **Arsenopyrite** | $FeS_2.FeAs_2$ | 0·6773 : 1 : 1·1882 |
| | Danaite | $(Fe,Co)S_2.(Fe,Co)As_2$ | |
| 99. | **Safflorite** | $CoAs_2$ | |
| 100. | **Rammelsbergite** | $NiAs_2$ | |
| 101. | **Glaucodot** | $(Co,Fe)S_2.(Co,Fe)As_2$ | 0·6942 : 1 : 1·1925 |
| 102. | **Alloclasite** | $(Co,Fe)(As,Bi)S$ | |
| 103. | **Wolfachite** | $NiS_2.Ni(As,Sb)_2$ | |

**96. MARCASITE.** Not Marchasite [= Cryst. Pyrite] *Arab.*, *Agric.*, 1546; *Henckel*, 1725; *Wall.*, 1747. *Cronst.*, 1758; *Linn.*, 1768; *de Lisle*, 1783. ? Pyrites argenteo colore, *Germ.* Wasserkies o. Weisserkies, *Agric.* Interpr., 477, 1546; Ferrum jecoris colore, *Germ.* Lebererz, pt., *Agric.*, ib., 469. Vattenkies pt., Pyrites fuscus pt., P. aquosus pt., *Wall.*, 212, 1747. Swafwelkies pt. *Cronst.*, 184, 1758. Pyrites lamellosus *Born.*, Lithoph., **2**, 106, 1772. P. aquosus? *id.*, 107. Pyrites rhomboidales pt. *de Lisle*, Crist., 1772, **3**, 242, 1783. Pyrites lamelleuse en crêtes de coq *Forst.*, Cat., 1772; *de Lisle*, Crist., **3**, 252, 1783. Pyrites fuscus lamellosus *Wall.*, **2**. 134, 1778. Strahlkies. Leberkies pt., *Wern.*, Bergm J., 1789 Fer sulfuré var. radié *H.*, Tr., 1801, *Brongn.*, Tr., 1807. Wasserkies (Dichter o. Leberkies, Strahlkies, Haarkies pt.) *Hausm.*, Handb., 149, 1813. Fer sulfuré blanc pt. *H.* White Pyrites *Aikin*, Min., 1814. Fer sulfuré prismatique rhomboidale *Bourn.*, Cat., 301, 1817. Prismatic Iron Pyrites *James.*, **3**, 297, 1820. Kammkies, Speerkies. Zellkies pt., *Germ.* Cockscomb, Spear, and Cellular Pyrites. Markasit *Haid.*, Handb., 467, 561, 1845. Pirite bianca *Ital.* Marcasita, Pirita blanca, *Span.*

Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c} = 0{\cdot}7662 : 1 : 1{\cdot}2342$ Sadebeck[1].

$100 \wedge 110 = 37° 27\frac{1}{2}'$, $001 \wedge 101 = 58° 10'$, $001 \wedge 011 = 50° 59'$.

| | | | | | |
|---|---|---|---|---|---|
| **Forms**[2] : | $b$ (010, $i$-$\breve{i}$) | $m$ (110, $I$) | $r$ (014, $\frac{1}{4}$-$\breve{i}$) | $y$ (025, $\frac{2}{5}$-$\breve{i}$) | $l$ (011, 1-$\breve{i}$) |
| $a$ (100, $i$-$\bar{i}$) | $c$ (001, $O$) | $e$ (101, 1-$\bar{i}$) | $v$ (013, $\frac{1}{3}$-$\breve{i}$) | $z$ (012, $\frac{1}{2}$-$\breve{i}$) | $s$ (111, 1) |

| | | | |
|---|---|---|---|
| $mm''' = {*}74° 55'$ | $rr' = 34° 18'$ | $yy' = 52° 33'$ | $cs = 63° 46'$ |
| $ee' = 116° 20'$ | $vv' = 44° 43'$ | $zz' = 63° 21'$ | $ss' = 66° 7'$ |
| | | $ll' = {*}101° 58'$ | $ss''' = 90° 48'$ |

Twins: (1) tw. pl. *m* (f. 4), often repeated (f. 5), sometimes producing stellate fivelings (f. 3); also (2) tw. pl. *e*, less common (f. 6), the crystals crossing at angles of nearly 60°. Crystals commonly tabular ‖ *c*, also pyramidal; the brachydomes deeply striated ‖ edge *b/c*. In stalactites with radiating internal structure and exterior covered with projecting crystals. Also globular, reniform, and other imitative shapes.

Cleavage: *m* rather distinct; *l* in traces. Fracture uneven. Brittle. H. = 6–6·5. G. = 4·85–4·90. Luster metallic. Color pale bronze-yellow, deepening on exposure. Streak grayish or brownish black. Opaque.

**Comp.**—Iron disulphide, like pyrite, $FeS_2$ = Sulphur 53·4, iron 46·6 = 100.

**Var.**—The varieties that have been recognized depend mainly on state of crystallization. 1. *Radiated* (*Strahlkies*, Germ.): Radiated; also the simple crystals. 2. *Cockscomb P.* (*Kammkies*, Germ.): Aggregations of flattened twin crystals into crest-like forms. 3. *Spear P.* (*Speerkies*, Germ.): Twin crystals, with re-entering angles a little like the head of a spear in form 4. *Capillary* (*Haarkies*, Germ.): In capillary crystallizations.

5. *Hepatic P.* (*Leberkies*, Germ.) and *Pyrites fuscus* pt.: The massive of dull colors, being named from *ἧπαρ, liver;* but including, among the older mineralogists especially, brown specimens of any pyrite, altered more or less to limonite.

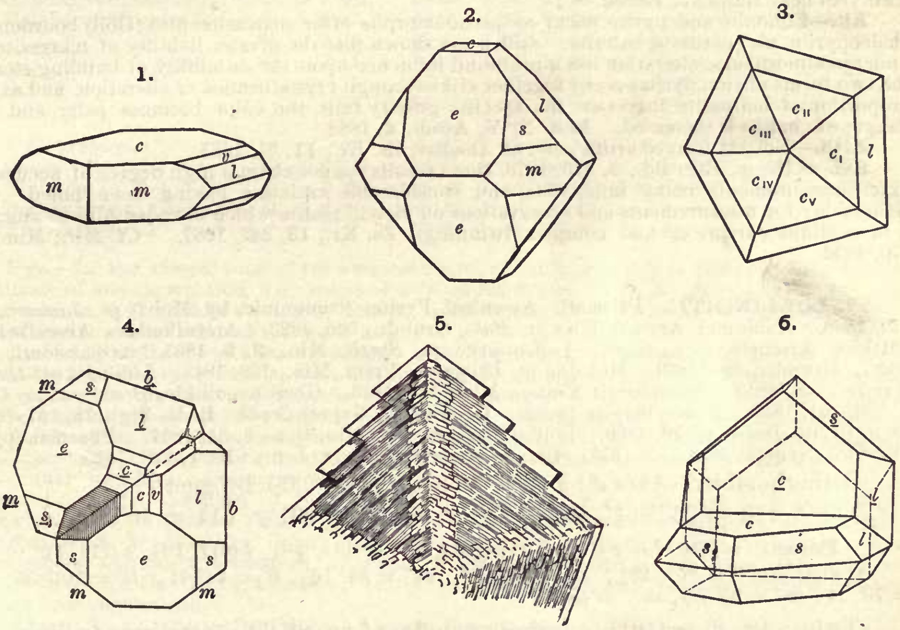
6. *Cellular P.* (*Zellkies*, Germ.): In cellular specimens, formed by the incrustation of the crystals of other minerals that have disappeared; partly pyrite.

7. *Arsenical:* Nearly white in color (in part *kyrosite* Breith., and *Weisskupfererz,* see below); contains a small amount of arsenic.

8. *Stalactitic:* In stalactites, sometimes with radiated structure, sometimes compact; the exterior distinct crystals, or rough; also in layers with galena or sphalerite, or both, resembling the "Schalenblende," and hence sometimes called "Schalenmarcasite."

**Pyr.,** etc.—Like pyrite; very liable to decomposition, more so than pyrite.

**Obs.**—The spear variety occurs abundantly in the plastic clay of the brown coal formation at Littmitz and Altsattell, near Carlsbad in Bohemia, and is extensively mined for its sulphur and the manufacture of ferrous sulphate. The radiated variety occurs at the same place; also at Joachimsthal, Bohemia, and in several parts of Saxony. The cockscomb variety occurs with galena and fluorite in Derbyshire; in chalk marl between Folkestone and Dover; Castleton in Derbyshire; near Alston Moor in Cumberland; near Tavistock in Devonshire; and radiated at East Wheal Rose and elsewhere in Cornwall. Schemnitz in Hungary, Andreasberg, Clausthal, etc., in the Harz are other localities.



1, Common Form. 2, Schemnitz, Sbk. 3, Freiberg, Id. 4, Galena, Ill. 5, Folkestone. 6, Freiberg, Sbk.

At Warwick, N. Y., it occurs in simple and compound crystals, in granite, with zircon. Hustis's farm, in Phillipstown, N. Y., affords small crystals, referred by Beck to this species, occurring in magnesian limestone. Massive fibrous varieties abound throughout the mica slate of New England, particularly at Cummington, Mass., where it is associated with cummingtonite and garnet. Occurs at Lane's mine, in Monroe, Conn., and in the topaz and fluorite vein in Trumbull; also in gneiss at East Haddam; at Haverhill, N. H., with common pyrite. Galena, Ill., in stalactites with concentric layers of sphalerite, galena, the exterior commonly marcasite in twin crystals pyramidal in aspect (f. 4). Mineral Point, Wis., in fine crystals; on sphalerite at Joplin, Mo. In Canada in Neebing, a few miles east of the Kamanistiquia R., north-west shore of L. Superior.

The word *marcasite,* of Arabic or Moorish origin (and variously used by old writers, for bismuth, antimony), was the name of common crystallized pyrite among miners and mineralogists in later centuries, until near the close of the last. It was first given to this species by Haidinger in 1845.

The species is probably recognized by Agricola under the name *wasserkies* and *lebererz,* and also under the same by Cronstedt; and it is *Wasserkies* of Hausmann in both editions of his great work. This name, wasserkies (pyrites aquosus, as Cronstedt translates it), is little applicable; yet may have arisen from the greater tendency of the mineral to become moist and alter to vitriol than pyrite—if it be not an early corruption, as Agricola seems to think (see above), of *Weisserkies* (white iron pyrites). It appears to have been used also for easily decomposable pyrite; and *pyrrhotite* was also included under its other name, *pyrites fuscus.* The rhombic crystallization is mentioned by de Lisle; but Haüy long afterward considered it only an irregularity of common iron pyrites. *Weisskupfererz* (also called *weisskupfer* and *weisserz*) occurs as the name of a species in all the mineralogical works of last century, from Henckel's Pyritology, in 1725, where it is called a whitish copper ore, and placed near tetrahedrite; and the light color, from Henckel down, is attributed to the presence of arsenic. It has finally been run out as mostly impure marcasite; and the domeykite and related species are now the only true white copper.

*Marcasite* is made by Breithaupt (J. pr. Ch., **4**, 257, 1835) a generic name for the various species of pyrites. He used the names *lonchidite* or *kausimkies* for varieties in which Plattner found 4·4 p. c. As; *kyrosite* or *weisskupfererz*, the latter an old term of varied signification; *hepatopyrite, leberkies* Werner; *hydropyrite* or weicheisenkies, wasserkies (see above). Cf. Frenzel, Min. Lex. Sachsen, pp. 197–201, 1874.

*Metalonchidite* of F. Sandberger (Oest. Jb. B. Hütt., **35**, 531, 1887) is a marcasite containing about half as much arsenic as Breithaupt's lonchidite. G. = 5·08. Analysis by F. Pecher gave: S 49·56, As 2·73, Fe 45·12, Ni 1·29, Cu 0·72, Pb 1·12, Ag 0·01 = 100·55. Locality, the St. Bernhard vein near Hausach, Baden.

**Alt.**—Limonite and pyrite occur as pseudomorphs after marcasite, also (Döll) bournonite, chalcopyrite, magnetite, sphalerite. Julien has shown that the greater liability of marcasite to undergo atmospheric alteration has a profound influence upon the durability of building-stones; the two forms of iron pyrites occur together either though crystallization or alteration, and as the proportion of marcasite increases, the specific gravity falls, the color becomes paler, and the danger of change is increased. Ann. N. Y. Acad., **4**, 1888.

**Artif.**—Not yet formed artificially, cf. Doelter, Zs. Kr., **11**, 31, 1885.

**Ref.**—[1] Pogg., Erg. Bd., 8, 625, 1878, these results cannot claim a high degree of accuracy, exact measurements being impossible and considerable variation having been noted. See Gehmacher for measurements and observations on vicinal planes which have led him to suggest a monoclinic parameter and complex twinning. Zs. Kr., **13**, 242, 1887. [2] Cf. Mlr., Min., p. 170, 1852.

**97. LÖLLINGITE.** Prismatic Arsenical Pyrites (communic. by Mohs) pt. *Jameson*, **3**, 272, 1820. Axotomer Arsenik-Kies pt. *Mohs*, Grundr., 525, 1823. Arsenikalkies, Arsenikeisen Giftkies, Arseneisen, pt., *Germ.* Leucopyrite pt. *Sheph.*, Min., **2**, 9, 1835. Arsenosiderit pt. *Glock.*, Grundr., 321, 1839. Mohsine pt. *Chapman*, Pract. Min., 138, 1843. Löllingit pt. *Haid.*, Handb., 559, 1845. Sätersbergit *Kenng.*, Min., 111, 1853. Glanzarsenikkies *Breith.*, J. pr. Ch., **4**, 260, 261, 1835. Hüttenbergite *Breith* Geierite (fr. Geyer) *Breith.*. B. H. Ztg., **25**, 167, 1866. Leucopyrite *Dana*, p. 76, 1868. Löllingite *Zeph.*, Vh. Min. Ges., **3**, 84, 1867. Pharmakopyrit *Weisbach*, Synops. Min., 57, 1875. Glaucopyrite *Sandberger*, J. pr. Ch., **1**, 230, 1870.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·66888 : 1 : 1·2331$ Brögger[1].

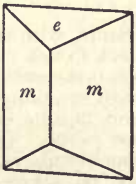
$100 \wedge 110 = 33^\circ\ 46\frac{2}{3}'$, $001 \wedge 101 = 61^\circ\ 31\frac{1}{3}'$, $001 \wedge 011 = 50^\circ\ 57\frac{1}{2}'$.

**Forms:** *m* (110, *I*) *e* (101, 1-ī) *u* (014, $\frac{1}{4}$-ĭ) *t* (013, $\frac{1}{3}$-ĭ) *l* (011, 1-ĭ) *o* (112, $\frac{1}{2}$).

Angles: $mm''' = {}^*67^\circ\ 33\frac{1}{3}'$, $ee' = 123^\circ\ 3'$, $uu' = 34^\circ\ 16'$, $tt' = 44^\circ\ 41'$, $ll' = 101^\circ\ 55'$, $oo' = 76^\circ\ 14'$, $oo'' = 95^\circ\ 55'$, $oo''' = 48^\circ\ 46'$.

Twins: tw. pl. *e* (101), crossing at angles of nearly 60°, sometimes trillings.

1.



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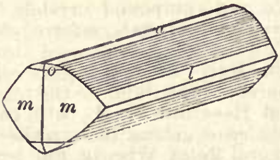


Stokö, Brögger.

Cleavage: basal, sometimes distinct. Fracture uneven. Brittle. H. = 5–5·5. G. = 7·0–7·4 chiefly, also 6·8. Luster metallic. Color between silver-white and steel-gray Streak grayish black.

**Comp., Var.**—Essentially iron diarsenide, $FeAs_2$, but passing into $Fe_3As_4$; also tending toward arsenopyrite ($FeAsS$) and safflorite ($CoAs_2$). Bismuth and antimony are sometimes present.

**Var.**—1. *Löllingite*, $FeAs_2$ = Arsenic 72·8, iron 27·2 = 100. G. = 7·234 Hüttenberg, Zeph.
2. *Leucopyrite*, $Fe_3As_4$ = Arsenic 64·1, iron 35·9 = 100. G. = 7·0–7·2.
3. *Geyerite*, containing sulphur, anal., 17–20. G. = 6·25–6.8.
4. *Cobaltiferous*. Glaucopyrite belongs here, cf. anals. 6, 8, 9.

**Anal.**—1, Scheerer, Pogg., **50**, 156, 1840. 2, Weidenbusch, Rose, Kr.-Ch. Min., 54, 1852. 3, Illing, Rg., Min. Ch., 19, 1860. 4, Nd., G. För. Förh.. **2**, 242, 1875. 5, Niedzwiedzki, Min. Mitth., 161, 1872. 6, Hillebrand, Am. J. Sc., **27**, 353, 1884. 7, Loczka, Zs. Kr., **11**. 261, 1885. 8, Frenzel, Jb. Min , 677, 1875. 9, R. Senfter, J. pr. Ch., **1**, 230, 1870. 10–12, Güttler, Jb. Min., 81, 1871. 13, Meyer, Pogg., **50**, 154, 1840. 14, Weidenbusch, l. c. 15, Hofmann, Scheerer, Pogg., **25**, 485, 1832. 16, McCay, Inaug. Diss., p. 43, 1883. 17, Behncke, Pogg., **98**, 187,

1856. 18, Petersen, ib., **137**, 393, 1869. 19, McCay, l. c., p. 45, 1883. 20, Jordan, J. pr. Ch., **10**, 436, 1837 (deducting 64 p. c. $SiO_2$).

| | | | As | S | Fe | Co | |
|---|---|---|---|---|---|---|---|
| 1. | Fossum, Sätersberg | | 70·22 | 1·28 | 28·14 | — | = 99·64 |
| 2. | Schladming | | 72·18 | 0·70 | 26·48 | — | = 99·36 |
| 3. | Andreasberg | G. = 6·80 | 70·59 | 1·65 | 28·67 | — | = 100·91 |
| 4. | Brevik, *Sätersbergite* | | 72·17 | 0·37 | 27·14 | *tr.* | = 99·68 |
| 5. | Dobschau | G. = 7·15 | 70·11 | 0·81 | 28·21 | — | Bi *tr.* = 99·13 |
| 6. | Gunnison Co., Col. | G. = 7·40 | 71·18 | 0·56 | 22·96 | 4.37 | Ni 0·21, Cu 0·39, Bi 0·08 [= 99·75 |
| 7. | Andreasberg | G. = 7·475 | 68·08 | 0 84 | 27·32 | — | Sb 4·03, Cu 0·10, $SiO_2$ 0·10 [= 100 47 |
| 8. | Mte. Challanches, *massive* | | 63·66 | 3·66 | 21·22 | 6·44 | Sb 5·61 = 100·59 |
| 9. | Guadalcanal. *Glaucopyrite* | G. = 7·181 | 66·90 | 2·36 | 21·38 | 4·67 | Sb 3·59, Cu 1·14 = 100·04 |
| 10. | Reichenstein, *massive* | G. = 6·97 | 66·59 | 1·93 | 28·28 | — | gangue 2·06 = 98·86 |
| 11. | " " | G. = 7·05 | 67·81 | 1·97 | 28·19 | — | gangue 1 14 = 99·11 |
| 12. | " *cryst.* | G. = 7·41 | 66·57 | 1·02 | 31·08 | — | gangue 0·92 = 99·59 |
| 13. | " | | 63·14 | 1·63 | 30·24 | — | gangue 3·55 = 98·56 |
| 14. | " | | 65·61 | 1·09 | 31·51 | — | gangue 1·04 = 99·25 |
| 15. | " | | 65·99 | 1·94 | 28·06 | — | gangue 2·17 = 98·16 |
| 16. | "*Hüttenbergite*" | | 68·87 | 1·09 | 29·20 | — | = 99·16 |
| 17. | Geyer | G. = 6·246 | 58·94 | 6·07 | 32·92 | — | Sb 1·37 = 99·30 |
| 18. | Wolfach | G. = 6·797 | 62·29 | 5·18 | 24·33 | 4·40 | Sb 4 37 Mn *tr.* = 100·57 |
| 19. | Breitenbrunn, *Geyerite* | G. = 6·58 | $\frac{2}{2}$ 61·40 | 6·73 | 31·20 | — | = 99·33 |
| 20. | Andreasberg | | 55·00 | 8·35 | 36·44 | — | Ag 0·01 = 99·80 |

**Pyr.**—In the closed tube gives a sublimate of metallic arsenic; in the open tube a white sublimate of arsenic trioxide, with traces of sulphurous fumes. B.B. on charcoal gives the odor of arsenic; in O.F. a white coating of arsenic trioxide, and in R.F. a magnetic globule. With the fluxes the roasted mineral reacts for iron.

**Obs.**—Löllingite occurs with siderite, also bismuth and chloanthite, in the Lölling-Hüttenberg district in Carinthia; with niccolite at Schladming; at Ehrenfriedersdorf, in Saxony; Andreasberg in the Harz; at Sätersberg, near Fossum, in Norway; on Stokö and at other points in the augite-syenite of southern Norway, there associated with homilite and meliphanite.

The arsenical iron from Reichenstein, Silesia, is in part löllingite, but mostly leucopyrite; it often carries gold. *Geyerite* is from Geyer in Saxony, in crystals and massive with quartz; also from other localities. *Glaucopyrite* is from Guadalcanal, Andalusia, Spain. In the U. S., löllingite occurs at the head of Brush Creek, Gunnison Co., Colorado (anal. 6), it is often embedded in barite or siderite. Other localities for arsenical iron (not yet analyzed) are Edenville and Monroe, N. Y.; Roxbury, Conn.; Paris, Me. A crystal of arsenical iron, weighing two or three ounces, was found in Bedford Co., Penn., but it is not known under what circumstances; and in Randolph Co., N. C., a mass of nearly two pounds weight. The composition of these has not been determined.

Named by Chapman after Mohs. by whom the mineral was first described, and who mentions Lölling as the first locality at which it was found; but as *mohsite* was previously given to a variety of ilmenite. Haidinger's name was adopted in the 5th Ed., 1868, for the Reichenstein mineral, $Fe_3As_4$, and Shepard's name leucopyrite (from λευκος, *white*) given to the arsenical iron conforming to $FeAs_2$. A little earlier, however, the same names were used by Zepharovich, but reversed, löllingite for $FeAs_2$ and leucopyrite for $Fe_3As_4$; this arrangement was adopted in subsequent reprints of the 5th Ed. In view of the variation of composition of other minerals of this and of the corresponding isometric group (e.g., arsenopyrite, smaltite, etc.) it seems best to unite the varieties under the most generally accepted name.

**Ref.**—[1] Norway (anal. 4). Zs. Kr., **16**, 8, 1890. The measurements of Schrauf, Jb. Min., 677, 1875, were probably made on arsenopyrite from Mte. Challanches near Allemont, not löllingite as supposed, cf. Groth, Ber. Ak. München, 384, 1885.

PACITE *Breithaupt*, B. H. Ztg., **25**. 167, 1866. In form and color near arsenopyrite. G. = 6·3. An analysis by Winkler gave: As 64·84, S 7·01, Fe 24·35, Co 0·13, Cu 0·11, Bi 0·10, Au, Ag 0·006, gangue 2·88 = 99·426. From La Paz in Bolivia, in masses and thin plates in the gangue, with native gold and bismuth.

**98. ARSENOPYRITE,** or MISPICKEL. ?Lapis subrutilus atque non fere aliter ac argenti spuma splendens et friabilis, *Germ.* Mistpuckel, *Agric.*, Interpr., 465, 1546. Pyrites candidus, Wasserkies, pt., *Gesner*, Foss., 1565. Arsenikaliskkies, Mispickel, *Henckel*. Pyrit., 1725. Arsenikaliskkies, Hvit Kies (= Pyrites albus), Mispickel. Arsenik-Sten, *Wall.*, 227, 228, 1747. Mispickel, Pyrite blanche, *Fr. trl.*, Wall., 1753. Arsenikkies *Wern.*, 1789. Rauschgelbkies. Fer arsenical *Fr.* Arsenical Pyrites. Dalarnit, Giftkies, Glanzarsenikkies, *Breith.*, J. pr. Ch., **4**, 259, 261, 1835. Arsenopyrite *Glock.*, Syn., 38, 1847. Plinian *Breith.*, Pogg., **69**, 430, 1846; B. H. Ztg., **25**, 168, 1866. Bronce blanco *Span.*, *S. A.*

Danaite = Cobaltic Mispickel (fr. Franconia) *Hayes*, Am. J. Sc., 24, 386, 1833. Kobaltarsenikkies *Germ.* ? Vermontit (fr. U. S.) *Breith.*, l. c. Thalheimit, Giftkies, *Breith.*, B. H. Ztg., 25, 167, 1866.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}67726 : 1 : 1{\cdot}18817$ Arzruni[1].
$100 \wedge 110 = 34^\circ\ 6\tfrac{1}{2}'$, $001 \wedge 101 = 60^\circ\ 19'$, $001 \wedge 011 = 49^\circ\ 54\tfrac{5}{6}'$.

**Forms**[2]:
$b$ (010, $i$-$\breve{i}$)
$c$ (001, $O$)
$m$ (110, $I$)

$e$ (101, 1-$\bar{i}$)
$\alpha$ (0·1·24, $\tfrac{1}{24}$-$\breve{i}$)[5]
$\xi$ (0·1·16, $\tfrac{1}{16}$-$\breve{i}$)

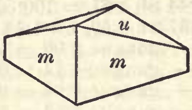
$r$ (018, $\tfrac{1}{8}$-$\breve{i}$)
$\beta$ (016, $\tfrac{1}{6}$-$\breve{i}$)[5]
$\rho$ (015, $\tfrac{1}{5}$-$\breve{i}$)[3]
$u$ (014, $\tfrac{1}{4}$-$\breve{i}$)

$t$ (013, $\tfrac{1}{3}$-$\breve{i}$)
$n$ (012, $\tfrac{1}{2}$-$\breve{i}$)
$\phi$ (023, $\tfrac{2}{3}$-$\breve{i}$)[4]?
$q$ (011, 1-$\breve{i}$)

$k$ (021, 2-$\breve{i}$)
$\tau$ (031, 3-$\breve{i}$)
$g$ (111, 1)

$v$ (331, 3)
$w$ (212, 1-$\bar{2}$)
$x$ (321, 3-$\bar{\tfrac{3}{2}}$)

1.



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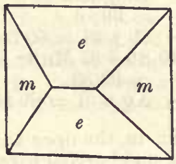

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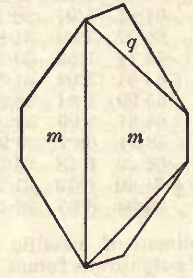

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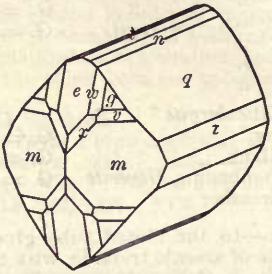

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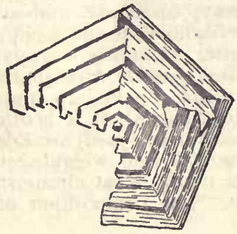

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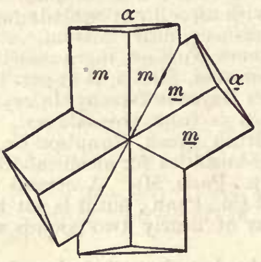

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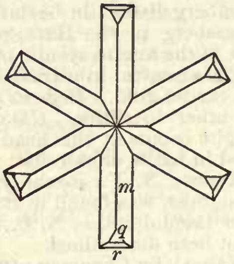


1, 3, Common forms. 2, Schladming, Rumpf. 4, *Danaite*, Franconia. 5, Deloro. 6, Servia Schmidt. 7, Weiler, Bkg.[6]

$mm''' = {}^*68^\circ\ 13'$
$ee' = 120^\circ\ 38'$
$ee''' = {}^*59^\circ\ 22'$
$\xi\xi' = 8^\circ\ 30'$
$rr' = 16^\circ\ 54'$
$\rho\rho' = 26^\circ\ 44'$

$uu' = 33^\circ\ 5'$
$tt' = 43^\circ\ 13'$
$nn' = 61^\circ\ 26'$
$\phi\phi' = 76^\circ\ 46'$
$qq' = 99^\circ\ 50'$
$kk' = 134^\circ\ 21'$
$\tau\tau' = 148^\circ\ 39\tfrac{1}{2}'$

$mg = 25^\circ\ 16'$
$mv = 8^\circ\ 56\tfrac{1}{2}'$
$gg' = 96^\circ\ 58'$
$gg'' = 129^\circ\ 28'$
$gg''' = 60^\circ\ 57'$
$vv' = 109^\circ\ 45'$

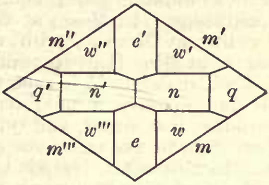
$vv''' = 67^\circ\ 17'$
$ww' = 112^\circ\ 54\tfrac{1}{2}'$
$ww''' = 32^\circ\ 47'$
$xx' = 127^\circ\ 48'$
$xx'' = 160^\circ\ 21'$
$xx''' = 47^\circ\ 50\tfrac{1}{2}'$

Twins: tw. pl. (1) *m*, as contact- or penetration-twins, sometimes repeated like marcasite (f. 5); (2) *e* in cruciform-twins (f. 6), also in trillings[5] sometimes star-shaped (f. 7) crossing at angles of 59° and 62°. Crystals prismatic *m*, or flattened vertically by the oscillatory combination of *n* (012). Brachydomes horizontally striated; also faces *m* often finely striated ‖ edges *m*/*e* or with *m*/*n*. Also columnar, straight, and divergent; granular, or compact.

Cleavage: *m* rather distinct; *c* in faint traces. Fracture uneven. Brittle. H. = 5·5–6. G. = 5·9–6·2; 6·269 Franconia, Kenng. Luster metallic. Color silver-white, inclining to steel-gray. Streak dark grayish black. Opaque. Thermo-electrically[7] both positive and negative.

**Comp., Var.**—Sulph-arsenide of iron, FeAsS or $FeS_2.FeAs_2$ = Arsenic 46·0, sulphur 19·7, iron 34·3 = 100. Part of the iron is sometimes replaced by cobalt.

8.



Schladming, after Rumpf.

**Var.**—1. *Ordinary.* Containing little or no cobalt. The analyses show considerable variation, and it has been proved that this is accompanied by a change in the angles, as exhibited below. Antimony is present in small amount (to 0·28 p. c.) Loczka. l. c.; also bismuth, Carnot, l. c. *Plinian* of Breithaupt, supposed to be monoclinic, belongs here, anal. 12; G. = 6·3.

2. *Cobaltiferous: Danaite.* Containing from 4 to 10 p. c. of cobalt replacing the iron, and thus graduating toward glaucodot.

3. *Niccoliferous.* Anal. 23.

**Anal.**—1, Rumpf, Min. Mitth., 178, 1874. 2–4, 6, 7, 9, 10, 13–17, Arzruni, Zs. Kr., **2**, 430 et seq. 1878, and Arzruni and Bärwald, ib., **7**, 337. 1882. 5, C. v. Hauer, Jb. G. Reichs., **4**, 400, 1853. 8, Balson, quoted by Arzruni. 9, Zimmermann, Ber. Ak. München, 385. 1885. 11, Magel. Ber. Oberhess, Ges., **22**, 297, 1882. 12, Plattner, Pogg., **69** 430, 1846. 18. Scheerer, Pogg., **42**, 546, 1837. 19, Wöhler, ib., **43**, 591, 1838. 20, Hayes, l c. 21, J. L. Smith, Gilliss Ex., **2**, 102. 22, Forbes, Phil. Mag., **29**, 7, 1865 23, Kroeber, ibid.

Also Genth, Alabama, Am. Phil. Soc., **23**, **39**, 1885; Loczka, varieties from Hungary, containing from 0·14 to 0·28 p. c. Sb, Zs. Kr., **11**, 269, 270, 1885; **15**, 40. 1888; Oebbeke-Böttiger, Wunsiedel, Zs. Kr., **17**, 384, 1890; Carnot, varieties from Meymac containing both bismuth and antimony, C. R., **79**, 479, 1874.

1. *Ordinary.*

| | G. | *mm'''* | *ee'* | As | S | Fe | |
|---|---|---|---|---|---|---|---|
| 1. Schladming | 5·89 | 67° 37′ | 58° 55′ | 45·23 | 21·06 | 34·47[a] | = 100·76 |
| 2. Reichenstein | 5·898 | 67° 43′ | 58° 53′ | [47·27] | 18·05 | 34·68 | = 100 |
| 3. Saugerberg | | | 59° 1′ | [46·66] | 18·29 | 35·05 | = 100 |
| 4. Marienberg | — | 67° 54′ | 59° 5′ | — | — | — | |
| 5. Mitterberg | — | 67° 59′ | 59° 9′ | 45·00 | 21·36 | 33·52 | = 99·88 |
| 6. Freiberg. I. | — | 68° 11′ | 59° 7′ | — | — | — | |
| 7. Hohenstein | 6·192 | 68° 13′ | 59° 22′ | [45·52] | 19·41 | 35·07 | = 100 |
| 8. " | | | | 45·62 | 19·76 | 34·64 | = 100·02 |
| 9. Mte. Challanches | | 67° 35′ | (58° 24′) | 45·78 | 19·56 | 34·64 | = 99·98 |
| 10. Ehrenfriedersdorf | — | 68° 17′ | 59° 15½ | — | 19·76 | — | |
| 11. Auerbach, II. | 6·082 | 68° 15′ | | 44·11 | 19·91 | 35·84 | = 99·06 |
| 12. Ehrenfried., *Plinian.* | 6·30 | 68° 24′ | 59° 10′ | 45·46 | 20·07 | 34·46 | = 99·99 |
| 13. Sala | | 68° 29′ | 59° 32′ | [42·63] | 20·41 | 36·96 | = 100 |
| 14. Auerbach, I. | | 68° 36′ | | | 20·64 | 35·81 | |
| 15. Joachimsthal | — | 68° 36′ | 60° 21½′ | [42·95] | 20·52 | 36·53 | = 100 |
| 16. Freiberg, II. | 6·035 | 68° 39′ | (61° 34′) | [44·14] | 20·83 | 35·03 | = 100 |
| 17. Binnenthal | 6·091 | 69° 11′ | (60° 1′) | [42·61] | 22·47 | 34·92 | = 100 |

[a] With 0·29 Ni.

2. *Cobaltiferous; Danaite.*

| | As | S | Fe | Co | |
|---|---|---|---|---|---|
| 18. Skutterud | 46·76 | 17·34 | 26·36 | 9·01 | = 99·47 |
| 19. " | 47·45 | 17·78 | 30·91 | 4·75 | = 100·89 |
| 20. Franconia, *Danaite* | 41·44 | 17·84 | 32·94 | 6·45 | = 98·67 |
| 21. Copiapo | 44·30 | 20·25 | 30·21 | 5·84 | = 100·60 |
| 22. Mt. Sorata | 42·83 | 18·27 | 29·22 | 3·11 | Ni 0·81, Mn 5·12, Bi 0·64 = 100 |
| 23. Bolivia | 43·68 | 16·76 | 34·93 | *tr.* | Ni 4·74, Ag 0·09 = 100·20 |

**Pyr., etc.**—In the closed tube at first gives a red sublimate of arsenic trisulphide, then a black lustrous sublimate of metallic arsenic. In the open tube gives sulphurous fumes and a white sublimate of arsenic trioxide. B.B. on charcoal reacts like löllingite. The varieties containing cobalt give, after the arsenic has been roasted off, a blue color with borax-glass when fused in O.F. with successive portions of flux until all the iron is oxidized. Gives fire with steel, emitting an alliaceous odor. Decomposed by nitric acid with the separation of sulphur.

**Obs.**—Found principally in crystalline rocks, and its usual mineral associates are ores of silver, lead, and tin, also pyrite, chalcopyrite, and sphalerite. Occurs also in serpentine.

Abundant at Freiberg and Munzig, where it occurs in veins; at Reichenstein in Silesia, in serpentine; at Auerbach in Baden; in beds at Breitenbrunn and Raschau, Andreasberg, and Joachimsthal; at Tunaberg in Sweden; at Skutterud in Norway; at Wheal Maudlin and Unanimity, Cornwall, and at other localities; in Devonshire at the Tamar mines. In S. America, in the San Baldomero mine of Mt. Sorata in Bolivia, the arsenopyrite and danaite, the former having crystallized out of the latter and the most abundant ore; also both at Inquisivi in Bolivia; also, *niccoliferous* var., (anal. 23) between La Paz and Yungas in Bolivia; at many localities in New South Wales, sometimes highly auriferous.

In *New Hampshire*, in fine crystallizations in gneiss, at Franconia (*danaite*) associated with chalcopyrite; also at Jackson, and at Haverhill. In *Maine*, at Blue Hill, Corinna; Newfield (Bond's mountain), and Thomaston (Owl's Head). In *Vermont*, at Brookfield, Waterbury, and Stockbridge. In *Mass.*, at Worcester and Sterling. In *Conn.*, at Chatham, with smaltite and niccolite; at Monroe, with wolframite and pyrite; at Derby, in an old mine associated with quartz; at Mine Hill, Roxbury, in fine crystals with siderite. In *New Jersey*, at Franklin. In *N. York*, massive, in Lewis, ten miles south of Keeseville, Essex Co., with hornblende; in crystals and massive, near Edenville, on Hopkins's farm, and elsewhere in Orange Co., with scorodite, iron sinter, and thin scales of gypsum; also in fine crystals at two localities a few rods apart, four or five miles north-west of Carmel, near Brown's serpentine quarry in Kent, Putnam Co. In *California*, Nevada Co., Grass valley, at the Betsey mine, and also at Meadow lake, with gold, the *danaite* in crystals sometimes penetrated by gold.

In crystals at St. François, Beauce Co., Quebec; on Moulton Hill, near Lennoxville, Sherbrooke Co.; large beds occur in quartz ore veins at Deloro, Marmora Township, Hastings Co., Ontario, where it is mined for gold.

**Alt.**—Pseudomorphs consisting of pyrite.

**Ref.**—[1] Hohenstein, this variety is taken as fundamental because conforming most closely to the formula FeAsS, Zs. Kr., **2**, 434, 1878; cf. also, ib., **7**, 337, 1882; on the variation of angle in the cobaltiferous varieties, cf. Becke, Min. Mitth., 101, 1877, and earlier, Scheerer, Pogg., **42**, 546, 1837.

[2] See Hausm., Handb., **2**, 72, 1847; Mlr., Min., 188, 1852, and later Arzruni, l. c., and Gdt., Index, **1**, 256, 1886; Hausm. gives also (340), (370), (027). Miller's $x = 312$ is apparently a mistake for 321. [3] Gamper, Joachimsthal, Vh. G. Reichs., 354, 1876; cf. Arzruni, Zs. Kr., **1**, 396, 1877. [4] Magel, Auerbach, Ber. Oberhess. Ges., **22**, 297, 1882. [5] Schmidt, Servia, Földt. Közl., **17**, 557, 1887, and Zs. Kr., **14**, 573, 1888. [6] Magel, l. c., Bücking, Mitth. G. Land. Els. Lothr., **1**, 114. [7] Schrauf and Dana, Ber. Ak. Wien, **69** (1), 152, 1874.

The name mispickel is an old German term of doubtful origin. *Danaite* is from J. Freeman Dana of Boston (1793–1827), who first made known the Franconia locality.

CRUCITE (Crucilite) *Thomson*, Min., **1**, 435, 1836. Cruciform crystals, twins or trillings crossing at angles of 60° and 120°, disseminated in clay slate at Clonmell, county of Waterford, Ireland. They are red in color and consist largely of iron sesquioxide. They have been referred to staurolite (pseudomorphous), but Des Cloizeaux has shown that they are probably pseudomorphs after arsenopyrite (cf. f. 7, p. 98), Bull. Soc. Min. **11**, 63, 1888.

**99. SAFFLORITE.** *Breith.*, J. pr. Ch., **4**, 265, 1835. Faseriger Weisser Speiskobalt *Werner*. Grauer Speiskobalt, Arsenikkobalt *Rose*, Kr.-Ch. Min., 50, 1852. Eisenkobaltkies, Spathiopyrit, Der rhombische Arsenkobalteisen, Quirlkies *Sandberger*, Jb. Min., 410, 1868; 59, 1873; Ber. Ak. München, 135, 1873. Schlackenkobalt *Schneeberg miners*.

Orthorhombic. Form near that of arsenopyrite. Forms combinations of *m* (110, *I*) and a macrodome (*h*0*l*, *m*-ī), the latter brilliant in luster. Twins: tw. pl. *m*, probably in fivelings; also often in cruciform-twins crossing at angles of nearly 120° with tw. pl. probably (101) like marcasite and arsenopyrite. Also massive and with fibrous radiated structure.

Cleavage: *b* distinct. Fracture uneven. Brittle. H. = 4·5–5. G. = 6·9–7·3; 7·123–7·129 Breith. Luster metallic. Color tin-white, soon tarnishing to dark gray. Streak grayish black. Opaque.

**Comp.**—Like smaltite, essentially cobalt diarsenide, $CoAs_2$ = Arsenic 71·8, cobalt 28·2 = 100. Nickel and iron are also present in varying amounts, especially the latter. Compare remarks under smaltite.

**Anal.**—1, Varrentrapp, Pogg., **48**, 505, 1839. 2, Petersen, Jb., Min., 410, 1868. 3, Hofmann, Pogg., **25**, 485, 1832. 4, McCay, Am. J. Sc., **29**, 373, 1885. 5, Id., Inaug. Diss., p. 20, 1883. 6, Jäckel, Rose, Kr.-Ch. Min., 53, 1852. 7, McCay, ib., p. 21. 8, Van Gerichten, Ber. Ak. München, 138, 1873. 9, Kbl., Gründz. Min., 300, 1838.

| | G. | As | S | Co | Ni | Fe | Cu | |
|---|---|---|---|---|---|---|---|---|
| 1. Tunaberg | 7·131 | 69·46 | 0·90 | 23·44 | — | 4·94 | — | = 98·74 |
| 2. Wittichen | 6·915 | 69·53 | 0·32 | 22·11 | 1·58 | 4·63 | 1·78 | Bi 0·33 = 100·28 |
| 3. Schneeberg | | 70·37 | 0·66 | 13·95 | 1·79 | 11·71 | 1·39 | Bi 0·01 = 99·88 |
| 4. " *Schlackenkobalt* | 7·167 | 70·36 | 0·90 | 18·58 | — | 9·51 | 0·62 | Bi *tr.* = 99·97 |
| 5. " | 7·28 | 69·34 | 0·51 | 17·06 | — | 11·95 | 0·69 | = 99·55 |
| 6. " | 6·84 | 66·02 | 0·49 | 21·21 | — | 11·60 | 1·90 | Bi 0·04 = 101·26 |
| 7. Bieber | 7·26 | 69·12 | 1·32 | 13·29 | 1·90 | 14·56 | 0·26 | = 100·45 |
| 8. " *Spathiopyrite* | 6·7 | 61·46 | 2·37 | 14·97 | — | 16·47 | 4·22 | = 99·49 |
| 9 Schneeberg, *Eisenkobaltkies* | 6·95 | 71·08 | *tr.* | 9·44(?) | — | 18·48(?) | — | Bi *tr.* = 100 |

In anal. 5, 5·82 quartz and 0·37 Bi have been deducted; also in 7, 1·24 Bi. McCay suggests that in anal. 9 the percentages of Co and Fe may have been exchanged, cf. anal. 4.

**Pyr.**—See smaltite.

**Obs.**—Occurs with smaltite, and implanted upon it, at Schneeberg in Saxony. Also similarly associated at Bieber near Hanau, in Hesse; at Wittichen in Baden; Tunaberg in Sweden.

Kenngott's *Einfach-Arsenik-Kobalt* from Bieber, supposed to be hexagonal in crystallization, is probably this species, Jb. Min., 754, 1869.

The name *safflorite* is from the German Safflor, *safflower, bastard saffron,* in allusion to its use. *Spathiopyrite* (from σπάθη) is the equivalent of the German *Quirtkies.*

The true position of safflorite was established by McCay, l. c.

**100. RAMMELSBERGITE.** Arseniknickel *Hofm.*, Pogg., **25**, 491, 1832. Weissnickelkies *Breith.*, Pogg., **64**, 184, 1845. Rammelsbergite *Dana*, Min., 61, 1854. [Not Rammelsbergite, Syn. of Chloanthite, *Haid.*, Handb., 1845.] Niguel blanco *Domeyko.*

Orthorhombic; *mm‴* = 56° to 57°. Crystals prismatic with a brachydome, resembling arsenopyrite. Also massive.

Cleavage: prismatic. Fracture uneven. Brittle. H. = 5·5–6. G. = 6·9–7·2; 7·099, 7·158 Breith. Luster metallic. Color tin-white with a tinge of red. Streak grayish black.

**Comp.**—Same as that of chloanthite, essentially nickel diarsenide, $NiAs_2$ = Arsenic 71·9, nickel 28·1 = 100. Cobalt and iron are present in small amount.

**Anal.**—1, Hofmann, l. c. 2, Hilger, Ber. Ak. München, 202, 1871. 3, McCay, Inaug. Diss., p. 8, 1883. Some of the analyses quoted under chloanthite may belong here; cf. p. 88.

| | | As | S | Ni | Co | Fe | Cu | Bi | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Schneeberg | | 71·30 | 0·14 | 28·14 | — | — | 0·50 | 2·19 | = 102·27 |
| 2. " | G. = 7·19 | 68·30 | *tr.* | 26·65 | *tr.* | 2·06 | *tr.* | 2·66 | = 99·67 |
| 3. " | G. = 6·9 | 69·90 | 0·17 | 29·26 | 0·67 | *tr.* | — | | = 100 |

In 3, 5·11 p. c. bismuth have been deducted.

A mineral from Hüttenberg, referred here by Zepharovich, gave Weyde: As 60·40, S 5·20, Ni 13·37, Co 5·10, Fe 13·49 = 97·56. Vh. Min. Ges., 3, 90, 1868.

**Pyr.**—In the closed tube gives a sublimate of metallic arsenic; other reactions the same as with niccolite (p. 71).

**Obs.**—Occurs at Schneeberg and at Riechelsdorf. It was first separated from the isometric white nickel by Breithaupt.

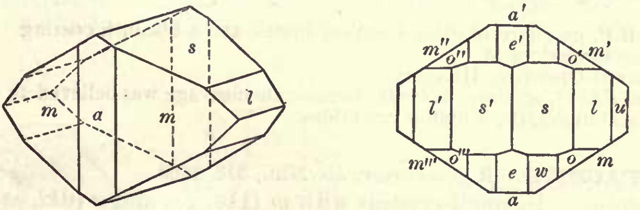
Domeyko refers here a massive mineral from Portezuelo del Carrizo, Chili, 3 to 4 leagues from Morado, Department of Huasco.

**101. GLAUCODOT.** Glaukodot *Breith. & Plattn.*, Pogg., **77**, 127, 1849. Glaucodot. Kobalt arsenkies *pt.* Glaucodote. Akontit *Breith.*, J. pr. Ch., **4**, 258, 1835.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·69416 : 1 : 1·1925 Lewis[1].

100 ∧ 110 = 34° 46′, 001 ∧ 101 = 59° 47¾′, 001 ∧ 011 = 50° 1′.

**Forms:**
*a* (100, *i*-ĭ)
*p* (610, *i*-6̄)[4]
*m* (110, *I*)
*e* (101, 1-ĭ)
*s* (012, ½-ĭ)
*l* (011, 1-ĭ)
*u* (021, 2-ĭ)[3]
*τ* (031, 3-ĭ)?
*o* (111, 1)[4]
*w* (212, 1-2̄)[4]



Hakansbö, Lewis.

*mm‴* = *69° 32′
*ee′* = 119° 35½′
*ss′* = 61° 36½′
*ll′* = *100° 2′
*uu′* = 134° 30′
*ττ′* = 148° 46′
*mo* = 25° 33½′
*oo′* = 56° 1′
*ww′* = 111° 45′
*oo‴* = 61° 55′
*ww‴* = 33° 24′

Twins: tw. pl. (1) *m*; (2) *e*, cruciform-twins, also in trillings. Crystals commonly prismatic ‖ $\breve{a}$; faces *a* vertically, also brachydomes horizontally, striated. Massive.

Cleavage: *c* rather perfect; *m* less so. Fracture uneven. Brittle. H. = 5.

G. = 5·90–6·01. Luster metallic. Color grayish tin-white. Streak black. Opaque. Shows both + and − varieties thermo-electrically[5].

**Comp.**—A sulph-arsenide of cobalt and iron, $(Co,Fe)AsS$ or $(Co,Fe)S_2.(Co,Fe)As_2$, = (if Co : Fe = 2 : 1) Sulphur 19·4, arsenic 45·5, cobalt 23·8, iron 11·3 = 100.

**Anal.**—1, Plattner, Pogg., **77**, 128, 1849. 2, Ludwig, Ber. Ak. Wien, **55** (1), 447, 1867. 3, Kobell, J. pr. Ch., **102**, 409, 1867.

| | As | S | Co | Ni | Fe |
|---|---|---|---|---|---|
| 1. Chili | 43·20 | 20·21 | 24·77 | *tr.* | 11·90 $SiO_2$ *tr.* = 100·08 |
| 2. Hakansbö G. = 5·973 | 44·03 | 19·80 | 16·06 | | 19·34 = 99·23 |
| 3. " G. = 5·96 | 44·30 | 19·85 | 15·00 | 0·80 | 19·07 $SiO_2$ 0·98 = 100 |

**Pyr.**—In the closed tube gives a faint sublimate of arsenic trioxide. In the open tube sulphurous fumes and a sublimate of arsenic trioxide. B.B. on charcoal in R.F. gives off sulphur and arsenic, fusing to a feebly magnetic globule, which is black on the surface, but on the fracture has a light bronze color and a metallic luster. Treated with borax in R.F. until the globule has a bright metallic surface, the flux shows a strong reaction for iron; if the remaining globule is treated with a fresh portion of borax in O.F., the flux becomes colored smalt-blue from oxidized cobalt.

**Obs.**—Occurs in chlorite slate with cobaltite, in the province of Huasco, Chili. In fine crystals, often twins, with chalcopyrite and pyrite at Hakansbö, Sweden; this is probably the akontite of Breithaupt, cf. Lewis, l. c. The supposed glaucodot of Orawitza is alloclasite.

Named from *γλαυκός*, *blue*, because it is used for making smalt.

**Ref.**—[1] Hakansbö, Phil. Mag., **3**, 354. 1877. Becke obtained *mm‴* = 68° 4′ to 8½′, *ll‴* = 80° 7½′, and Sbk. *mm‴* = 69° 26′, *ll‴* = 80° 0′; cf. Min. Mitth., pp. 101, 353, 1877. [2] Mlr.. Huasco, Min., 190, 1852, gives *c*, *m*, *l*. [3] Tsch., Ber. Ak. Wien, **55** (1), 447, 1867. [4] Lewis, l. c. [5] Schrauf and Dana, Ber. Ak. Wien, **69** (1), 153, 1874.

**102. ALLOCLASITE.** Alloklas *Tschermak*, Ber. Ak. Wien, **53** (1), 220, 1866. Glaucodot pt. *Breith.*

Orthorhombic. Rarely in crystals, with *mm‴* = 74°, *ee′* = 58° (*e* = 101, 1-ĭ). Commonly in columnar to hemispherical aggregates.

Cleavage: *m* perfect; *c* distinct. H. = 4·5. G. = 6·6. Color steel-gray. Streak nearly black.

**Comp.**—Probably essentially $Co(As,Bi)S$ with cobalt in part replaced by iron; that is, a glaucodot containing bismuth.

**Anal.**—1–6, Frenzel, Min. Mitth., **5**, 181, 1883. Also 5th Ed., p. 81.

| | As | Bi | S | Co | Fe | Cu |
|---|---|---|---|---|---|---|
| 1. | 33·04 | 25·99 | 18·21 | 21·06 | 3·54 | 0·20 = 102·04 |
| 2. | 28·17 | 28·65 | 16·22 | 24·46 | 3·70 | 0·45 = 101·65 |
| 3. | 28·41 | 29·19 | 15·78 | 22·50 | 3·84 | 0·28 = 100·00 |
| 4. | 30·48 | 22·96 | 18·10 | 23·29 | 3·40 | 0·16 = 98·39 |
| 5. | 32·59 | 24·07 | 18·34 | 21·66 | 3·28 | 0·16 = 100·10 |
| 6. | 28·22 | 32·83 | 16·06 | 20·25 | 2·71 | 0·22 = 100·29 |

The mechanically mixed gold has been deducted, viz.: 1·24, 1·10, 1·10, 1·20, 1·10, 1·70 p. c. respectively.

**Pyr., etc.**—B.B. on charcoal gives arsenical fumes, and a bismuth coating. Fuses to a dull globule. Soluble in nitric acid.

**Obs.**—Occurs at Orawitza, Hungary.

Named from *ἄλλος*, *κλάειν*, *to break*, because its cleavage was believed to differ from that of arsenopyrite and marcasite, which it resembles.

**103. WOLFACHITE.** *F. Sandberger*, Jb. Min., 313, 1869.

Orthorhombic. In small crystals with *m* (110, *I*), and *x* (0*kl*, *m*-ĭ) and sometimes *b* (010, *i*-ĭ), resembling arsenopyrite. Also in columnar radiated aggregates.

Brittle. Fracture uneven. H. = 4·5–5. G. = 6·372. Luster metallic. Color silver-white to tin-white. Streak black.

**Comp.**—Probably $Ni(As,Sb)S$, near corynite.

**Anal.**—Petersen, Pogg., **137**, 397, 1869.

| As | Sb | S | Ni | Co | Fe |
|---|---|---|---|---|---|
| 38·83 | 13·26 | 14·36 | 29·81 | *tr.* | 3·74 = 100 |

A little lead (1·32 p. c.) and silver (0·12) have been deducted.
**Pyr.**—See corynite.
**Obs.**—From Wolfach in Baden.

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## 3. Sylvanite Group.

| | | | | | |
|---|---|---|---|---|---|
| | | | | $\grave{a} : \overset{\mid}{b} : \acute{c}$ | $\beta$ |
| **104.** | **Sylvanite** | $(Au,Ag)Te_2$ | Monoclinic | 1·6339 : 1 : 1·1265 | 89° 35′ |
| | | | | $\breve{a} : \bar{b} : \acute{c}$ | |
| **105.** | **Krennerite** | | Orthorhombic | 0·9407 : 1 : 0·5044 | |
| | Calaverite | $AuTe_2$ | Massive | | |
| | | | | $\breve{a} : \bar{b} : \acute{c}$ | |
| **106.** | **Nagyagite** | $Au_2Pb_{14}Sb_3Te_7S_{17}$? | Orthorhombic | 0·2810 : 1 : 0·2761 | |

**104. SYLVANITE.** Weissgolderz *Müller v. Reichenstein*, Ph. Arb. eintr. Fr. Wien, Qu. 3, 48. Or blanc d'Offenbanya, ou graphique, Aurum graphicum, *v. Born*, Cat. de Raab, **2**, 467, 1790. Prismatisches weisses Golderz *v. Fichtel*, Min. Bemerk. Carpathen, **2**, 108, 1791, Min., 124, 1794; Aurum bismuticum *Schmeisser*, Min., **2**, 28, 1795. Schrifterz *Esmark*, N. Bergm. J., **2**, 10, 1798, *Wern.*, 1800. Sylvane graphique *Broch.*, 1800. Tellure ferrifère et aurifère *H.*, 1801. Schrift-Tellur *Hausm.*. 1813. Graphic Tellurium *Aikin*, 1814. Goldtellur. Tellure auro-argentifère *H.*, 1822. Sylvane *Beud.*, Tr., 1832. Sylvanit *Necker*, Min., 1835. Aurotellurite *Dana*, Min., 390, 1837. Tellursilberblende. Tellurgoldsilber. Silvanite, Oro-grafico, Silvanografico, Ital. Oro gráfico, Metal escrito *Span.*

Monoclinic. Axes $\grave{a} : \overset{\mid}{b} : \acute{c} = 1{\cdot}63394 : 1 : 1{\cdot}12653$; $\beta = 89° \, 35' = 001 \wedge 100$ Schrauf[1].

$100 \wedge 110 = 58° \, 31' \, 55''$, $001 \wedge 101 = 34° \, 27' \, 0''$, $001 \wedge 011 = 48° \, 24' \, 16''$.

**Forms**[2]:
$a$ (100, $i\text{-}\bar{\imath}$)
$b$ (010, $i\text{-}\grave{\imath}$)
$c$ (001, $O$)
$S$ (510, $i$-5)
$f$ (210, $i$-2)
$m$ (110, $I$)
$R$ (120, $i\text{-}\grave{2}$)
**m** (101, — $1\text{-}\bar{\imath}$)
$n$ (201, — $2\text{-}\bar{\imath}$)
$v$ (301, — $3\text{-}\bar{\imath}$)

$M$ ($\bar{1}01$, $1\text{-}\bar{\imath}$)
$N$ ($\bar{2}01$, $2\text{-}\bar{\imath}$)
$V$ ($\bar{3}01$, $3\text{-}\bar{\imath}$)
$x$ (012, $\tfrac{1}{2}\text{-}\grave{\imath}$)
$d$ (011, $1\text{-}\grave{\imath}$)
$K$ (021, $2\text{-}\grave{\imath}$)
$y_2$ (112, — $\tfrac{1}{2}$)
$r$ (111, — 1)
$D$ (221, — 2)
$\Upsilon_2$ ($\bar{1}12$, $\tfrac{1}{2}$)
$\xi$ ($\bar{2}23$, $\tfrac{2}{3}$)

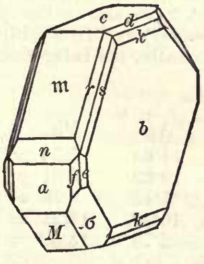
$\rho$ ($\bar{1}11$, 1)
$\Delta$ ($\bar{2}21$, 2)
$t_4$ (414, — $1\text{-}\bar{4}$)
$y_4$ (314, — $\tfrac{3}{4}\text{-}\bar{3}$)
$t_3$ (313, — $1\text{-}\bar{3}$)
$l_3$ (311, — $3\text{-}\bar{3}$)
$h$ (621, — $6\text{-}\bar{3}$)
$y_3$ (213, — $\tfrac{2}{3}\text{-}\bar{2}$)
$t_2$ (212, — 1-2)
$l$ (211, — $2\text{-}\bar{2}$)
$i_2$ (421, — $4\text{-}\bar{2}$)

$t$ (323, — $1\text{-}\overline{\tfrac{3}{2}}$)
$i$ (321, — $3\text{-}\overline{\tfrac{3}{2}}$)
$F$ (542, — $\tfrac{5}{2}\text{-}\overline{\tfrac{5}{4}}$)
$\Gamma$ ($\bar{7}21$, $7\text{-}\overline{\tfrac{7}{2}}$)
$\chi$ ($\bar{6}21$, $6\text{-}\bar{3}$)
$\lambda_3$ ($\bar{3}11$, $3\text{-}\bar{3}$)
$\lambda_2$ ($\bar{5}22$, $\tfrac{5}{2}\text{-}\overline{\tfrac{5}{2}}$)
$I_3$ ($\bar{5}21$, $5\text{-}\overline{\tfrac{5}{2}}$)
$\Upsilon_3$ ($\bar{2}13$, $\tfrac{2}{3}\text{-}\bar{2}$)
$\tau_2$ ($\bar{2}12$, $1\text{-}\bar{2}$)
$\lambda$ ($\bar{2}11$, $2\text{-}\bar{2}$)

$I_2$ ($\bar{4}21$, $4\text{-}\bar{2}$)
$\tau$ ($\bar{3}23$, $1\text{-}\overline{\tfrac{3}{2}}$)
$I$ ($\bar{3}21$, $3\text{-}\overline{\tfrac{3}{2}}$)
$\Phi$ ($\bar{5}42$, $\tfrac{5}{2}\text{-}\overline{\tfrac{5}{4}}$)
$p$ (341, — $4\text{-}\tfrac{4}{3}$)
$u$ (231, — $3\text{-}\grave{\tfrac{3}{2}}$)
$y$ (123, — $\tfrac{2}{3}\text{-}\grave{2}$)
$P$ (122, — $1\text{-}\grave{2}$)
$s$ (121, — $2\text{-}\grave{2}$)
$w$ (381, — $8\text{-}\grave{\tfrac{8}{3}}$)
$o$ (131, — $3\text{-}\grave{3}$)

$q$ (141, — $4\text{-}\grave{4}$)
$\zeta$ ($\bar{6}71$, $7\text{-}\tfrac{7}{6}$)
$\pi$ ($\bar{3}41$, $4\text{-}\tfrac{4}{3}$)
$X$ ($\bar{2}31$, $3\text{-}\tfrac{3}{2}$)
$\Upsilon$ ($\bar{1}23$, $\tfrac{2}{3}$-2)
$\Pi$ ($\bar{1}22$, $1\text{-}\grave{2}$)
$\sigma$ ($\bar{1}21$, $2\text{-}\grave{2}$)
$\Omega$ ($\bar{3}81$, $8\text{-}\grave{\tfrac{8}{3}}$)
$\omega$ ($\bar{1}31$, $3\text{-}\grave{3}$)
$Q$ ($\bar{1}41$, $4\text{-}\grave{4}$)

1.



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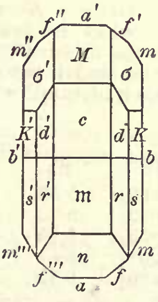

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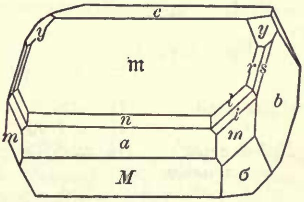


Offenbánya, etc., Schrauf.

*ff'''* = 78° 30'
*mm'''* = 117° 4'
*RR'* = 34° 2'
*cn* = 53° 47'
*cv* = 63° 52'
*cM* = 34° 43'
*cN* = 54° 19'
*xx'* = 58° 47'

*dd'* = 96° 48½'
*KK'* = 132° 8'
*cr* = 52° 44'
*cm* = 89° 47'
*cρ* = 53° 0'
*cs* = 66° 54'
*cσ* = 67° 6'
*ai* = 49° 54'

*al* = 47° 23'
*ar* = 65° 11'
*as* = 74° 13'
*a'ρ* = 65° 38'
*a'σ* = 74° 32'
*ll'* = 66° 46½'
*ii'* = 88° 43'
*rr'* = 85° 30'

*ss'* = 123° 11'
*ΔΔ'* = 106° 1'
*ρρ'* = 85° 53'
*σσ'* = 123° 30'
*bs* = 28° 25'
*br* = 47° 15'
*bσ* = 28° 15'

Twins: tw. pl. 𝔪, (1) as contact twins; (2) sometimes as twinned lamellæ; (3) as penetration-twins giving rise to branching arborescent forms resembling written characters and crossing at an angle of 69° 44′, rarely 55° 8′ as too 90°. Crystals in part nearly orthorhombic in symmetry, with *a*, or 𝔪, or *a* and *b* predominating; again monoclinic and usually with 𝔪 or *a* largely developed; *σ* also sometimes prominent. Skeleton forms common. Also bladed and imperfectly columnar to granular.

Cleavage: *b* perfect. Fracture uneven. Brittle. H. = 1·5–2. G. = 7·9–8·3. Luster metallic, brilliant. Color and streak pure steel-gray to silver-white, inclining to yellow.

**Comp.**—Telluride of gold and silver $(Au,Ag)Te_2$ with Au : Ag = 1 : 1; this requires: Tellurium 62·1, gold 24·5, silver 13·4 = 100.

**Anal.**—1, 2, Petz, Pogg., **57**, 472, 1842. 3, Sipöcz, Zs. Kr., **11**, 210, 1885. 4, Hankó, Zs. Kr., **17**, 514, 1890. 5, Genth, Am. Phil. Soc., **14**, 228, 1874. 6, F. W. Clarke, Am. J. Sc., **14**, 286, 1877. Also 5th Ed., p. 82, and Jennings, Trans. Am. Mng. Eng., **6**, 507, 1877.

| | | Te | Au | Ag | Pb | Sb | |
|---|---|---|---|---|---|---|---|
| 1. Offenbánya | G. = 8·28 | [59·97] | 26·97 | 11·47 | 0·25 | 0·58 | Cu 0·76 = 100 |
| 2. " | | [58·81] | 26·47 | 11·31 | 2·75 | 0·66 | = 100 [100·72 |
| 3. " | G. = 8·073 | 62·45 | 25·87 | 11·90 | — | — | Cu 0·10, Fe 0·40 = |
| 4. Nagyág | G. = 8·036 | 61·98 | 26·08 | 11·57 | *tr.* | — | Cu 0·09, Fe 0·30 = |
| 5. Red Cloud mine, Col. | G. = 7·94 | 59·78 | 26·36 | 13·86 | — | — | = 100 [100·02 |
| 6. Grand View mine, Col. | | 58·91 | 29 35 | 11·74 | — | — | = 100 |

**Pyr., etc.**—In the open tube gives a white sublimate of tellurium dioxide which near the assay is gray; when treated with the blowpipe flame the sublimate fuses to clear transparent drops. B.B. on charcoal fuses to a dark gray globule, covering the coal with a white coating, which treated in R.F. disappears, giving a bluish green color to the flame; after long blowing a yellow, malleable metallic globule is obtained. Most varieties give a faint coating of lead oxide and antimony trioxide on charcoal.

**Obs.**—With gold, at Offenbánya in Transylvania, in narrow veins, which traverse porphyry; also at Nagyág. In California, Calaveras Co., at the Melones and Stanislaus mines. In Boulder Co., Colorado, at the Red Cloud, Grand View and Smuggler mines; also associated with tetrahedrite near Lake City.

Named from Transylvania, the country in which it was first found, and in allusion to *sylvanium*, one of the names at first proposed for the metal tellurium. Called *graphic* because of a resemblance in the arrangement of the crystals to writing characters.

**Ref.**—[1] Zs. Kr., **2**, 211, 1878. Early made orthorhombic (Miller) but shown to be monoclinic by Koksharov. [2] From Schrauf, l. c., whom see for a careful discussion of earlier results and literature. See also Mlr., Min., 134, 1852. Kk., Bull. Ac. St. Pet., **6**, 192, 1865, or Vh. Min. Ges., **1**, 6, 1866; also Min. Russl., **10**, 165, 1889.

MÜLLÉRINE *Beud.*, Tr., **2**, 541, 1832. Gelberz *Karsten*, Tab., 56, 1800. Weisstellur, Weisserz, *Petz*, Pogg., **57**, 473, 1842. A white to brass-yellow telluride from Nagyág, occurring in bladed foliated forms, cleavable and massive. Analyses have shown the presence of antimony and lead, in part due to impurities, and it has been formerly referred with a question to sylvanite. Krenner and Schrauf make it identical with krennerite, see references under these species.

**Anal.**—Petz, l. c.

| | | Te | Sb | Au | Ag | Pb | |
|---|---|---|---|---|---|---|---|
| 1. *White cryst.* | G. = 8·27 | [55·39] | 2·50 | 24·89 | 14·68 | 2·54 | = 100 |
| 2. " | G. = 7·99 | [48·40] | 8·42 | 28·98 | 10·69 | 3·51 | = 100 |
| 3. *Yellow cryst.* | G. = 8·33 | [51·52] | 5·75 | 27·10 | 7·47 | 8·16 | = 100 |
| 4. " *massive* | | [44·54] | 8·54 | 25·31 | 10·40 | 11·21 | = 100 |
| 5. " " | | [49·96] | 3·82 | 29·62 | 2·78 | 13·82 | = 100 |

Named after Fr. J. Müller von Reichenstein (1740–1825), the discoverer of tellurium (1782).

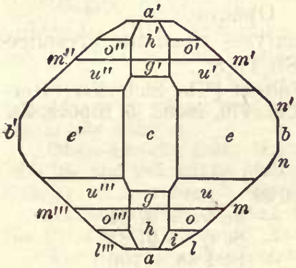
**105. KRENNERITE.** Bunsenin *Krenner* [Termesz. Füzetek, 1877], Wied. Ann., **1**, 637, 1877. Krennerite *vom Rath*, Ber. Ak. Berlin, 292, 1877; Zs. Kr., **1**, 614, 1877.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}94071 : 1 : 0{\cdot}50445$ Rath [1].
$100 \wedge 110 = 43° 15'$, $001 \wedge 101 = 28° 12\tfrac{1}{6}'$, $001 \wedge 011 = 26° 46\tfrac{1}{6}'$.

| | | | | | |
|---|---|---|---|---|---|
| **Forms:** | *c* (001, *O*) | *m* (110, *I*) | *g* (102, ½-ī) | ~~*τ* (301, 3-ī)~~[2] | *ω* (211, 2-2̄) |
| *a* (100, *i*-ī) | *k* (210, *i*-2̄) | *n* (120, *i*-2̆) | *h* (101, 1-ī) | *e* (011, 1-ĭ) | *i* (322, $\tfrac{3}{2}$-$\tfrac{\breve{3}}{2}$) |
| *b* (010, *i*-ĭ) | *l* (320, *i*-$\tfrac{\breve{3}}{2}$) | *s* (130, *i*-3̆) | *ρ* (201, 2-ī)[2] | *o* (111, 1) | *u* (122, 1-2̆) |

| | | | |
|---|---|---|---|
| *ll'''* = 64° 11′ | *gg'* = 30° 1′ | *co* = 36° 22′ | *oo'''* = 47° 56′ |
| *mm'''* = *86° 30′ | *hh'* = 56° 24′ | *oo'* = 51° 10′ | *ii'''* = 42° 55′ |
| *nn'* = 55° 59′ | *ee'* = 53° 32′ | *uu'* = 26° 55½′ | *me* = *72° 1½′ |

In prismatic crystals, vertically striated.



Cleavage: *c* perfect. Fracture subconchoidal to uneven. Brittle. G. = 8·353 Sipöcz. Luster metallic, brilliant. Color silver-white to brass-yellow. Opaque.

**Comp.**—A telluride of gold and silver, composition uncertain.

**Anal.**—1*a*, Scharizer, Jb. G. Reichs., **30**, 604, 1880; 1*b*, after deducting admixed stibnite assumed to be present. 2, Sipöcz, Zs. Kr., **11**, 210, 1885.

Anal. 1*b* corresponds to $AgAuTe_2$ (or $Ag_2Te.Au_2Te_3$) = Te 45·1, Au 35·5, Ag 19·4 = 100. Schrauf obtained Te [48], Au 31, Ag 21 = 100, Zs. Kr., **2**, 236, 1878. Anal. 2, on the contrary, is $(Ag,Au)Te_2$ like sylvanite, with Ag : Au = 3 : 10.

| | | Te | Au | Ag | Sb | |
|---|---|---|---|---|---|---|
| 1*a*. | G. 5·598 | 39·14 | 30·03 | 16·69 | [9·75] | S 4·39 = 100 |
| 1*b*. | | 45·59 | 34·97 | 19·44 | | = 100 |
| 2. | G. 8·353 | 58·60 | 34·77 | 5·87 | 0·65 | Cu 0·34, Fe 0·59 = 100·82 |

**Pyr.**—Decrepitates violently; see sylvanite and calaverite.
**Obs.**—Found at Nagyág, Transylvania, associated with quartz and pyrite.
**Ref.**—[1] Knr., and Rath, l. c., and Zs. Kr., **2**, 252, 1878. [2] Schrauf, ib., **2**, 235. See also p. 1039.

Calaverite *F. A. Genth*, Am. J. Sc., **45**, 314, 1868.

Massive, indistinctly crystalline. Brittle. Fracture uneven, inclining to subconchoidal. H. = 2·5. G. = 9·043. Color pale bronze-yellow. Streak yellowish gray.

**Comp.**—Like sylvanite $(Au,Ag)Te_2$ with Au : Ag = 6 : 1 or 7 : 1, the latter (anal. 4) requires: Tellurium 57·4, gold 39·5, silver 3·1 = 100.

**Anal.**—1–4, Genth. 1, 2, l. c. 3, Am. Phil. Soc., **14**, 229, 1874. 4, Ib., **17**, 117, 1877. From 2, 1·45 p. c. quartz deducted, from 4, 4·96 p. c.

| | | | Te | Au | Ag |
|---|---|---|---|---|---|
| 1. | California | | 55·89 | 40·70 | 3·52 = 100·11 |
| 2. | " | | [56·00] | 40·92 | 3·08 = 100 |
| 3. | Boulder Co., Col. | | 57·67 | 40·59 | 2·24 = 100·50 |
| 4. | " | G. = 9·043 | 57·32 | 38·75 | 3·03 = 99·10 |

**Pyr., etc.**—B.B. on charcoal fuses with a bluish green flame, yielding globules of very yellow gold. Dissolves in aqua regia, with separation of silver chloride.

Occurs with petzite at the Stanislaus mine, Calaveras county, California. Also at the Red Cloud mine, Colorado, with sylvanite and quartz; and at the Keystone and Mountain Lion mines.

Calaverite has the same general formula as sylvanite but a much higher percentage of gold, and may belong with it; or if anal. 2 of krennerite expresses its true composition, it may be the crystallized form of calaverite.

**106. NAGYAGITE.** Aurum Galena, Ferro et particulis volatilibus mineralisatum, *Scopoli*, Ann. Hist. Nat., **3**, 107; *v. Born*, Lithoph., **1**, 68, 1772. Nagiakererz *Wern.* Bergm. J., 1789. Or gris lamelleux *v. Born*, Cat. de Raab, 1790. Blättererz *Karst.*, Tab., 56, 1800. Foliated Tellurium; Black Tellurium. Elasmose *Beud.*, Tr., **2**, 539, 1832. Elasmosine *Huot*, Min., **1**, 185, 1841. Nagyagite *Haid.*, Handb., 566, 1845.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·28097 : 1 : 0·27607$ Schrauf[1].
$100 \wedge 110 = 15° 41\frac{2}{3}'$, $001 \wedge 101 = 44° 29\frac{3}{4}'$, $001 \wedge 011 = 15° 26'$.

**Forms**[2]: $e$ (120, $i$-$\breve{2}$) $\epsilon$ (101, 1-$\bar{i}$) $g$ (051, 5-$\breve{i}$) $r$ (121, 2-$\breve{2}$) $x$ (131, 3-$\breve{3}$)
$b$ (010, $i$-$\breve{i}$) $i$ (130, $i$-$\breve{3}$) $d$ (011, 1-$\breve{i}$) $t$ (111, 1) $p$ (252, $\frac{5}{2}$-$\frac{5}{2}$) $y$ (141, 4-$\breve{4}$)
$m$ (110, $I$) $o$ (160, $i$-$\breve{6}$) $f$ (031, 3-$\breve{i}$) $s$ (343, $\frac{4}{3}$-$\frac{4}{3}$)

$mm''' = 31° 23'$ $\epsilon\epsilon' = 88° 59\frac{1}{2}'$ $tt' = 86° 53'$ $ss''' = 29° 25'$
$ee''' = 58° 40'$ $dd' = 30° 52'$ $tt'' = 91° 10'$ $pp''' = 52° 25'$
$be = {}^*60° 40'$ $bd = {}^*74° 34'$ $tt''' = 22° 17'$ $xx''' = 61° 9'$
$ii''' = 80° 15'$ $ff' = 79° 16'$ $rr' = 81° 24'$ $yy''' = 76° 27'$
$oo''' = 118° 39'$ $gg' = 108° 9\frac{1}{2}'$ $rr''' = 42° 59\frac{1}{2}'$

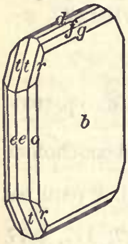
Crystals tabular ‖ *b*. Faces *b* striated ‖ *a* and *c*. Also granular massive, particles of various sizes; generally foliated.

Cleavage: *b* perfect. Thin laminæ flexible. H.=1–1·5. G.=6·85–7·2. Luster metallic, splendent. Streak and color blackish lead-gray. Opaque.

**Comp.**—A sulpho-telluride of lead and gold; recent analyses show the presence also of about 7 p. c. of antimony. Sipöcz writes $Au_2Pb_{14}Sb_3Te_7S_{17}$.

**Anal.**—1, P. Schönlein, J. pr. Ch., **60**, 166, 1853. 2, 3, Folbert [Vh. Sieb. Ver. Hermannstadt, **8**, 99] Kenng., Ueb., 179, 1856. 4, S. J. Kappel, JB. Ch., 770, 1859. 5, Sipöcz, Zs. Kr., **11**, 211, 1885. 6, Hankó, Zs. Kr., **17**, 514, 1890.

| | | Te | S | Sb | Pb | Au | Ag | Cu | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | | 30·52 | 8·07 | — | 50·78 | 9·11 | 0·53 | 0·99 | = 100 |
| 2. | G. = 6·85 | 17·22 | 9·76 | 3·69 | 60·83 | 5·84 | — | — | Se *tr.* = 97·34 |
| 3. | | 18·04 | 9·68 | 3·86 | 60·27 | 5·98 | — | — | Se *tr.* = 97·83 |
| 4. | | 15·11 | 8·56 | — | 60·10 | 12·75 | 1·82 | — | Se 1·66 = 100 |
| 5. | G. = 7·46 | 17·72 | 10·76 | 7·39 | 56·81 | 7·51 | — | — | Fe 0 41 = 100·60 |
| 6. | G. = 7·347 | $\frac{2}{2}$ 17·87 | 10·03 | 6·99 | 57·16 | 7·41 | — | — | Fe 0·32 = 99·78 |



Schrauf.

**Pyr.**, etc.—In the open tube gives, near the assay, a grayish sublimate of antimonate and tellurate, with perhaps some sulphate of lead; farther up the tube the sublimate consists of antimony trioxide, which volatilizes when treated with the flame, and tellurium dioxide, which at a high temperature fuses into colorless drops. B.B. on charcoal forms two coatings: one white and volatile, consisting of a mixture of antimonate, tellurate, and sulphate of lead; and the other yellow, less volatile, of lead oxide quite near the assay. If the mineral is treated for some time in O.F. a malleable globule of gold remains; this cupelled with a little assay lead assumes a pure gold color. Decomposed by aqua regia.

**Obs.**—At Nagyág in Transylvania, in foliated masses and crystalline plates, accompanying rhodonite, sphalerite, and gold; and at Offenbánya associated with antimonial ores. Reported from Colorado with other tellurides.

Berthier has analyzed another ore, very similar to the above in physical characters, consisting of: Tellurium 13·0, sulphur 11·7, lead 63·1, gold 6·7, antimony 4·5, copper 1·0 = 100. It is called *Blatterine* (Blätterin, Blättererz *Germ.*) by Huot, Min., **1**, 189, 1841.

**Ref.**—[1] Zs. Kr., **2**, 239, 1878, earlier regarded as tetragonal, to which it closely approximates; cf. also Fletcher, Phil. Mag., **9**, 188, 1880.

SILBERPHYLLINGLANZ *Breith.*, Schw. J., **1**, 178, 1828. Nobilite *Adam*, Tabl. Min., 35, 1869. Occurs in gneiss at Deutsch-Pilsen, Hungary, appears to be related to nagyagite Color blackish gray. Structure foliated massive. One perfect cleavage. H. = 1·2. G. = 5·8–5·9.

According to Plattner (Probirkunst, 3d Ed., 421) the constituents are: antimony, lead, tellurium, gold, silver, and sulphur—4·9 p. c. of gold, 0·3 of silver—the sulphur probably in combination with the antimony and lead. Only a trace of selenium was found, contrary to the earlier determinations of Harkort and Breithaupt.

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## Oxysulphides.

| | | | | |
|---|---|---|---|---|
| **107.** | **Kermesite** | $Sb_2S_2O$ | Monoclinic | $\dot{a} : \dot{c} = 1 : 1·4791$ $\beta = 77° 51'$ |
| **108.** | **Voltzite** | $Zn_5S_4O$ | | |

**107. KERMESITE.** Röd Spitsglasmalm, Antimonium Sul. et Ars. mineralisatum, Minera Ant. colorata, *Wall.*, 239, 1747 (fr. Bräunsdorf), *Cronst.*, 203, 1758. Antimonium plumosum *v. Born*, Lithoph., **1**, 137, 1772. Mine d'antimoine en plumes, ib. granuleuse, = Kermes mineral natif, *Sage*, Min., **2**, 251, 1779, *de Lisle*, Crist., **3**, 56, 60, 1783. Roth-Spiesglaserz *Wern.*, 1789. Rothspiessglanzerz *Emmerling*, Min., 1793; *Klapr.*, Beitr., **3**, 132, 1802 (with anal., making it an oxysulphide). Antimoine oxydé sulfuré *H.*, Tabl., 1809. Red antimony. Spiessglanzblende pt. *Hausm.* Handb., 225, 1813. Antimony Blende *Jameson*, Min. **3**, 421, 1820. Antimonblende *Leonh.*, Handb., 157, 1821. Kermès *Beud.*, Tr., **2**, 617, 1832. Kermesite *Chapman*, Min., 61, 1843. Pyrostibit *Glock.*, Syn., 16, 1847. Pyrantimonite *Breith.* Antimonio rosso *Ital.* Antimonio rojo *Span.*

Monoclinic. Axes $\grave{a} : \acute{c} = 1 : 1{\cdot}4791$; $\beta = {}^{*}77° \, 51' = 001 \wedge 100$ Kenngott[1].

**Forms:** *a* (100, *i-ī*, *p*), *c* (001, *O*, *u*), *s* ($\bar{1}03$, $\frac{1}{3}$-$\bar{\imath}$), *o* ($\bar{1}01$, 1-$\bar{\imath}$).
Angles: *cs* = 28° 16′, *co* = 64° 32′, *a′o* = *37° 37′.

Usually in tufts of capillary crystals, prismatic ‖ orthodiagonal.

Cleavage: *a* perfect. Sectile; thin leaves slightly flexible. H. = 1–1·5. G. = 4·5–4·6. Luster adamantine, inclining to metallic. Color cherry-red. Streak brownish red. Feebly translucent.

**Comp.**—Antimony oxysulphide, $Sb_2S_2O$ or $2Sb_2S_3.Sb_2O_3$ = Antimony trisulphide 70·0, antimony trioxide 30·0 = 100; or antimony 75·0, sulphur 20·0, oxygen 5·0 = 100. Analyses, Rose, 5th Ed., p. 187.

**Pyr., etc.**—In the closed tube blackens, fuses, and at first gives a white sublimate of antimony trioxide; with strong heat gives a black or dark-red sublimate. In the open tube and on charcoal reacts like stibnite.

**Obs.**—Results from the alteration of stibnite. Occurs in veins in quartz, accompanying stibnite and valentinite at Malaczka near Posing in Hungary; at Bräunsdorf near Freiberg in Saxony; at Allemont in Dauphiné; at New Cumnock in Ayrshire, Scotland.

At South Ham, Wolfe Co., Quebec, Canada; in cavities in native antimony and stibnite at the Prince William mine, York Co., New Brunswick.

The *tinder ore* (*Zundererz*) has been shown to be wholly distinct from red antimony.

Named from *kermes*, a name given (from the Persian *qurmizq*, crimson) in the older chemistry to red amorphous antimony trisulphide, often mixed with antimony trioxide.

**Ref.**—[1] Min. Unt., **1**, 1, 1849, Breslau; cf. Mohs, Min., **2**, 598, 1824.

**108. VOLTZITE.** Voltzine *Fournet*, Ann. Mines, **3**, 519, 1833. Leberblende *Breith.*, J. pr. Ch., **15**, 333, 1838, B. H. Ztg., **22**, 26. Voltzit *Rg.*, Handw., 260, 1841.

In implanted spherical globules; structure thin curved lamellar.

H. = 4–4·5. G. = 3·66–3·80. Luster vitreous to greasy; or pearly on a cleavage surface. Color dirty rose-red, yellowish, brownish. Opaque or subtranslucent. Optically uniaxial, positive.

**Comp.**—Zinc oxysulphide, $Zn_5S_4O$ or $4ZnS.ZnO$ = Zinc sulphide 82·7, zinc oxide 17·3 = 100.

**Anal.**—1, Fournet, l. c. 2, Lindaker, Vogl's Min. Joach., 175.

| | | ZnS | ZnO | $Fe_2O_3$ |
|---|---|---|---|---|
| 1. Rosières | G. = 3·66 | 82·82 | 15·34 | 1·84 = 100 |
| 2. Joachimsthal | | 82·75 | 17·25 | — = 100 |

**Pyr., etc.**—B.B. like sphalerite. In hydrochloric acid affords fumes of hydrogen sulphide.

**Obs.**—Occurs at Rosières, near Pont Gibaud, in Puy de Dôme; Elias mine near Joachimsthal, with galena, sphalerite, native bismuth, etc.; near Marienberg (the *leberblende*); Hochmuth near Geyer; at Bernkastel on the Mosel, in pseudomorphs after quartz; Cornwall, probably at Redruth.

Named after the French mining engineer, Voltz.

Supposed artificial voltzite from the Freiberg smelting-works has been shown to be sphalerite.

## Appendix to Sulphides, etc.

**Arsenotellurite.** *Hannay* J. Ch. Soc., **26**, 989, 1873. A supposed new telluride. Stated to occur in small brownish scales upon arsenical iron-pyrites. Analysis: Te 40·71, As 23·61, S 35·81 = 100·13. No locality given.

**Bolivianite.** Bolivian *Breith.*, B. H. Ztg., **25**, 188, 1866. Orthorhombic. In acicular rhombic prisms, tufts, and fine columnar. Resembles stibnite. H. = 2·5. G. = 4·820–4·828. Cleavage: brachydiagonal distinct. Luster submetallic. Color lead-gray, a little darker than in stibnite. According to T. Richter, an antimonial silver sulphide containing 8·5 p. c. of silver. From Bolivia.

**Kaneite.** *R. J. Kane*, Q. J. Sci., **28**, 381, 1829; *Haid.*, Handb. 559, 1845. Arsenikmangan. Described as a manganese arsenide ($MnAs$) occurring in botryoidal, granular masses attached to galena. G. = 5·55. Color grayish white, tarnishing black. Luster metallic. Supposed to be from Saxony. Needs confirmation.

**Plakodin.** *Breithaupt*, Pogg., **53**, 631, 1841. Plattner, ib., 58, 283, 1843. Placodine. A supposed nickel arsenide ($NiAs_2$) in monoclinic tabular crystals. Stated by Breithaupt to occur at Müsen, near Siegen, with siderite and gersdorffite, but probably only a furnace product. Cf. Schnabel, Pogg., **84**, 585, 1851; Rose, Kr.-Ch. Min., 47, 1852. Dana, Min., 3d Ed., 475, 1850.

**Plumbomanganite.** *Hannay*, Min. Mag., **1**, 151, 1877. Massive, crystalline. G. = 4·01. Color dark steel-gray, with a bronze tinge when exposed to the air for some time. Analysis: Mn 49·00, Pb 30·68, S 20·73 = 100·41. Of unknown source.

**Plumbostannite.** *A. Raimondi*, Minéraux du Pérou, p. 187, 1878.

Amorphous; structure granular. H. = 2. Feel greasy, like graphite. Slightly ductile. Luster feebly metallic. Color gray. Analysis (deducting 38·8 p. c. quartz):

G. = 4·5 S 25·14 Sb 16·98 Sn 16·30 Pb 30·66 Fe 10·18 Zn 0·74 = 100

B.B. gives on charcoal antimonial fumes and a lead coating: yields metallic tin. Dissolves completely in hydrochloric acid to which a little nitric acid has been added. With concentrated nitric acid leaves a white residue of the oxides of tin and antimony and lead sulphate.

From the district of Moho, province of Huancané, Peru; occurs with cassiterite and sphalerite.

**Sulphide of Copper and Silver.** A massive mineral from the Gagnon mine, near Butte, Montana. resembling bornite has been described by R. Pearce. H. = 3·5–4. G. = 4·95. Analysis: S 20·51, Cu 41·10, Ag 24·66, Zn 9·80, Fe 2·09, insol. 1·02 = 99·18. This conforms to $3Cu_2S.Ag_2S.2ZnS$. Col. Sc. Soc., **2**, 70, 1887. Hillebrand obtained for the same mineral: S 20·88, Cu 40·24, Ag 21·80, Zn 12·83, Fe 1·98, Pb 1·46 = 99·19. G. = 5·407. Ibid., **3**, 45, 1888. It is not certain that the mineral was homogeneous. Cf. jalpaite, p. 47; castillite, p. 78.

Another ore from Idaho Springs, Col., is regarded by Pearce as a mixture of bornite and stromeyerite (ibid., p. 188); it gave: S 19·40, Cu 42·49, Ag 26·31, Fe 6·22, Pb, insol. *undet.* = 94·42.

**Valleriite.** *Blomstrand*, Öfv. Ak. Stockh., **27**, 19, 1870. A massive metallic mineral resembling pyrrhotite in color; very soft. Contains sulphur, copper, iron, alumina, magnesia, and water. Of doubtful purity. Found sparingly at the Aurora mine, Nya-Kopparberg, Sweden. Named for the Swedish mineralogist Vallerius. For analyses see 5th Ed., App. II., p. 58, 1875.

**Youngite.** *Hannay*, Min. Mag., **1**, 152, 1877; **2**, 88, 1878. A metallic mineral of doubtful homogeneity, containing sulphur, lead, zinc, iron, and manganese. One specimen analyzed was of unknown source, another from Ballarat, Australia. For analyses, etc., see 5th Ed., App. III., p. 133, 1882.

# III. SULPHO-SALTS.

## I. Sulpharsenites, Sulphantimonites, Sulphobismuthites.

## II. Sulpharsenates, etc.

The species here included are chiefly salts of the sulpho-acids of trivalent arsenic, antimony and bismuth. The most important acids are the ortho-acids, $H_3AsS_3$, etc., and the meta-acids, $H_2AsS_2$, etc.; but $H_4As_2S_5$, etc., and a series of others are included. A smaller section includes the sulpharsenates, etc., chiefly normal salts of the acid $H_3AsS_4$, analogous to $H_3AsO_4$. The metals present as bases are chiefly copper, silver, lead; also, iron, zinc, mercury, rarely others (as Ni,Co) in small amount. In view of the hypothetical character of many of the acids whose salts are here represented, there is a certain advantage, for the sake of comparison, in writing the composition after the dualistic method, $RS.As_2S_3$, $2RS.As_2S_3$, etc.

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## I. Sulpharsenites, Sulphantimonites, etc.

| | |
|---|---|
| **A. Acidic Division.** | $RS : (As,Sb,Bi)_2S_3 = 1 : 2,\ 2 : 3,\ 3 : 4,\ 4 : 5.$ |
| **B. Meta- Division.** | $RS : (As,Sb,Bi)_2S_3 = 1 : 1.$ |
| General formula: | $RAs_2S_4$, $RSb_2S_4$, $RBi_2S_4$. |
| **C. Intermediate Division.** | $RS : (As,Sb,Bi)_2S_3 = 5 : 4,\ 3 : 2,\ 2 : 1,\ 5 : 2.$ |
| **D. Ortho- Division.** | $RS : (As,Sb,Bi)_2S_3 = 3 : 1.$ |
| General formula: | $\overset{II}{R}_3As_2S_6$, $\overset{II}{R}_3Sb_2S_6$, etc. Also $\overset{I}{R}_3AsS_3$, $\overset{I}{R}_3SbS_3$. |
| **E. Basic Division.** | $RS : (As,Sb,Bi)_2S_3 = 4 : 1,\ 5 : 1,\ 6 : 1,\ 9 : 1,\ 12 : 1.$ |

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### A. Acidic Division.

| | | |
|---|---|---|
| 109. | **Livingstonite** | $HgS.2Sb_2S_3$ |
| 110. | **Guejarite** | $Cu_2S.2Sb_2S_3$ Orthorhombic $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}8221 : 1 : 0{\cdot}7841$ |
| 111. | **Chiviatite** | $2PbS.3Bi_2S_3$ |
| 112. | **Cuprobismutite** | $3Cu_2S.4Bi_2S_3$ |
| 113. | **Rezbanyite** | $4PbS.5Bi_2S_3$ |

**109. LIVINGSTONITE.** *Mariano Barcèna*, Naturaleza, 3, 35, 172, 1874. Am. J. Sc., **8**, 145, 1874; **9**, 64, 1875.

In groups of slender prismatic crystals; also columnar massive, resembling stibnite.

H. = 2. G. = 4·81. Luster metallic. Color bright lead-gray. Streak red. Opaque.

**Comp.**—$HgSb_4S_7$ or $HgS.2Sb_2S_3$ = Sulphur 22·1, antimony 53·1, mercury 24·8 = 100.

**Anal.**—1, Barcena, l. c. 2, Id., Naturaleza, **4**, 268, 1879. 3, Venable, Chem. News, **40**, 186, 1879. 4, Page, ib., **42**, 195, 1880.

| | S | Sb | Hg | |
|---|---|---|---|---|
| 1. Huitzuco | 29·08 | 53·12 | 14·00 | Fe 3·50 = 99·70 |
| 2. " | 22·97 | 53·12 | 20·00 | gangue and loss 3·91 = 100 |
| 3. " | $\frac{2}{2}$ 23·73 | 53·75 | 22·52 | = 100 |
| 4. Guadalcazar | 24·50 | 52·21 | 22·61 | Fe 0·68 = 100 |

The results under (3) and (4) have been obtained by recalculation, after deducting impurities (chiefly gypsum, free sulphur, insol. residue), viz. in (3), 13 to 16 p. c., in (4), 37·6 p. c. Groth suggests that the formula may more properly be written $Hg_2S.4Sb_2S_3$ = Sulphur 21·9, antimony 57·0, mercury 21·1 = 100.

**Pyr.**, etc.—B.B. very fusible, giving off white antimonial fumes freely. Yield's metallic mercury in the open tube, or in the closed tube with soda. Not sensibly attacked by cold nitric acid, but dissolved by warm acid, with the separation of antimony trioxide.

**Obs.**—Occurs at Huitzuco, State of Guerrero, Mexico, in a matrix of calcite and gypsum with sulphur, cinnabar, stibnite, and valentinite. Also at Guadalcazar, in San Luis Potosi, with gypsum, sulphur, etc.

Named after David Livingstone (1813–1873), the African explorer and missionary.

**Alt.**—Page (l. c.) gives an analysis of an ill-defined alteration product of livingstonite.

**Artif.**—Baker, by fusing together HgS and $Sb_2S_3$ in an atmosphere of $CO_2$ has obtained a crystalline mass resembling livingstonite and yielding on analysis: S 24·83, Sb 53·20, Hg 22·71 = 100·74. Chem. News, **42**, 196, 1880.

**110. GUEJARITE.** *Cumenge*, Bull. Soc. Min., **2**, 201, 1879.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·8221 : 1 : 0·7841 Friedel[1].

$100 \wedge 110 = 39° 25\frac{1}{2}'$, $001 \wedge 101 = 43° 39'$, $001 \wedge 011 = 38° 6'$.

**Forms:** *b* (010, *i*-ĭ), *c* (001, *O*); *h* (210, *i*-$\bar{2}$), *k* (320, *i*-$\frac{3}{2}$)[2]?, *m* (110, *I*), *l* (230, *i*-$\frac{3}{2}$)[2]?; *d* (013, $\frac{1}{3}$-ĭ), *e* (011, 1-ĭ). Also doubtful 410, 310, 032, and two pyramids *x*, *z*, with *bx* = 56° 24′, *bz* = 39° 58′.

Angles: *hh‴* = 44° 41′, *bh* = *67° 39$\frac{1}{3}$′, *kk‴* = 57° 27′, *mm‴* = 78° 51′, *ll′* = 78° 5′; *dd′* = 29° 18′, *ee′* = 76° 12′, *be* = *51° 54′.

In prismatic crystals, flattened ∥ *b*.

Cleavage: *b* nearly perfect. Brittle. H. = 3·5. G. = 5·03. Luster metallic. Color steel-gray, with a tinge of blue. Streak black. Opaque.

**Comp.**—$Cu_2Sb_4S_7$ or $Cu_2S.2Sb_2S_3$ = Sulphur 27·0, antimony 57·8, copper 15·2 = 100.

**Anal.**—Cumenge, l. c.

S 25·0 Sb 58·5 Cu 15·5 Fe 0·5 Pb *tr.* = 99·5

**Pyr.**—B.B. on charcoal gives off antimonial fumes, and yields metallic copper when treated with soda.

**Obs.**—Occurs with siderite at the copper mines at the foot of Muley-Hacen, in the district of Guejar, Sierra Nevada, Andalusia.

**Ref.**—[1] Bull. Soc. Min., **2**, 203, 1879. [2] Given as (730) and (370) which correspond with the angles less well than these, which, however, are only approximate.

**111. CHIVIATITE.** Chiviatit *Rammelsberg*, Pogg., **88**, 320, 1853.

Foliated massive; resembling bismuthinite.

Cleavage in three directions in one zone, one making an angle with the second of 27°, and with the third of 47°, Mlr. G. = 6·920. Luster metallic. Color lead-gray.

**Comp.**—$Pb_2Bi_6S_{11}$ or $2PbS.3Bi_2S_3$=Sulphur 17·5, bismuth 61·9, lead 20·6=100. Part of the lead is replaced by copper.

**Anal.**—Rammelsberg, l. c.

| S | Bi | Pb | Cu | Fe | Ag | insol. |
|---|---|---|---|---|---|---|
| 18·00 | 60·95 | 16·73 | 2·42 | 1·02 | *tr.* | 0·59 = 99·71 |

**Pyr.**—Same as for aikinite, Rg.

**Obs.**—From Chiviato, in Peru, with pyrite and barite.

**112. CUPROBISMUTITE.** Sulphobismuthite of copper and silver *Hillebrand*, Am. J. Sc., **27**, 355, 1884. Kupfersulfobismutit *Brezina*. Cuprobismutite *Dana*.

In groups of slender prismatic crystals, deeply striated longitudinally and resembling bismuthinite; also compact.

G. = 6·31–6·68. Luster metallic. Color dark bluish black. Streak black. Opaque.

**Comp.**—Probably $Cu_6Bi_8S_{16}$ or $3Cu_2S.4Bi_2S_3$ = Sulphur 19·1, bismuth 65·9, copper 15·0 = 100. The copper is sometimes in part replaced by silver.

**Anal.**—1–3, Hillebrand, l. c.

| | S | Bi | Cu | Ag | Pb | Fe | Zn |
|---|---|---|---|---|---|---|---|
| 1. Missouri Mine | 19·94[a] | 60·80 | 15·96 | 0·89 | — | 2·13 | 0·10 = 99·82 |
| 2. " | 18·83[a] | 63·42 | 12·65 | 4·09 | — | 0·59 | 0·07 = 99·65 |
| 3. Missouri Mine? | 17·90 | 62·51 | 6·68 | 9·89 | 2·74 | 0·10 | 0·07 = 99·89 |

[a] Calculated.

From (1) 4·43 p. c. gangue have been deducted; from (2) 59·75 p. c.; from (3) 47·57 p. c. There remain in (1) 6·97 chalcopyrite; in (2) 1·91 p. c.; in (3) 0·33 p. c.; also a little sphalerite. Deducting these the ratio of $R_2$ : Bi : S corresponds to 3 : 8 : 15.

**Pyr., etc.**—In the closed tube a sublimate of sulphur; a bismuth coating on charcoal; soluble in acids.

**Obs.**—Occurs in a quartz gangue associated with chalcopyrite and wolframite at the Missouri mine, Hall's Valley, Park Co., Colorado; the ore is auriferous, sometimes highly so.

DOGNACSKAITE Földt. Közl., **14**, 564, 1884. Briefly mentioned by Krenner as a "Wismuthkupfererz" with the following characters:

Cleavage in one direction; color gray, tarnishing on exposure to the air. Analysis by Maderspach:

S 15·75 Bi 71·79 Cu 12·28 = 99·82

Occurs at Dognácska, Hungary, with gold, pyrite, chalcocite, and bismuth ocher.

**113. REZBANYITE** *A. Frenzel*, Min. Mitth., 5, 175, 1883.

Massive; fine granular to compact.

Cleavage indistinct. H. = 2·5–3. G. = 6·09–6·38. Luster metallic. Color light lead-gray, becoming darker. Streak black. Opaque.

**Comp.**—$Pb_4Bi_{10}S_{19}$ or $4PbS.5Bi_2S_3$=Sulphur 17·3, bismuth 59·1, lead 23·6=100.

**Anal.**—1–3, Frenzel, l. c.

| | S | Bi | Pb | Ag | Cu | Zn |
|---|---|---|---|---|---|---|
| 1. | 17·85 | 59·08 | 19·80 | 1·89 | 1·71 | *tr.* = 100·33 |
| 2. | 16·61 | 62·57 | 15·10 | 1·89 | 3·71 | 0·12 = 100 |
| 3. | 16·89 | 62·88 | 13·88 | 2·46 | 3·77 | 0·12 = 100 |

The above results obtained after the deduction of chalcopyrite: in (1) 4·64 p. c., in (2) 3·63, in (3) 6·58; also calcite in (1) 5·00 p. c., in (2) [4·72], in (3) [4·08].

**Obs.**—Occurs at Rezbanya, Hungary, intimately mixed with chalcopyrite and calcite; also embedded in quartz. Named from the locality. The same name was given by Hermann to a lead-gray bismuth ore from Rezbanya, which was probably an impure cosalite, cf. p. 121.

**Pyr.**—Like galenobismutite.

## B. Meta-Division. $RAs_2S_4$, $RSb_2S_4$, $RBi_2S_4$.

### Zinkenite Group. $RS.(As,Sb,Bi)_2S_3$. Orthorhombic.

| | | | $\breve{a} : \bar{b} : \acute{c}$ |
|---|---|---|---|
| **114.** | **Zinkenite** | $PbS.Sb_2S_3$ | 0·5575 : 1 : 0·6353 |
| **115.** | **Sartorite** | $PbS.As_2S_3$ | 0·5389 : 1 : 0·6188 |
| **116.** | **Emplectite** | $Cu_2S.Bi_2S_3$ | 0·5430 : 1 : 0·6256 |
| **117.** | **Chalcostibite** | $Cu_2S.Sb_2S_3$ | 1 : 0·6065 |
| **118.** | **Galenobismutite** | $PbS.Bi_2S_3$ | |
| **119.** | **Berthierite** | $FeS.Sb_2S_3$ | |

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**120. Matildite** $Ag_2S.Bi_2S_3$

Plenargyrite

It is uncertain whether matildite and plenargyrite are the same species, isomorphous with miargyrite; or whether, as seems probable, the compound $AgBiS_2$

is dimorphous, matildite belonging to the zinkenite group, and plenargyrite with miargyrite.

| | | | | $\grave{a} : \bar{b} : \dot{c}$ | β |
|---|---|---|---|---|---|
| 121. | **Miargyrite** | $Ag_2S.Sb_2S_3$ | Monoclinic | 2·9945 : 1 : 2·9095 | 81° 23′ |

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## Zinkenite Group.

**114. ZINKENITE.** Zinkenit *G. Rose*, Pogg., **7**, 91, 1826. Bleiantimonglanz *Groth*, Tab. Ueb., 25, 1882. Zinckenit.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·5575 : 1 : 0·6353 Rose[1].
100 ∧ 110 = 29° 8⅓′, 001 ∧ 101 = 48° 44′, 001 ∧ 011 = 32° 25⅔′.

**Forms**: ϵ (102, ½-ī), *k* (061, 6-ĭ). Angles: ϵϵ′ = *59° 21′, *kk′* = *150° 36′.

Crystals seldom distinct; sometimes in nearly hexagonal forms through twinning. Lateral faces longitudinally striated. Also columnar, fibrous, massive.

Cleavage not distinct. Fracture slightly uneven. H.=3–3·5. G.=5·30–5·35. Luster metallic. Color and streak steel-gray. Opaque.

**Comp.**—$PbSb_2S_4$ or $PbS.Sb_2S_3$ = Sulphur 22·3, antimony 41·8, lead 35·9 = 100. Arsenic sometimes replaces part of the antimony.

**Anal.**—1, H. Rose, Pogg., **8**, 99, 1826. 2, Kerl B. H. Ztg., **12**, 20, 1853. 3, Hilger, Lieb. Ann., **185**, 205, 1877. 4, W. F. Hillebrand, Proc. Col. Soc., **1**, 121, 1884.

| | | S | Sb | Pb | |
|---|---|---|---|---|---|
| 1. Wolfsberg | | 22·58 | 44·39 | 31·84 | Cu 0·42 = 99·23 |
| 2. " | | 21·22 | 43·98 | 30·84 | Ag 0·12, Fe 1·45 = 97·61 |
| 3. Kinzigthal | | 23·04 | 46·18 | 30·80 | = 100·02 |
| 4. Red Mt., Col. | G. = 5·21 | 22·50 | 35·00 | 32·77 | As 5·64, Cu 1·20, Ag 0·23, gangue, etc., 1·37 [= 98·71 |

**Pyr., etc.**—Decrepitates and fuses very easily; in the closed tube gives a faint sublimate of sulphur, and antimony trisulphide. In the open tube sulphurous fumes and a white sublimate of antimony trioxide; the arsenical variety gives also arsenical fumes. On charcoal is almost entirely volatilized, giving a coating which on the outer edge is white, and near the assay dark yellow; with soda in R.F. yields globules of lead.

Soluble in hot hydrochloric acid with evolution of hydrogen sulphide and separation of lead chloride on cooling.

**Obs.**—Occurs in the antimony mine of Wolfsberg in the Harz; the groups of columnar crystals occur on a massive variety in quartz; the crystals sometimes over half an inch long and two or three lines broad, frequently extremely thin and forming fibrous masses. From the Ludwig mine, Adlerbach near Hausach, Kinzigthal, Baden. Pontgibaud, Puy de Dôme, France. In the U. S., at the antimony mines of Sevier County, Arkansas; in Colorado at the Brobdignag mine, Red mountain, San Juan Co.

Named after J. K. L. Zinken (1798–1862), director of the Anhalt mines (also written Zincken).

**Ref.**—[1] l. c. Kenng., Ber. Ak. Wien, **9**, 1852.

**115. SARTORITE.** Skleroklas + Arsenomelan *Waltershausen*, Pogg., **94**, 115, 1855, **100**, 537, 1857. Skleroklas *Rath*, ib., **122**, 380, 1864. Binnit *C. Heusser*, Pogg., **94**, 335, 1855, **97**, 120, 1856. Dufrenoysite, pt., *Dufr.*, Tr., pl. 235, f. 66; *Dx.*, Ann. Mines, **8**, 389, 1855. Arsenomelan *Petersen*, Offenb. Ver., **7**, 13, 1866. Sartorite *Dana*, Min., 87, 1868. Bleiarsenglanz *Groth* Tab. Ueb., 22, 1882.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·5389 : 1 : 0·6188 Rath[1].
100 ∧ 110 = 28° 19¼′, 001 ∧ 101 = 48° 56⅚′, 001 ∧ 011 = *31° 45′.

**Forms**[2]:
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)
*c* (001, *O*)
α (108, $\frac{1}{8}$-ī)
β (104, $\frac{1}{4}$-ī)
γ (5·0·14, $\frac{5}{14}$-ī)
δ (5·0·11, $\frac{5}{11}$-ī)
ϵ (102, $\frac{1}{2}$-ī)?
*u* (509, $\frac{5}{9}$-ī)
*g* (507, $\frac{5}{7}$-ī)
*z* (506, $\frac{5}{6}$-ī)
*v* (101, 1-ī)
λ (504, $\frac{5}{4}$-ī)
*y* (503, $\frac{5}{3}$-ī)
*x* (501, 5-ī)?
ω (10·0·1, 10-ī)
*f* (011, 1-ĭ)
*e* (043, $\frac{4}{3}$-ĭ)
*l* (032, $\frac{3}{2}$-ĭ)
*d* (021, 2-ĭ)
*h* (041, 4-ĭ)
*o* (111, 1)

αα′ = 16° 20′
ββ′ = 32° 2′
ϵϵ′ = 59° 43′
*uu′* = 65° 4′
*gg′* = 78° 43′
*zz′* = 87° 28½′
*vv′* = 97° 54′
λλ′ = 110° 16′
*yy′* = 124° 49′
*xx′* = 160° 14′
ωω′ = 170° 3′
*ff′* = 63° 30′
*ee′* = 79° 3′
*ll′* = 85° 44′
*dd′* = 102° 7′
*hh′* = 136° 0′
*oo′* = 88° 38
*oo″* = 105° 3
*oo‴* = 44° 14
*fo′* = *44° 19

Crystals slender, elongated ‖ axis b̄; also striated or channeled in this direction.

Cleavage: c distinct. Fracture conchoidal. Very brittle. H. = 3. G. = 5·393. Luster metallic. Color dark lead-gray. Streak reddish brown. Opaque.

**Comp.**—$PbAs_2S_4$ or $PbS.As_2S_3$ = Sulphur 26·4, arsenic 31·0, lead 42·9 = 100.

**Anal.**—Uhrlaub, Pogg., **94**, 124, 1855. Other analyses, 5th Ed., p. 87.

| S | As | Pb | Ag | Fe |
|---|---|---|---|---|
| 25·91 | 28·56 | 44·56 | 0·42 | 0·45 = 99·90 |

The excess of lead is probably due to admixed dufrenoysite.

**Pyr., etc.**—Nearly the same as for dufrenoysite, but differing in strong decrepitation.

**Obs.**—From the Binnenthal with dufrenoysite and binnite.

Named after Sartorius v. Waltershausen (1809–1876) who first announced the species; *scleroclase* is from σκληρός, *hard, violent*, and κλάειν, *to break*, in allusion to its brittle character.

**Ref.**—[1] Pogg., **122**, 380, 1864; see earlier (l. c.) Heusser, Dx. and Mgc., but note Rath's criticism of Dx. (l. c. p. 392 *et al.*), whose determinations were made in part on crystals of jordanite. [2] Cf. Rath, l. c.; the symbols of some of the macrodomes need confirmation; the measurements of earlier observers (see above) add other planes in the two series of domes, but mostly of doubtful position.

**116. EMPLECTITE.** Wismuth-Kupfererz (fr. Tannenbaum) *Selb*, Tasch. Min., **11**, 441, 451, 1817. Kupferwismuthglanz *R. Schneider*, Pogg., **90**, 166, 1853. Emplektit *Kenng.*, Ueb., 125, 1853. Tannenite *Dana*, Min., 73, 1854. Hemichalcit *Kbl.*, Gesch. Min., 600, 1864.

Orthorhombic. Axes: ă : b̄ : ċ = 0·5430 : 1 : 0·6256 Weisbach[1].

100 ∧ 110 = 28° 30$\frac{1}{6}$′, 001 ∧ 101 = 49° 2$\frac{1}{2}$′, 001 ∧ 011 = 32° 1$\frac{5}{6}$′.

**Forms:** b (010, i-ĭ) u (509, $\frac{5}{9}$-ī) z (506, $\frac{5}{6}$-ī) x (501, 5-ī) k (061, 6-ĭ)
a (100, i-ī) c (001, O) g (507, $\frac{5}{7}$-ī) y (503, $\frac{5}{3}$-ī) d (021, 2-ĭ)

Angles: *uu′* = 65° 15′, *gg′* = 79° 2′, *zz′* = 87° 40′, *yy′* = 124° 59′, *xx′* = 160° 18′, *dd′* = 102° 44′, *kk′* = 150° 10′, *cz* = *43° 50′, *kc* = *75° 5′.

In thin striated prisms, elongated ‖ b̄.

Cleavage: c perfect; b less so; also z (?) distinct. Fracture conchoidal to uneven. Brittle. H. = 2. G. = 6·3–6·5. Luster metallic. Color grayish to tin-white. Opaque.

**Comp.**—$CuBiS_2$ or $Cu_2S.Bi_2S_3$ = Sulphur 19·1, bismuth 62·0, copper 18·9 = 100.

**Anal.**—1, Schneider, Pogg., **90**, 166, 1863. 2, Petersen, Jb. Min., 847, 1869. 3, Daw, Ch. News, **40**, 225, 1879. 4, Loczka, Földt. Közl., **14**, 564, 1884.

| | | S | Bi | Cu |
|---|---|---|---|---|
| 1. Tannenbaum | | § 18·83 | 62·16 | 18·72 = 99·71 |
| 2. Freudenstadt | | 19·06 | 59·09 | 20·32 Fe 0·40 = 98·87 |
| 3. Aamdal | | 19·20 | 57·72 | 17·23 Ag 2·91, Pb *tr.*, $SiO_2$ 1·30 = 98·36 |
| 4. Rezbanya | G. = 6·521 | 18·61 | 63·20 | 16·84 Te 0·16, Pb 1·14, Ag 0·20, Fe 0·11 = 100·26 |

**Pyr., etc.**—In the open tube gives sulphurous fumes. B.B. on charcoal fuses easily, with frothing and spirting; treated with soda coats the coal dark yellow from bismuth oxide, and gives a globule of copper. Decomposed by nitric acid, with separation of sulphur.

**Obs.**—Occurs embedded in quartz at the mines of Tannenbaum, near Schwarzenberg, also near Pöhla, and on the Schreckenberg at Annaberg, Saxony. At Christophsau near Freudenstadt, Würtemberg; Rezbanya, Hungary. At the Aamdal copper mines, Telemarken, Norway. From Cerro Blanco in Copiapo, Chili.

Named from ἐμπλεκτος, *entwined, interwoven*, in allusion to its intimate association with quartz.

**Artif.**—Obtained by Schneider, J. pr. Ch., **40**, 564, 1889.

**Ref.**—[1] Pogg., **128**, 435, 1866; see also Dbr., ib., **92**, 241, 1854.

**117. CHALCOSTIBITE.** Kupferantimonglanz *Zinken*, Pogg., **35**, 357, 1835. Sulphuret of Copper and Antimony; Antimonial Copper. Rosite *Huot*, Min., 1, 197, 1841. Chalkostibit *Glock*, Syn., 32, 1847. Wolfsbergite *Nicol*, Min., 484, 1849.

Orthorhombic. Axes: b : ċ = 1 : 0·6065 Rose[1].

**Forms:** b (010, i-ĭ), c (001, O), d (021, 2-ĭ), h (041, 4-ĭ). Angles: *dc* = *50° 30′, *dd′* = 101°, *bh′* = 135° 12.

In small aggregated prisms, elongated ‖ ă; also fine granular, massive.

Cleavage: *c* perfect: *a* less so. Fracture subconchoidal. Brittle. H. = 3–4. G. = 4·75–5·0. Luster metallic. Color between lead-gray and iron-gray. Opaque.

**Comp.**—$CuSbS_2$ or $Cu_2S.Sb_2S_3$ = Sulphur 25·9, antimony 48·5, copper 25·6 = 100.

**Anal.**—1, H. Rose, Pogg., **35**, 361, 1835. 2, T. Richter, B. H. Ztg., **16**, 220, 1857.

| | | S | Sb | Cu | Fe | Pb | |
|---|---|---|---|---|---|---|---|
| 1. Wolfsberg | | 26·34 | 46·81 | 24·46 | 1·39 | 0·56 | = 99·56 |
| 2. Guadiz | G. = 5·015 | 25·29 | 48·30 | 25·36 | 1·23 | — | = 100·18 |

The iron is supposed to exist as pyrite, and the lead as jamesonite.

**Pyr., etc.**—In the closed tube decrepitates at first, and then fuses, giving a faint sublimate of antimony trisulphide, which on cooling is dark red; in the open tube gives sulphurous and antimonial fumes, the latter forming a white sublimate. B.B. on charcoal fuses to a globule, emitting antimonial fumes, coating the coal white; the globule treated with borax reacts for iron; with soda gives a globule of metallic copper.

Decomposed by nitric acid, with separation of sulphur and antimony trioxide.

**Obs.**—From Wolfsberg in the Harz, in nests embedded in quartz; and at Guadiz, Spain. It is usually covered with a coating of pyrite. Glocker's name antedates Nicol's. *Rosite* has an earlier use.

**Ref.**—[1] Pogg., **35**, 360, 1835. See also p. 1030.

**118. GALENOBISMUTITE.** *H. Sjögren*, G. För. Förh., **4**, 109, 1878. Alaskaite *Koenig*, Am. Phil. Soc., 472, 1881. Bleiwismuthglanz *Groth*, Tab. Ueb., 25, 1882. Selenbleiwismuthglanz *Id.*, Tab. Ueb., 28, 1889.

Crystalline, columnar with indistinct faces; also massive, foliated or radiated to compact.

H. = 3–4. G. = 6·88; 7·145 Falun. Luster metallic. Color dark to light lead-gray to tin-white. Streak grayish black. Opaque.

**Comp., Var.**—$PbBi_2S_4$ or $PbS.Bi_2S_3$ = Sulphur 17·1, bismuth 55·4, lead 27·5 = 100. The lead is sometimes replaced in part by silver and copper, and the sulphur by selenium.

**Var.**—1. *Ordinary.*—Analyses 1, 2, H. Sjögren, l. c.

2. *Argentiferous—Alaskaite.* Analyses 3, 4, Koenig, l. c.; in 3, 2·3 p. c. chalcopyrite and 15 p. c. barite have been deducted; in 4, 4·7 p. c. chalcopyrite and 2·8 p. c. barite. G. = 6·878. 5, Id., ib., **22**, 211, 1885.

3 *Seleniferous.*—A variety from Falun, Sweden, more or less impure, see Atterberg, G. För. Förh., **2**, 76, 1874, who gives an analysis of a mineral (with Se = 1·15 p. c.) regarded as a mixture of native bismuth and a sulphobismuthite of lead; also Nordström, ib. **4**, 268, 1879, with Se = 4·79–5·11 p. c. Anal. 6, Genth, Am. Phil. Soc. **23**, 34, 1885. H. = 2. Color dark lead-gray. Cleavage in one direction, eminent. 7, Weibull, G. För. Förh., **7**, 657, 1885.

| | | | S | Se | Bi | Pb | Ag | Cu | Zn | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Nordmark | G. = 6·88 | | 17·35 | — | 54·69 | 27·65 | — | — | — | = 99·69 |
| 2. “ | | | 16·78 | — | 54·13 | 27·18 | — | — | — | = 98·09 |
| 3. *Alaskaite* | G. = 6·878 | $\frac{2}{2}$ | 17·63 | — | 56·97 | 11·79 | 8·74 | 3·46 | 0·79 | Sb 0·62 = 100 |
| 4. “ | | $\frac{3}{3}$ | 17·62 | — | 55·81 | 19·02 | 3·26 | 4·07 | 0·22 | = 100 |
| 5. “ | G. = 6·782 | | 17·98 | — | 53·39 | 12·02 | 7·80 | 5·11 | 0·34 | Fe 0·84, insol. 1·80 |
| 6. Falun | G. = 7·145 | $\frac{5}{5}$ | 9·75 | 12·43 | 49·88 | 27·88 | 0·33 | — | — | = 100·27 [= 99·28 |
| 7. “ | G. = 6·97 | | 9·82 | 13·61 | 49·73 | 24·62 | — | 0·77 | — | Fe 0·61 = 99·16 |

**Pyr.**—B.B. fuses easily on charcoal, giving bismuth and lead coatings. The argentiferous variety yields silver, and the seleniferous the odor of selenium. Dissolves with difficulty in hydrochloric acid, readily in strong nitric acid.

**Obs.**—Occurs with bismutite at the Ko mine, Nordmark in Wermland, Sweden, where it sometimes carries gold. Also intimately mixed with quartz, barite, chalcopyrite, and tetrahedrite, at the Alaska mine, Poughkeepsie Gulch, Colorado (*alaskaite*). The seleniferous variety is from Falun, Sweden; it occurs with native bismuth.

**119. BERTHIERITE.** Haidingerite *Berthier*, Ann. Ch. Phys., **35**, 351, 1827; Pogg., **11**, 478, 1827. Berthierit *Haid.*, Ed. J. Sc., **7**, 353, 1827. Eisenantimonglanz *Germ.*

In elongated prisms; also fibrous massive, plumose; granular.

Cleavage: longitudinal, rather indistinct. H. = 2–3. G. = 4–4·3. Luster metallic. Color dark steel-gray, inclining to pinchbeck-brown; surface often covered with iridescent spots. Opaque.

**Comp.**—Probably $FeSb_2S_4$ or $FeS.Sb_2S_3$ = Sulphur 30·2, antimony 56·6, iron 13·2 = 100.

Analyses show a somewhat varying composition, doubtless due to the impurity of the material examined, cf. Fischer, Zs. Kr., **4**, 362, 1880.

**Anal.**—1, Berthier, l. c. 2, Rg., Pogg., **40**, 153, 1837. 3, Pettko, Haid. Ber., **1**, 62, 1847. 4, Hauer, Jb. G. Reichs., **4**, 635, 1853. 5, Sackur, Rg., Min. Ch., 988, 1860. 6, Rg., Zs. G. Ges., **18**, 244, 1866.

| | | S | Sb | Fe | Zn | | |
|---|---|---|---|---|---|---|---|
| 1. Chazelles | | 30·3 | 52·0 | 16·0 | 0·3 | | = 98·6 |
| 2. Bräunsdorf | | 31·33 | 54·70 | 11·43 | 0·74 | Mn 2·54 | = 100·74 |
| 3. Arany Idka | G. = 4·043 | 29·27 | 57·88 | 12·85 | — | | = 100 |
| 4. Bräunsdorf | | 30·53 | 59·30 | 10·16 | — | | = 99·99 |
| 5. " | | 28·77 | 56·91 | 10·55 | — | Mn 3·73 | = 99·96 |
| 6. S. Antonio, Cal. | G. = 4·062 | 29·12 | 56·61 | 10·09 | — | Mn 3·56 | = 99·38 |

Other analyses by Berthier (Ann. Mines, **3**, 49, 1833) gave:

Anglar $Sb_2S_3$ 80·6 FeS 19·4 deducting 7 p.c. gangue.
Martouret 84·3 15·7 " 60 " "

These correspond approximately to $FeS.Sb_2S_3$ and $3FeS.4Sb_2S_3$. while anal. (1) above gives $3FeS.2Sb_2S_3$; little dependence can be placed upon them. N. Nordenskiöld in his Atom.-Ch. Min. System, 1848, introduces for the three varieties analyzed by Berthier the following names: *Anglarite* for $FeS.Sb_2S_3$, *Chazellite* for $3FeS.2Sb_2S_3$, *Martourite* for $3FeS.4Sb_2S_3$.

**Pyr., etc.**—In the closed tube fuses, and gives a faint sublimate of sulphur; with a strong heat yields a black sublimate of antimony oxysulphide, which on cooling becomes brownish-red. In the open tube gives off fumes of sulphur and antimony, reacting like stibnite. B.B. on charcoal gives off sulphurous and antimonial fumes, coats the coal white, and the antimony is expelled, leaving a black magnetic slag, which with the fluxes reacts for iron.

Dissolves readily in hydrochloric acid, giving off hydrogen sulphide.

**Obs.**—At Chazelles and Martouret in Auvergne, associated with quartz, calcite, and pyrite; in the Vosges, Commune of Lalaye; at Anglar, Depart. La Creuse; also at Bräunsdorf near Freiberg in Saxony, and at Padstow in Cornwall; at Arany Idka in Hungary; at Real San Antonio, Lower California, massive; N. Brunswick, probably from the antimony mine in Prince William parish. 25 miles from Fredericton, York Co.

Named after the French chemist, Pierre Berthier (1782–1861).

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**120. MATILDITE.** Silberwismuthglanz *Rammelsberg*, Zs. G. Ges., **29**, 80, 1877. Matildite *A. D'Achiardi*, I Metalli, **1**, 136, 1883. Morocochite *Heddle*, Enc. Brit., **16**, 394, 1883. Argento-bismutite *Genth*, Am. Phil. Soc. 23, 35, 1885.

In slender striated prismatic crystals; also massive, compact.

Soft. G. = 6·92. Luster metallic. Color gray. Streak light gray. Opaque.

**Comp.**—$AgBiS_2$ or $Ag_2S.Bi_2S_3$ = Sulphur 16·9, bismuth 54·7, silver 28·4 = 100. Sometimes with lead replacing part of the silver and hence tending toward galenobismutite (p. 114).

**Anal.**—1, Rg., l. c., after deducting some galena. 2, Genth, l. c.

| | | S | Bi | Ag | Pb | |
|---|---|---|---|---|---|---|
| 1. Peru | G. = 6·92 | ⅜ 17·24 | 54·50 | 28·26 | — | = 100 |
| 2. Colorado | | [16·66] | 52·89 | 26·39 | 4·06 | = 100 |

**Pyr.**—B.B. fuses readily on charcoal, giving a coating of bismuth oxide and on long blowing a globule of silver. Soluble in nitric acid with separation of sulphur.

**Obs.**—Associated with tetrahedrite, galena, sphalerite, and pyrite at the Matilda mine, near Morococha, Peru. Also from Lake City, Colorado.

**Artif.**—Obtained by Schneider, but not in distinct crystals, J. pr. Ch., **41**, 414, 1890.

PLENARGYRITE *Sandberger*, Erzgänge, **1**, 96, 1882.

In indistinct crystals and crystalline groups, apparently like miargyrite in form. Fracture conchoidal. Brittle. H. = 2·5. G. = 7·22 (calc.). Luster metallic. Color iron-black. Streak black. Opaque.

COMP.—Probably like matildite, $AgBiS_2$ or $Ag_2S.Bi_2S_3$. Anal.—Zeitszchel, after deducting 15·83 p.c. pyrite, 1·46 quartz:

S 18·31 Bi 55·20 Ag 26·49 = 100

Occurs intimately associated with pyrite, chalcopyrite, and quartz at Schapbach, Baden. The name is stated to have been given in allusion to the fact that it contains less silver than miargyrite.

**121. MIARGYRITE.** Hemiprismatische Rubin-Blende (fr. Bräunsdorf) *Mohs*, Grundr., 606, 1824. Miargyrit *H. Rose*, Pogg., 15, 469, 1829. Hypargyrite, Hypargyron-Blende (fr. Clausthal) *Breith.*, Char., 286, 333, 1832. Kenngottite (fr. Felsöbánya) *Haid.*, Ber. Ak. Wien. 22, 236, 1856.

Monoclinic. Axes à : b̄ : ċ = 2·99449 : 1 : 2·90951; β = 81° 22′ 35″ = 001 ∧ 100 Lewis[1].

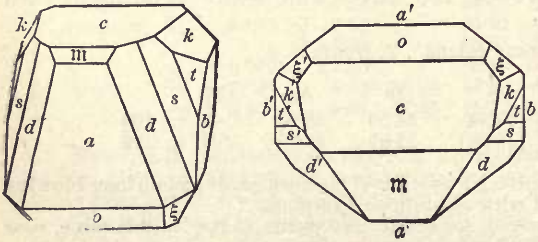
100 ∧ 110 = 71° 20′ 12″, 001 ∧ 101 = 39° 58′ 45″, 001 ∧ 011 = 70° 49′ 52″.

Forms[2]:
a (100, i-ī)
b (010, i-ì)
c (001, O)
d (210, i-2̄)
Ω (105, −⅕-ī)
Π (104, −¼-ī)
λ (102, −½-ī)?
𝔪 (101, −1-ī)
L (703, −7/3-ī)
n (301, −3-ī)
μ (702, −7/2-ī)
M (1̄03, ⅓-ī)
u (2̄03, ⅔-ī)
o (1̄01, 1-ī)
R (2̄01, 2-ī)
N (3̄01, 3-ī)
β (013, ⅓-ì)
ω (011, 1-ì)
h (113, −⅓)
t (111, −1)
A (1̄11, 1)
Ξ (15·1·1, −15-1̄5)?
Φ (811, −8-8̄)
Θ (711, −7-7̄)
η (611, −6-6̄)
F (511, −5-5̄)
f (922, −9/2-9̄/2)
φ (411, −4-4̄)
δ (13·4·4, −13/4-1̄3̄/4)
d (311, −3-3̄)
ϵ (522, −5/2-5̄/2)
E (212, −1-2̄)?
s (211, −2-2̄)
w (1̄2̄·1·15, ⅘-1̄2̄)
q (1̄2̄·1·3, 4-1̄2̄)
p (5̄16, 1-6̄)
π (5̄15, 1-5̄)
γ (4̄14, 1-4̄)
Ψ (4̄13, 4/3-4̄)
g (3̄13, 1-3̄)
i (3̄11, 3-3̄)
e (1̄2̄·5·20, 6/10-1̄2̄/5)
ζ (2̄15, ⅖-2̄)
ξ (2̄13, ⅔-2̄)
τ (2̄12, 1-2̄)
σ (2̄11, 2-2̄)
κ (124, −½-2̀)
χ (122, −1-2̀)
[illegible] (121, −2-2̀)
[illegible] (137, −3/7-3̀)
ρ (181, −8-8̀)
[illegible] (6̄76, 7/6-7̀/6)
x (2̄33, 1-3̀/2)
υ (1̄22, 1-2̀)

Lewis adds as doubtful (1̄19), (139), (1·6·16), (1·2·10), and several others still more uncertain

ΔΔ′′′ = 111° 55′
cΠ = 13° 3′
c𝔪 = 41° 24′
cn = 63° 30′
cu = 35° 21′
co = *48° 21′ 10″
a′o = *50° 16′ 15″
cR = 69° 45′
cN = 78° 57′
ββ′ = 87° 36′
ωω′ = 141° 40′
= 69° 18′
cA = 74° 16′
cd = 70° 34′
cs = 69° 32′
ck = 54° 36′
cg = 57° 49′
ci = 82° 8′
cξ = 51° 56′
cσ = 78° 25½′
aΦ = 21° 0′
aη = 26° 58′
aφ = 37° 0′
ad = 44° 47′
as = 55° 28′
at = 69° 45½′
aω = 87° 11′
ak = 77° 19′
a′i = 47° 44′
a′σ = 59° 29′
a′A = 74° 53′
a′x = 83° 42′
a′ξ = 70° 8′
a′g = 59° 11′
tt′ = 125° 4½′
dd′ = 83° 33′
dd′′ = *96° 27′
ss′ = 102° 21′
kk′ = 107° 1′
AA′ = 131° 50′
χχ′ = 96° 25′
gg′ = 73° 26′
γγ′ = 58° 27′
ππ′ = 48° 13′
pp′ = 40° 54′
ii′ = 88° 49′
ξξ′ = 81° 48′
σσ′ = 109° 6½′

Crystals usually thick tabular ‖ *c* or *a*; also prismatic ‖ *o*. Faces in the zones *a o c* and *a d s* often deeply striated, parallel to their mutual intersections; hence *a* shows two sets of striations ‖ edges *a*/*d* and less uniformly ‖ edge *a*/*o*. Also massive.



Bräunsdorf, after Lewis.

Cleavage: *b* in traces. Fracture subconchoidal to uneven. Brittle. H. = 2–2·5. G. = 5·1-5·30. Luster metallic-adamantine. Color iron-black to steel-gray, in thin splinters deep blood-red. Streak cherry-red. Nearly opaque.

**Comp.**—$AgSbS_2$ or $Ag_2S.Sb_2S_3$ = Sulphur 21·9, antimony 41·2, silver 36·9 = 100.

**Anal.**—1, H. Rose, l. c. 2, Sotomayor and Cortez, Min.-Chili, 2d Append., p. 40, 186 3, 4, L. Sipöcz, Min. Mitth., 213, 1877. 5, Jenkins, Jb. Min., 2, 109, 1880. 6, Andreasch, Min. Mitth., 4, 185, 1881.

| | | G. | | S | Sb | Ag | Pb | Cu | Fe | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Bräunsdorf | | | 21·95 | 39·14 | 36·40 | — | 1·06 | 0·62 | = 99·17 |
| 2. | Tres Puntas | | | 19·69 | 41·95 | 37·30 | — | — | 1·05 | = 99·99 |
| 3. | Felsöbánya | G. = 5·298 | $\frac{2}{2}$ | 21·80 | 40·68 | 32·77 | 4·01 | 0·51 | 0·19 | = 99·96 |
| 4. | *Kenngottite* | G. = 5·337 | | 20·66 | 39·46 | 35·28 | 1·76 | 0·50 | 0·25 | = 97·91 |
| 5. | *Hypargyrite* | | $\frac{2}{2}$ | 21·35 | 41·07 | 37·40 | — | — | — | As 0·79 = 100·61 |
| 6. | Přibram | G. = 5·077 | | 21·68 | 41·15 | 36·71 | — | — | *tr.* | = 99·54 |

**Pyr., etc.**—In the closed tube decrepitates, fuses easily, and gives a sublimate of antimony oxysulphide; in the open tube sulphurous and antimonial fumes, the latter as a white sublimate. BB. on charcoal fuses quietly with emission of sulphur and antimony fumes to a gray bead, which after continued treatment in O.F. leaves a bright globule of silver. If the silver globule is treated with phosphorus salt in O.F., the green glass thus obtained often shows traces of copper when fused with tin in R.F.

Decomposed by nitric acid, with separation of sulphur and antimony trioxide.

**Obs.**—At Bräunsdorf, near Freiberg in Saxony, associated with tetrahedrite, pyrargyrite, etc.; Felsöbánya (*kenngottite*) with pyrite, galena, sphalerite, barite; Přibram in Bohemia; Clausthal (*hypargyrite*); Guadalajara in Spain; at Parenos, and the mine Sta. M. de Catorce, San Luis Potosi, Mexico; also at Molinares, with rhodochrosite; at Tres Puntas, Chili.

Named from μείων, *less*, ἄργυρος, *silver*, because it contains less silver than some kindred ores.

**Artif.**—Formed artificially by Doelter, Zs. Kr., **11**, 39, 1885.

**Ref.**—[1] Result deduced (recalc., E.S.D.) from many measurements, Zs. Kr., **8**, 545, 1884. For earlier observations see Naumann, Pogg., **17**, 142, 1829; Miller, Min., p. 214; Weisb., Pogg., **125**, 441, 1865, and Zs. Kr., **2**, 55, 1877; Friedländer, Min.-Samml. Strassburg, p. 58, 1878; Rath, Zs. Kr., **8**, 25, 1883; Lewis, ib., 545, 1884. With Weisb. and Rath $a = 101$, $o = 100$, $g = 110$, etc. In general for $h\,k\,l$ (Lewis) and $p\,q\,r$ (Weisb.), $h = -p$, $k = \frac{q}{3}$, $l = p + r$.

[2] See Rath and Lewis for authorities, etc., but note Lewis's explanation of Miller's error in identifying the forms, and the consequent rejection of several planes included by Rath.

## C. Intermediate Division.

| | | | | $\grave{a} : \bar{b} : \dot{c}$ | $\beta$ |
|---|---|---|---|---|---|
| **122.** | **Plagionite** | $5PbS.4Sb_2S_3$? | Monoclinic | 1·1331 : 1 : 0·4228 | 72° 50′ |

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| | | | | $\breve{a} : \bar{b}$ |
|---|---|---|---|---|
| **123.** | **Binnite** | $3Cu_2S.2As_2S_3$? | Isometric | |
| **124.** | **Klaprotholite** | $3Cu_2S.2Bi_2S_3$ | Orthorhombic | 0·740 : 1 |
| **125.** | **Schirmerite** | $3(Ag_2,Pb)S.2Bi_2S_3$ | | |
| **126.** | **Warrenite** | $3PbS.2Sb_2S_3$ | | |

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### Jamesonite Group. $2RS.(As,Sb,Bi)_2S_3$. Orthorhombic.

| | | | $\breve{a} : \bar{b} : \dot{c}$ |
|---|---|---|---|
| **127.** | **Dufrenoysite** | $2PbS.As_2S_3$ | 0·9381 : 1 : 1·5309 |
| **128.** | **Cosalite** | $2PbS.Bi_2S_3$ | 0·9187 : 1 : 1·4601 |
| **129.** | **Schapbachite** | $PbS.Ag_2S.Bi_2S_3$ | |
| **130.** | **Jamesonite** | $2PbS.Sb_2S_3$ | 0·8915 : 1 |
| **131.** | **Kobellite** | $2PbS.(Bi,Sb)_2S_3$ | |

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**132.** **Brongniardite** $2(Ag_2,Pb)S.Sb_2S_3$. Isometric.

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| | | | | $\grave{a} : \bar{b} : \dot{c}$ | $\beta$ |
|---|---|---|---|---|---|
| **133.** | **Semseyite** | $7PbS.3Sb_2S_3$? | Monoclinic | 1·1442 : 1 : 1·1051 | 71° 4′ |

| | | | | $\breve{a} : \bar{b} : \grave{c}$ | |
|---|---|---|---|---|---|
| 134. | **Diaphorite** | $5(Ag_2,Pb)S.2Sb_2S_3$ | Orthorhombic | $0·4919 : 1 : 0·7345$ | |
| | | | | $\grave{a} : \bar{b} : \grave{c}$ | $\beta =$ |
| 135. | **Freieslebenite** | | Monoclinic | $0·5871 : 1 : 0·9277$ | 87° 46′ |

**122. PLAGIONITE.** Ein neues Spiessglanzerz *C. Zincken*, Pogg., **22**, 492, 1831. Plagionit *G. Rose*, ib., **23**, 421, 1833.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 1·1331 : 1 : 0·4228$; $\beta = {}^*72° 49\frac{1}{2}' = 001 \wedge 100$ Luedecke[1].

$100 \wedge 110 = 47° 16\frac{1}{4}'$, $001 \wedge 101 = 17° 48\frac{1}{6}'$, $001 \wedge 011 = 21° 59\frac{3}{4}'$.

**Forms**[1]:
*a* (100, *i*-$\bar{i}$)
*c* (001, *O*)
*δ* (0·20·3, $\frac{20}{3}$-$\grave{i}$)[2]
*d* (081, 8-$\grave{i}$)[2]
*p* (112, − $\frac{1}{2}$)[2]
*o* (111, − 1)
*r* (221, − 2)
*i* (773, − $\frac{7}{3}$)[2]
*x* (441, − 4)[2]
*y* (661, − 6)[2]
*z* ($\bar{7}$78, $\frac{7}{8}$)[2]
*ω* ($\bar{1}$11, 1)

*dd′* = 145° 37′
*cp* = 14° 19′
*co* = 25° 53′
*cr* = 41° 26½′
*cx* = *56° 14′

*cy* = 62° 48′
*cω* = 31° 12′
*pp′* = 21° 23′
*oo′* = 38° 13′
*rr′* = 59° 30′

*xx′* = *77° 6·8′
*yy′* = 83° 39′
*ωω′* = 45° 42′
*ao* = 57° 12′

*ar* = 50° 13½′
*ax* = 46° 24′
*ay* = 45° 47½′
*a′ω* = 85° 42½′

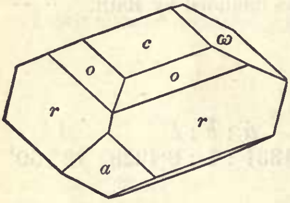
Crystals thick tabular ‖ *c*, or short prismatic ‖ *r*; often grouped in druses and geodes. Faces *c* smooth, pyramids striated ‖ edge *c*/*o*. Also massive; granular to compact.

Cleavage: *r* tolerably perfect. Fracture conchoidal to uneven. Brittle. H. = 2·5. G. = 5·4. Luster metallic. Color and streak blackish lead-gray. Opaque.

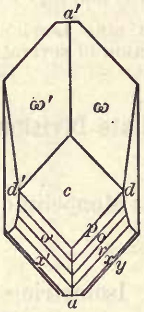
**Comp.**—Perhaps $5PbS.4Sb_2S_3$ = Sulphur 21·5, antimony 37·8, lead 40·7 = 100.

**Anal.**—1, H. Rose, Pogg., **28**, 422, 1833. 2, Kudernatsch, ib., **37**, 588, 1836. 3, Schultz, Rg., Min. Ch., 1006, 1860.

1.



2.



Figs. Wolfsberg; 1, Rose; 2, after Luedecke.

| | S | Sb | Pb | | |
|---|---|---|---|---|---|
| 1. Wolfsberg | 21·53 | 37·94 | 40·52 | | = 99·99 |
| 2. " | 21·49 | [37·53] | 40·98 | | = 100 |
| 3. " | 21·10 | 37·84 | 39·36 | Cu 1·27 | = 99·57 |

**Pyr.**—Same as for zinkenite.

**Obs.**—At Wolfsberg in geodes and druses of crystals in massive plagionite, or crystallized on quartz, discovered by Zincken; also at Wolfach, Baden; Arnsberg, Westphalia.

Named, in allusion to its unusually oblique crystallization, from *πλάγιος, oblique*.

**Ref.**—[1] Jb. Min., **2**, 112, 1883; Rose obtained earlier (l. c.) *ac* = 72° 28′, *rr′* = 59° 11′, *cr* = 41° 8′, etc. [2] Luedecke, l. c.

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**123. BINNITE.** Dufrenoysite *Waltershausen*, Pogg., **94**, 119, 1855; *C. Heusser*, Pogg., **94**, 334, **97**, 115. Binnite *Dx.*, Ann. Mines, **8**, 389, 1855.

Isometric. Observed forms[1]:

*a* (100, *i*-*i*)
*d* (110, *i*)
*o* (111, 1)
*r* (332, $\frac{3}{2}$)
*ω* (441, 4)
*Ψ* (10·1·1, 10-10)
*ψ* (711, 7-7)[2]
*φ* (611, 6-6)
*μ* (411, 4-4)
*n* (211, 2-2)
*s* (321, 3-$\frac{3}{2}$)

In complex crystals; also massive.

Cleavage not distinct. Fracture conchoidal. Brittle. H. = 2·5–3. G. = 4·477. Luster metallic. Color dark steel-gray to iron-black, sometimes brownish. Streak reddish brown. Opaque.

**Comp.**—Perhaps $Cu_6As_4S_9$ or $3Cu_2S.2As_2S_3$ = Sulphur 29·8, arsenic 31·0, copper 39·2 = 100.

**Anal.**—Uhrlaub, Pogg., **94**, 120, 1855.

| S | As | Cu | Pb | Ag | Fe |
|---|---|---|---|---|---|
| 27·55 | 30·06 | 37·74 | 2·75 | 1·23 | 0·82 = 100·15 |

A second analysis (of the same mineral?) by Stockar-Escher (5th Ed., p. 90) is near enargite; as also another by McIvor, viz.: S 32·46, As 18·79, Cu 46·05, Ag 2·43 = 99·73. Ch. News, **30**, 103, 1874. The true character and place of binnite is hence in doubt.

**Pyr.**—In the closed tube gives a sublimate of arsenic trisulphide; in the open tube a crystalline sublimate of arsenic trioxide, with sulphurous fumes. B.B. on charcoal gives an arsenical odor and a faint white coating, fuses with intumescence to a dull iron-black globule which yields metallic copper with soda.

**Obs.**—In the Binnenthal in cavities in crystalline dolomite with realgar, orpiment, sphalerite, pyrite, sartorite, and dufrenoysite.

**Ref.**—[1] Hbg., Min. Not., 1875, p. 6, gives authorities and new forms, and discusses the supposed hemihedral character of the species with a negative conclusion. [2] Lewis, Zs. Kr., **2**, 192, 1878.

### 124. KLAPROTHOLITE.

Kupferwismutherz, Wismuthkupfererz, pt. Klaprothit, *Petersen* and *Sandberger*, Jb. Min., 415, 1868. Klaprotholite, *G. J. Brush*, Dana Min., App. I., 8, 1872.

Orthorhombic. Occurs in longitudinally furrowed prismatic crystals, with *a*, *m*, and *u* (*h0l*, *m-ī*)?; *mm'''* = 73° approx. Twins: tw. pl. *m*.

Cleavage: *a* distinct. Fracture uneven. Brittle. H. = 2·5. G.= 4·6 Petersen. Luster metallic. Color steel-gray, tarnishing to brass-yellow or iridescent. Streak black.

**Comp.**—$Cu_6Bi_4S_9$ or $3Cu_2S.2Bi_2S_3$ = Sulphur 19·3, bismuth 55·4, copper 25·3 = 100.

**Anal.**—1, Schneider, Pogg., **127**, 309, 1866. 2, Petersen, l. c.

| | S | Bi | Cu | Fe |
|---|---|---|---|---|
| 1. Wittichen | $\frac{2}{2}$ 18·69 | 51·40 | 28·82 | 0·91 = 99·82 |
| 2. " | $\frac{3}{3}$ 18·66 | 53·87 | 23·96 | 1·70 = 98·19 |

**Pyr.**—Same as for emplectite.

**Obs.**—Occurs with other bismuth minerals, and especially with cobalt tetrahedrite and chalcopyrite at the Daniel mine near Wittichen, Baden; at Freudenstadt; Eberhard mine near Alpirsbach, and other localities in the Black Forest. The mineral examined by Schneider was referred to wittichenite by Hilger.

The name klaprothite (after the German mineralogist, M. H. Klaproth, 1743–1817) was given to lazulite by Beudant in 1824, hence the change of Petersen's name to klaprotholite.

### 125. SCHIRMERITE.

*Genth*, Am. Phil. Soc., **14**, 230, 1874.

Massive, finely granular, disseminated.

Cleavage none. Fracture uneven; soft; brittle. G. = 6·737. Luster metallic. Color lead-gray, inclining to iron-black.

**Comp.**—$3(Ag_2,Pb)S.2Bi_2S_3$ = Sulphur 11·8, bismuth 47·3, lead 16·4, silver 24·5 = 100, if $Ag_2 : Pb = 2 : 1$.

**Anal.**—1, 2, Genth, l. c.; in 1, 1 p. c. quartz deducted, in 2, 1·07 p. c. deducted.

| | S | Bi | Pb | Ag | Zn | Fe |
|---|---|---|---|---|---|---|
| 1. | 14·41 | 46·91 | 12·69 | 22·82 | 0·08 | 0·03 = 96·94 |
| 2. | 15·02 | [47·27] | 12·76 | 24·75 | 0·13 | 0·07 = 100·00 |

**Pyr.**—B.B. fuses easily, and gives sulphurous fumes with reactions for bismuth, lead, and silver.

**Obs.**—Occurs with several tellurium minerals at Treasury lode, Park Co., Colorado.

Named from J. F. L. Schirmer, Esq.

*Schirmerite* of Endlich (Eng. Mng. J., Aug. 29, 1874), containing tellurium, gold, silver iron, is a mixture according to Genth.

**126. WARRENITE.** Sulphantimonite from Colorado *L. G. Eakins*, Am. J. Sc., **36**, 450, 1888. Domingit *Groth*, Tab. Ueb., 30, 1889.

In aggregates of acicular crystals, forming matted, wool-like masses.

Luster metallic, dull. Color grayish black, sometimes iridescent in spots. Opaque.

**Comp.**—$Pb_3Sb_4S_9$ or $3PbS.2Sb_2S_3$ = Sulphur 20·8, antimony 34·6, lead 44·6 = 100. Iron is present in small amount.

**Anal.**—Eakins, l. c.

S 21·19 Sb 36·34 Pb 39·33 Fe 1·77 Ag, Cu, Mn *tr.*, gangue 0·52 = 99·15

**Pyr., etc.**—Fuses easily. In the closed tube a slight sublimate of sulphur; in the open tube sulphurous fumes and a white sublimate of antimony trioxide. On charcoal sublimates of the oxides of lead and antimony, and in R. F. a lead button. Soluble in hot hydrochloric acid with evolution of hydrogen sulphide.

**Obs.**—From the Domingo mine, Gunnison Co., Colorado, where it occurs in cavities in a decomposed siliceous rock mixed with some calcite, locally called "mineral wool."

Named by Eakins after Mr. E. R. Warren of Crested Butte, Col.

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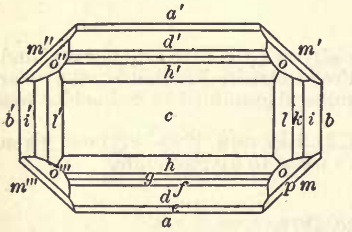
**127. DUFRENOYSITE.** Dufrenoysite *Damour*, Ann. Ch. Phys., **14**, 379, 1845. Gotthardit *Rg.*, Berz. Ch. Min., 229, 256, 1847. Arsenomelan and Scleroclase pt. *Waltersh.* Pogg., **94**, 115, 1855. Dufrenoysite pt. *Dx.*, Ann. Mines, 8, 389, 1856. Skleroklas *Petersen*, Offenb. Ver., **7**, 13, Jb. Min., 203, 1867. Bleiarsenit, *Groth*, Tab. Ueb., p. 18, 1874.

Orthorhombic. Axes: $\breve{a} : \bar{b} : \dot{c}$ = 0·9381 : 0 : 1·5309 Rath[1].

100 ∧ 110 = 43° $10\frac{1}{4}'$, 001 ∧ 101 = *58° 30′, 001 ∧ 011 = 56° $50\frac{5}{6}'$.

**Forms**[2]:
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)
*c* (001, *O*)
*m* (110, *I*)
*h* (104, $\frac{1}{4}$-ī)
*g* (102, $\frac{1}{2}$-ī)
*f* (203, $\frac{2}{3}$-ī)
*d* (101, 1-ī)
*e* (201, 2-ī)
*l* (012, $\frac{1}{2}$-ĭ)
*k* (023, $\frac{2}{3}$-ĭ)
*i* (011, 1-ĭ)
*o* (111, 1)
*p* (221, 2)

*mm‴* = 86° $20\frac{1}{2}'$
*hh′* = 44° 23′
*gg′* = 78° $25\frac{1}{2}'$
*ff′* = 94° $49\frac{1}{2}'$
*dd′* = 117° 0′
*ee′* = 145° 56′
*ll′* = 74° 52′
*kk′* = 91° 10′
*ck* = *45° 35′
*ii′* = 113° 42′
*co* = 65° 55′
*cp* = 77° 24′
*oo′* = 83° 30′
*oo‴* = 77° 19′



Binnenthal, Berendes.

Crystals sometimes one inch in length, usually thick rectangular; prismatic ‖ $\bar{b}$; and somewhat tabular ‖ *c*; faces in zone *ac* horizontally striated. Also massive.

Cleavage: *c* perfect. Fracture conchoidal. Brittle. H. = 3. G. = 5·55–5·57. Luster metallic. Color blackish lead-gray. Streak reddish brown. Opaque.

**Comp.**—$Pb_2As_2S_5$ or $2PbS.As_2S_3$ = Sulphur 22·2, arsenic 20·7, lead 57·1 = 100.

**Anal.**—1, 2, Damour, l. c. 3, Berendes, Inaug. Diss., Bonn, 1864.

| | | S | As | Pb | Ag | Fe | Cu | |
|---|---|---|---|---|---|---|---|---|
| 1. Binnenthal | | 22·49 | 20·69 | 55·40 | 0·21 | 0·44 | 0·30 | = 99·53 |
| 2. " | | 22·30 | 20·87 | 56·61 | 0·17 | 0·32 | 0·22 | = 100·49 |
| 3. " | G. = 5·56 | 23·27 | 21·76 | 53·62 | 0·05 | 0·30 | — | = 99·0 |

**Pyr., etc.**—In the closed tube easily fuses and gives a sublimate of sulphur and arsenic trisulphide; in the open tube gives sulphurous fumes ($SO_2$) and a white crystalline sublimate of arsenic trioxide. On charcoal decrepitates, fuses, yields fumes of arsenic and a globule of lead, which on cupellation yields silver.

**Obs.**—From the Binnenthal in Switzerland, in cavities in crystalline dolomite, along with sartorite, jordanite, binnite, realgar, orpiment, sphalerite, pyrite.

Damour, who first studied the sulpharsenites of the Binnenthal, analyzed the massive ore and named it *dufrenoysite* (after the French mineralogist, P. A. Dufrénoy, 1792–1857). He inferred that the crystallization was isometric from some associated crystals, and so published it. This led von Waltershausen and Heusser to call the isometric mineral dufrenoysite, and the latter to name the orthorhombic *binnite.* Von Waltershausen, after studying the prismatic mineral, made out the species *arsenomelan* and *scleroclase*, yet partly on hypothetical grounds. Later it was found that three orthorhombic minerals existed at the locality, as announced by vom Rath, who identified one, by specific gravity and composition, with Damour's *dufrenoysite;* another he made *scleroclase* of von Waltershausen (sartorite, p. 112); and the other he named *jordanite* (p. 141).

**Ref.**—[1] Pogg., **122**, 373, 1864. See earlier Dx., Ann. Mines, 8, 389, 1855; Heusser, Pogg., **97**, 120, 1856; Berendes, Inaug. Diss., Bonn, 1864. [2] Cf. Berendes, l. c.

**128. COSALITE.** *Genth,* Am. J. Sc., **45**, 319, 1868. Ett nytt vismutsvafladt svafvelbly *Lundström,* G. För. Förh., **2**, 178, 1874. Bleibismutit *Groth,* Tab. Ueb., 18, 1874. **Bjelkite** *H. Sjögren,* G. För. Förh., **4** 107, 1878.

Orthorhombic. Axes: $\breve{a} : \bar{b} : \acute{c} = 0·91874 : 1 : 1·4601$ Flink.[1]

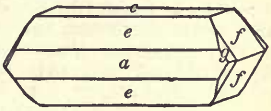
$100 \wedge 110 = 42° \ 34' \ 30''$, $001 \wedge 101 = 57° \ 49' \ 14''$, $001 \wedge 011 = {}^{*}55° \ 35' \ 36''$.

**Forms:** *b* (010, *i*-$\bar{\imath}$) *i* (140, *i*-$\breve{4}$) *e* (101, 1-$\bar{\imath}$) *k* (221, 2) *h* (142, 2-$\bar{4}$)
*a* (100, *i*-$\bar{\imath}$) *c* (001, *O*) *d* (104, $\frac{1}{4}$-$\bar{\imath}$) *f* (011, 1-$\breve{\imath}$) *g* (144, 1-$\breve{4}$)

*ii″* = 30° 27′ *cf* = *55° 35′ 36″ *cg* = 56° 32½′ *kk‴* = 82° 28′
*cd* = *21° 40′ 6″ *ff′* = 111° 11′ *ch* = 71° 43′ *gg′* = 25° 18′
*ee′* = 115° 38½′ *ck* = 76° 57′ *kk′* = 91° 41′ *hh′* = 28° 52′

Usually massive with indistinct crystalline structure; fibrous, radiated. Fracture uneven. Brittle. H. = 2·5–3. G. = 6·39–6·75. Luster metallic. Color lead-gray, steel-gray. Streak black. Opaque.

**Comp.**—$Pb_2Bi_2S_5$ or $2PbS.Bi_2S_3$ = Sulphur 16·2, bismuth 42·0, lead 41·8 = 100. The lead is sometimes in part replaced by silver and copper.



Nordmark, Flink.

**Anal.**—1, 2, Genth, l. c., after deducting 6·79 p. c. and 11·88 p. c. cobaltite. 3, 4, Frenzel, Jb. Min., 681, 1874. 5, Lundström, l. c., containing some pyrrhotite. 6, 7, H. Sj., l. c. 8, G. Lindström, G. För. Förh., **11**, 171, 1889. 9, Tilden, Proc. Col. Soc., **1**, 74, 1884. 10, W. F. Hillebrand, Am. J. Sc., **27**, 354, 1884. 11, 12, Genth, Am. Phil. Soc., **23**, 36, 1885. 13, Koenig Am. Phil. Soc., **22**, 211, 1885. 14, Low, Proc. Col. Soc., **1**, 111, 1884.

| | | | S | Bi | Pb | Ag | Cu | Fe | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Cosala | | 15·27 | 41·76 | 40·32 | 2·65 | — | — | = 100 |
| 2. | ‘ | | 15·23 | 42·77 | 38·79 | 3·21 | — | — | = 100 [99·84 |
| 3 | Rezbanya | G. = 6·22–6·33 | 16·11 | 35·90 | 38·08 | 1·37 | 0·86 | 2·96 | Zn 1·54, As 3·02 = |
| 4. | “ | “ | 16·68 | 44·48 | 31·93 | 0·22 | 3·49 | 1·18 | Zn 0·18, As 2·82 = |
| 5. | Nordmark *Bjelkite* | | 17·83 | 39·40 | 37·64 | — | — | 5·13 | = 100 [100·98 |
| 6. | “ | G. = 6·39–6·75 | 15·98 | 41·55 | 40·10 | — | — | 0·67 | insol. 2·19 = 100·49 |
| 7. | “ | “ | 16·48 | 41·86 | 39·19 | — | — | 1·32 | = 98·85 |
| 8 | Gladhammar | G. = 7·0–7·07 | 15·92 | 33·84 | 48·05 | — | 0·69 | 0·16 | Zn 0·05, insol. 0·45 |
| 9 | Candameña | | 16·58 | 40·13 | 25·12 | 15·66 | 1·63 | — | = 99·12 [= 99·16 |
| 10 | Comstock mine, Col | | 17·11 | 42·97 | 22·49 | 8·43 | 7·50 | 0·70 | Zn *tr.* = 99·20 |
| 11 | Gladiator mine, Col. | | 17·17 | 45·09 | 24·61 | 5·75 | 5·84 | — | Sb 0·84, Zn 0·58 = [99·88 |
| 12. | Alaska mine, Col. | | 16·80 | 44·95 | 28·10 | 1·44 | 8·00 | — | Zn 0·24, Sb 0·51, As [0·04, Se *tr.* = 100·08 |
| 13. | “ “ | G. = 6·782 | 17·13 | 43·54 | 26·77 | 1·35 | 8·78 | 0·52 | Zn *tr.*, Sb *undet.*, [insol. 0·60 = 98·69 |
| 14. | Red Mt., Col. | | [18·64] | 36·22 | 28·22 | 8·70 | 3·74 | 4·48 | = 100 |

**Pyr.**—B.B. fuses easily, giving the usual reactions for sulphur, bismuth, and lead; some varieties yield a small globule of silver.

**Obs.**—Found associated with quartz and cobaltite in a silver mine at Cosala, Province of Sinaloa, Mexico. An argentiferous variety (anal. 9) occurs at Candameña, Chihuahua. In calcite at the Bjelke mine, at Nordmark, Wermland, Sweden (*bjelkite*); also at Gladhammar. At Rezbanya, Hungary, with sphalerite, pyrite, and chalcopyrite; an impure form of this mineral was called *rezbanyite* (retzbanyite) by Hermann, J. pr. Ch., **75**, 450, 1859; cf. Frenzel, l. c.

In the U. S., from the Comstock mine (anal. 10), near Parrott City, La Plata county, Col., in a quartz vein with pyrite, sphalerite, a telluride probably sylvanite and native gold. Also from the Gladiator and Alaska mines, Colorado, and at the Yankee Girl mine, Red Mt., San Juan county.

**Ref.**—[1] Ak. H. Stockh., Bihang, **12** (2), No. 2, 6, 1886.

**129. SCHAPBACHITE.** Wismutisches Silber *Selb*, Crell's Ann., **1**, 10, 1793. Wismuthbleierz. Schapbachit *Kenngott*, Min., 118, 1853. *Sandberger* Erzgänge, **1**, 90, 1882.

Orthorhombic? In minute acicular crystals, with *b, c, m*; $mm''' = 75°$. Also fine granular, massive.

Cleavage: basal, distinct. Fracture uneven. H. = 3·5. G. = 6·43. Luster metallic. Color lead-gray. Streak black. Opaque.

**Comp.**—$PbAg_2Bi_2S_6$ or $PbS.Ag_2S.Bi_2S_3$ = Sulphur 16·1, bismuth 41·6, lead 20·7, silver 21·6 = 100.

**Anal.**—Hilger, l. c., after deducting 1·86 p. c. pyrite.

S 16·08 Bi 42·02 Pb 20·82 Ag 21·08 = 100

This species may be regarded as an argentiferous variety of cosalite.

**Obs.**—From Schapbach, Baden, intimately associated with galena, pyrite and chalcopyrite, quartz and native bismuth or bismuthinite. Earlier regarded as merely a mixture of bismuthinite, argentite and galena (cf. Sandberger, Jb. Min., 22, 1864).

**130. JAMESONITE.** Gray antimony pt. *Jam.*, Syst., 3, 390, 1820. Axotomous Antimony. Glance *Jam.*, Man., 285. Axotomer Antimon-Glanz *Mohs*, Grundr., 586, 1824. Jamesonite *Haid.*, Trl. Mohs's Min., **1**, 451 (3, 26), 1825. Bleischimmer *Pfaff*, Schw. J., **27**, 1. Pfaffite *Huot.*, **1**, 192, 1841. Antimonialisk Fädererz pt., Minera antimonii plumosa pt., *Wall.*, 1747; Federerz *Germ.*, Mine d'antimoine au plumes *Fr.*; Feather ore, Plumose Antimonial ore, pt. (rest mostly Stibnite), *through last cent.* Antimoine sulfuré capillaire pt. [or var. of Stibnite] *H.*, Tr., 1801; Haarförmiges Grauspiessglanzerz pt. *Karst.*, Tab., 52, 1800; Haarf. Antimonglanz *Mohs*, 1824, *Leonh.*, 1826. Federerz of Wolfsberg *H. Rose*, Pogg., **15**, 471, 1829; *Beud.*, Tr., **2**, 425, 1832 Federerz, var. of Jamesonite, *Kbl.*, Char., **2**, 175, 1831. Wolfsbergite *Huot.*, Min., **1**, 193. Plumosit *Haid.*, Handb., 569, 1845. Plumites *Glock.*, Syn., 30, 1847. Heteromorphit *Rg.*, Pogg., **77**, 240, 1849. Federerz, var. of Jamesonite, *Rg.*, Min. Ch., 71, 1860. Bleiantimonit *Groth*, Tab. Ueb., 18, 1874. Querspiessglanz, *Germ.*

Orthorhombic. Axes: $\breve{a} : \bar{b} = 0.8915 : 1$. Angles: $mm''' = 78° 40'$, $bm = 50° 40'$. Usually in acicular crystals, with *b, m*; common in capillary forms, cobweb-like. Also fibrous massive, parallel or divergent; compact massive.

Cleavage: basal, perfect; *b, m* less so. Fracture uneven to conchoidal. Brittle. H. = 2–3. G. = 5·5–6·0. Luster metallic. Color steel-gray to dark lead-gray. Streak grayish black. Opaque.

**Comp.**—$Pb_2Sb_2S_5$ or $2PbS.Sb_2S_3$ = Sulphur 19·7, antimony 29·5, lead 50·8 = 100. Most varieties show a little iron (1 to 3 p. c.), and some contain also silver, copper, and zinc.

**Anal.**—1, Bořicky, Ber. Ak. Wien, **56** (1), 32, 1867. 2, Burton, Am. J. Sc., **45**, 36, 1868. 3, Siewert, Min. Mitth., 248, 1873. 4, Sarlay, ib., 355, 1877. 5, Dunnington, Amer. Assoc., 184, 1877. 6, Wait, Trans. Am. Mng. Eng., **8**, 51, 1880. 7, Genth, Am. Ch. J., **1**, 325, 1879. 8, Pisani, C. R., **83**, 747, 1876. For early analyses, 5th Ed., p. 91.

| | | S | Sb | Pb | Ag | Cu | Fe | Zn | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Přibram | | 20·21 | 30·81 | 47·17 | — | — | 1·35 | — | As *tr.* = 99·54 |
| 2. Star City | G. = 6·03 | $\frac{2}{2}$ 19 06 | 29 26 | 43·86 | 6·14 | 1·55 | 0·05 | — | = 99 92 |
| 3. Famatina | G. = 5·54 | 21·75 | 32·00 | 39·05 | 1·34 | 3·45 | 2·00 | 0·62 | As 0·20 = 100·41 |
| 4. Wiltau | G. = 5·2 | 21·66 | 34·02 | 40·39 | — | — | 3·43 | — | As 0·39 = 99·89 |
| 5. Arkansas | | 22·18 | 32·89 | 36·78 | — | — | 2·62 | 5·07 | $SiO_2$ 0·74 = 100·28 |
| 6. " | G. = 5·15 | 22·07 | 35·06 | 38·44 | 0·22 | 0·01 | 2·53 | — | Bi,Cd 0·01 $SiO_2$ 1·58 [= 99·92 |
| 7. Huelva | G. = 5·47 | 22·31 | 34·03 | 38·49 | — | — | 5·16 | — | = 99·99 |
| 8. Arnsberg<br>*Heteromorphite* | G. = 5·59–5·73 | 19·90 | 31·20 | 47·86 | — | — | — | 0·60 | = 99·56 |

**Pyr.**—Same as for zinkenite.

**Obs.**—Occurs principally in Cornwall, associated with quartz and minute crystals of bournonite; occasionally also in Siberia, Hungary, at Valentia d'Alcantara in Spain, and Brazil; at the antimony mines in Sevier Co., Arkansas; at the Montezuma mine, Nevada. Named after Prof. Robert Jameson of Edinburgh (1774–1854).

The *feather ore* (Federerz *Germ.*) occurs at Wolfsberg in the Eastern Harz; also at Andreasberg and Clausthal; at Freiberg and Schemnitz; in the Anhalt at Pfaffenberg and Meiseberg; in Tuscany, near Bottino; at Chonta in Peru. It was regarded as a species by nearly all the mineralogists of last century, but included capillary stibnite; made a variety of stibnite by v. Born, Karsten, Haüy, Mohs, Leonhard, and other authors, until 1829; and a distinct species again by most authors after the analysis by Rose in 1829; but referred to jamesonite by v. Kobell in 1830, and Rammelsberg in 1860.

*Zundererz*, or Bergzunderz [ = Tinder Ore] of G. Lehmann (Mem. Ak. Berlin, 20, 1758), which is soft like tinder and dark dirty red in color, has been referred to kermesite, but proves to be an impure jamesonite or feather ore sometimes mixed with red silver and arsenopyrite; also with free sulphur. From Andreasberg and Clausthal in the Harz.

**Alt.**—The lead antimonate, bindheimite, is a common alteration product.

**Artif.**—Obtained by Doelter in forms resembling the natural mineral, Zs. Kr., **11**, 40, 1885.

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**131. KOBELLITE.** Kobellit *Sätterberg*, Ak. H. Stockh., 188, 1839; Berz. Jahresb., **20**, 215.

Massive, sometimes fibrous and radiated, resembling stibnite; also fine granular.

H. = 2·5–3. G. = 6·29–6·32 Sätterberg; 6·334 Keller. Color blackish lead-gray to steel-gray. Streak black.

**Comp.**—$Pb_2(Bi,Sb)_2S_5$ or $2PbS.(Bi,Sb)_2S_3$ = (if Bi : Sb = 2 : 1) Sulphur 17·2, bismuth 29·8, antimony 8·6, lead 44·4 = 100. Silver is also present.

**Anal.**—1, Sätterberg, recalculated by Rammelsberg, Min. Ch., 100, 1875. 2, H. F. Keller, Zs. Kr., **17**, 67, 1889, deducting impurities.

| | S | Bi | Sb | Pb | Ag | Cu | Fe |
|---|---|---|---|---|---|---|---|
| 1. Sweden | [18·61] | 28·37 | 9·38 | 40·74 | — | 0·88 | 2·02 = 100 |
| 2. Colorado $\frac{4}{4}$ | 17·76 | 30·61 | 8·13 | 38·95 | 3·58 | 0·97 | — = 100 |

**Pyr., etc.**—B.B. decrepitates, and fuses easily; in the open tube sulphurous fumes and a sublimate of antimony trioxide; on charcoal, a yellow coating ($Bi_2O_3$) near the assay and beyond white ($Sb_2O_3$); with potassium iodide and sulphur a bright red coating (bismuth iodide). Soluble in concentrated hydrochloric acid with evolution of hydrogen sulphide.

**Obs.**—From the cobalt mine of Hvena in Sweden, associated with actinolite, chalcopyrite, and small reddish white crystals of a cobaltiferous arsenopyrite (Kobaltarsenikkies). Also from the Silver Bell mine at Ouray, Colorado, associated with chalcopyrite and barite.

Named after the Bavarian mineralogist and poet, Franz von Kobell (1803–1882).

Rammelsberg rejected Sätterberg's analysis, and on the basis of analyses by himself and Genth deduced the composition $3PbS.(Bi,Sb)_2S_3$. Keller, however, has proved the existence of the compound $2PbS.(Bi,Sb)_2S_3$, to which Sätterberg's analysis conforms, and to the other has given the name of *lillianite* (p. 130); cf. also Groth, Tab. Ueb., pp. 30, 31, 1889. If this conclusion is correct, both these compounds must occur at the Swedish locality.

**132. BRONGNIARDITE.** *Damour*, Ann. Mines, **16**, 227, 1849. Bleisilberantimonit *Groth*, Tab. Ueb., 18, 1874.

Isometric. In octahedrons (*o*) with truncated edges (*d*). Massive without cleavage.

H. above 3. G. = 5·950. Luster metallic. Color and streak grayish black.

**Comp.**—$PbAg_2Sb_2S_5$ or $PbS.Ag_2S.Sb_2S_3$ = Sulphur 19·5, antimony 29·2, silver 26·2, lead 25·1 = 100.

**Anal.**—Damour, l. c.:

| | S | Sb | Ag | Pb | Cu | Fe | Zn |
|---|---|---|---|---|---|---|---|
| $\frac{3}{3}$ | 19·24 | 29·77 | 24·77 | 24·91 | 0·62 | 0·26 | 0·36 = 99·93 |

**Pyr., etc.**—In the closed tube a feeble orange sublimate with a white one above; in the open tube fuses, affords an odor of sulphur and a white sublimate of antimony trioxide. B B. on charcoal decrepitates, fuses easily, giving off an odor of sulphur and white vapors; after roasting, yields a globule of silver, with a yellow coating of lead oxide. Rapidly attacked by concentrated nitric acid.

**Obs.**—From Mexico. Named for the French mineralogist, Alexandre Brongniart (1770–1847).

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**133. SEMSEYITE.** *Krenner* [Mag. Akad. Értes., **15**, 111, 1881], Ungar. Revue, 367, 1881; Zs. Kr. 8, 532, 1883.

Monoclinic. Axes $\grave{a} : \overset{|}{b} : \grave{c}$ = 1·14424 : 1 : 1·10515; $\beta$ = 71° 4′ = 100 ∧ 001 Krenner[1].

100 ∧ 110 = 47° 15$\frac{5}{6}$′, 001 ∧ 101 = 34° 49$\frac{1}{3}$′, 001 ∧ 011 = 46° 16$\frac{1}{4}$′.

**Forms:** *a* (100, *i-ī*), *c* (001, *O*), *s* (113, − $\frac{1}{3}$), *p* (111, − 1), *q* (221, − 2), *t* ($\bar{1}$13, $\frac{1}{3}$).

Angles: *cs* = *22° 44′, *cp* = 46° 35′, *cq* = *59° 38′, *ct* = 27° 20′, *ss′* = 33° 50′, *pp′* = 66° 19′, *qq′* = 81° 2′, *qq″* = *98° 58′, *tt′* = 40° 27′.

In small tabular crystals, often elongated ‖ $\bar{b}$.

Cleavage: pyramidal, *p*. G. = 5·952 Sipöcz. Luster metallic. Color gray. Opaque.

**Comp.**—Near jamesonite, perhaps $Pb_7Sb_6S_{16}$ or $7PbS.3Sb_2S_3$ = Sulphur 19·1, antimony 26·9, lead 54·0 = 100.

**Anal.**—Sipöcz, Zs. Kr., **11**, 216, 1885.

S 19·42 Sb 26·90 Pb 53·16 Fe 0·10 = 99·58

**Obs.**—Occurs with galena, also diaphorite, sphalerite and pyrite at Felsöbánya, Hungary. Named for Andor von Semsey.

**Ref.**—[1] Zs. Kr., **8**, 532, 1883.

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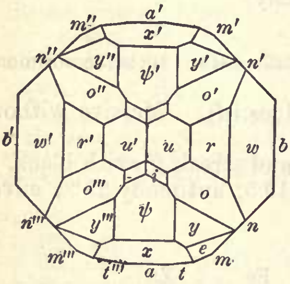
**134. DIAPHORITE.** Freieslebenite pt. Diaphorit *Zepharovich*, Ber. Ak. Wien, **63** (1), 130, 1871.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·49194 : 1 : 0·73447 Zepharovich.

100 ∧ 110 = 26° 11$\frac{2}{3}$′, 001 ∧ 101 = 56° 11$\frac{1}{6}$′, 001 ∧ 011 = 36° 17$\frac{3}{4}$′.

**Forms:**
*a* (100, $i$-$\bar{i}$)
*b* (010, $i$-$\breve{i}$)
*t* (310, $i$-$\bar{3}$)
*m* (110, $I$)
*n* (120, $i$-$\breve{2}$)
*k* (5·12·0, $i$-$\breve{\frac{12}{5}}$)
*π* (130, $i$-$\breve{3}$)
*ρ* (150, $i$-$\breve{5}$)
*α* (1·11·0, $i$-$\breve{11}$)
*ψ* (102, $\frac{1}{2}$-$\bar{i}$)
*x* (101, 1-$\bar{i}$)
*u* (012, $\frac{1}{2}$-$\breve{i}$)
*r* (011, 1-$\breve{i}$)
*v* (032, $\frac{3}{2}$-$\breve{i}$)
*q* (053, $\frac{5}{3}$-$\breve{i}$)
*w* (021, 2-$\breve{i}$)
*i* (114, $\frac{1}{4}$)
*y* (112, $\frac{1}{2}$)
*ω* (314, $\frac{3}{4}$-$\bar{3}$)
*e* (534, $\frac{5}{4}$-$\bar{\frac{5}{3}}$)
*ζ* (122, 1-$\breve{2}$) tw. pl.
*o* (134, $\frac{3}{4}$-$\breve{3}$)
*d* (144, 1-$\breve{4}$)

*tt‴* = 18° 37$\frac{1}{2}$′
*mm‴* = 52° 23′
*nn′* = 90° 56′
*ψψ′* = 73° 29′
*xx′* = 112° 22′
*ax* = *33° 48$\frac{5}{6}$′
*uu′* = 40° 20′
*rr′* = 72° 36′
*ww′* = 111° 31′
*mi* = 67° 25′
*ay* = 54° 59′
*ao* = 71° 54′
*by* = 73° 36′
*xw* = *71° 45′



After Zepharovich.

Twins: tw. pl. (1) *n* (120); (2) *ζ* (122). Habit prismatic, faces in zone *a m* often vertically striated.

Cleavage not observed. Fracture subconchoidal to uneven. Brittle. H. = 2·5–3. G. = 5·902 Zeph.; 6·042 Vrba. Luster metallic. Color steel-gray. Opaque.

**Comp.**—$(Pb,Ag_2)_5Sb_4S_{11}$ or $5(Pb,Ag_2)S.2Sb_2S_3$. If $Pb : Ag_2 = 4 : 3$, this requires: Sulphur 18·7, antimony 25·5, lead 31·3, silver 24·5 = 100. The composition is the same as for freieslebenite.

**Anal.**—1, Helmhacker, Kenng. Ueb. 294,, 1865. Referred here (Zeph.) on the ground that freieslebenite is not found at Přibram. 2, Morawski, Zs. Kr., **2**, 161, 1878.

| | S | Sb | Pb | Ag | Fe | Cu |
|---|---|---|---|---|---|---|
| 1. Přibram | 20·18 | 26·43 | 28·67 | 23·44 | 0·67 | 0·73 = 100·12 |
| 2. " | 18·51 | 25·92 | 31·56 | 23·36 | — | — = 99·35 |

**Pyr.**—As for freieslebenite.

**Obs.**—Occurs at Přibram and at Bräunsdorf near Freiberg; freieslebenite is also found at Freiberg. Reported from Zancudo, U. S. of Colombia, S. A., with sphalerite and heteromorphite. Named from διαφορά, *difference*, because distinct from, while similar to, freieslebenite.

**135. FREIESLEBENITE.** Mine d'antimoine grise tenant argent (fr. Himmelsfürst) *de Lisle*, Descr. de Min., 35, 1773, Crist., **3**, 54, 1783. Dunkles Weissgültigerz (id. loc., known since 1720) *Klapr.*, Beitr., **1**, 173, 1795. Schilf-Glaserz *Freiesleben*, Geogn. Arb., **6**, 97. 1817. Antimonial Sulphuret of Silver, Sulphuret of Silver and Antimony. Argent sulfuré antimonifère et cuprifère *Lévy*, Descr. Min. Heuland, 1838. Donacargyrite *Chapm.*, Min., 128, 1843. Freieslebenit *Haid.*, 569, 1845.

Monoclinic. Axes $\grave{a} : \overset{1}{\bar{b}} : \grave{c} = 0·58714 : 1 : 0·92768$; $\beta = {*}87° 46' = 100 \wedge 001$ Miller[1].

$100 \wedge 110 = 30° 24'$, $001 \wedge 101 = {*}56° 5'$, $001 \wedge 011 = 42° 49\frac{5}{6}'$.

| | | | | | |
|---|---|---|---|---|---|
| **Forms**[2]: | $t$ (310, $i$-$\bar{3}$) | $o$ (230, $i$-$\frac{3}{2}$)[4] | $i$ (150, $i$-$\grave{5}$)[4] | $r$ (011, 1-$\grave{i}$) | $f$ (111, − 1) |
| $a$ (100, $i$-$\bar{i}$) | $\beta$ (210, $i$-$\bar{2}$)[3] | $k$ (120, $i$-$\grave{2}$) | $x$ (101, −1-$\bar{i}$) | $d$ (054, $\frac{5}{4}$-$\grave{i}$)[4] | $h$ (414, − 1-$\bar{4}$) |
| $b$ (010, $i$-$\grave{i}$) | $s$ (430, $i$-$\frac{4}{3}$) | $n$ (350, $i$-$\frac{5}{3}$) | $\xi$ ($\bar{1}$01, 1-$\bar{i}$)[3] | $v$ (032, $\frac{3}{2}$-$\grave{i}$) | $g$ (312, − $\frac{3}{2}$-$\bar{3}$) |
| $c$ (001, $O$) | $m$ (110, $I$) | $\pi$ (250, $i$-$\frac{5}{2}$)[3] | | $w$ (021, 2-$\grave{i}$) | $z$ (212, − 1-$\bar{2}$) |
| $q$ (810, $i$-$\bar{8}$) | $l$ (560, $i$-$\frac{6}{5}$) | $p$ (130, $i$-$\grave{3}$)[3] | $u$ (012, $\frac{1}{2}$-$\grave{i}$) | $y$ (112, − $\frac{1}{2}$) | $\phi$ ($\bar{1}$12, $\frac{1}{2}$) |
| | $\sigma$ (450, $i$-$\frac{5}{4}$)[4] | | $e$ (034, $\frac{3}{4}$-$\grave{i}$)[4] | | |

$tt''' = 22° 8'$
$\beta\beta''' = 32° 42'$
$mm''' = {*}60° 48'$
$nn' = 91° 17'$
$kk' = 80° 53'$
$\pi\pi' = 68° 34'$
$pp' = 59° 12'$
$ax = 31° 41'$
$c\xi = 59° 16'$

$a'\xi = 32° 58'$

$uu' = 49° 44'$
$rr' = 85° 40'$
$ww' = 123° 19'$

$cy = 41° 36\frac{1}{2}'$
$cf = 59° 54'$
$cm = 88° 4\frac{1}{2}'$
$c\phi = 43° 22'$

$ch = 56° 22'$
$my = 46° 28'$
$mf = 28° 11'$
$m'\phi = 48° 34'$

$ag = 24° 34'$
$az = 34° 14'$
$af = 40° 5\frac{1}{2}'$

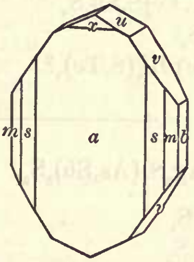
$bf = 64° 1\frac{1}{3}'$
$b\phi = 69° 39'$
$ff' = 51° 57'$
$hh' = 13° 53'$
$zz' = 27° 23'$
$gg' = 20° 9'$
$\phi\phi' = 40° 41'$

Twins: tw. pl. *a*. Habit prismatic, prismatic planes vertically striated.

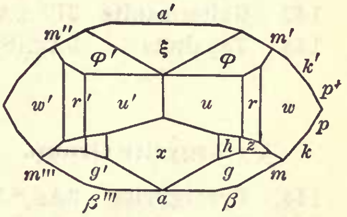
Cleavage: *m* imperfect. Fracture subconchoidal to uneven. Rather brittle. H. = 2–2·5. G. = 6·2–6·4; 6·194 Hausm., 6·35 Vrba. Luster metallic. Color and streak light steel-gray inclining to silver-white, also to blackish lead-gray. Opaque.

**Comp.**—$(Pb,Ag_2)_5Sb_4S_{11}$ or $5(Pb,Ag_2)S.2Sb_2S_3$ = (if Pb : $Ag_2$ = 4 : 3) Sulphur 18·7, antimony 25·5, lead 31·3, silver 24·5 = 100. Also (anal. 6) $Pb_5Sb_4S_{11}$ = Sulphur 18·9, antimony 25·7, lead 55·4 = 100.

1.



2.



**Anal.**—1, 2, Wöhler, Pogg., **46**, 153, 1839. 3, Escosura [Rev. Minera, **6**, 358], Ann. Mines, **8**, 495, 1855. 4, Payr, Jb. Min., 579, 1860. 5, Morawski, Zs. Kr., **2**, 161, 1878. 6, L. G. Eakins, Am. J. Sc., **36**, 452, 1888.

| | | S | Sb | Pb | Ag | Fe | |
|---|---|---|---|---|---|---|---|
| 1. Freiberg | | 18·77 | 27·72 | 30·00 | 22·18 | 0·11 | Cu 1·22 = 100 |
| 2. " | | 18·71 | 27·05 | 30·08 | 23·76 | — | = 99·60 |
| 3. Spain | | 17·60 | 26·83 | 31·90 | 22·45 | — | = 98·78 |
| 4. Přibram | G. = 6·230 | 18·41 | 27·11 | 30·77 | 23·08 | 0·63 | = 100 |
| 5. Spain | G. = 6·040 | 18·90 | 25·64 | 31·38 | 23·31 | — | Cu 0·13 = 99·36 |
| 6. Colorado | | 18·98[a] | 25·99 | 55·52 | *tr.* | *tr.* | = 100·49 |

[a] By calculation.

Pisani refers here the massive dark *Weissgültigerz* analyzed by Klaproth, who obtained (l.c.) S 22·00, Sb 21·50, Pb 41·00, Ag 9·25, Fe 1·75, $Al_2O_3$ 1·00, $SiO_2$ 0·75 = 97·25, considering part of the silver as here replaced by lead.

**Pyr.**—In the open tube gives sulphurous and antimonial fumes, the latter condensing as a white sublimate. B.B. on charcoal fuses easily, giving a coating, on the outer edge white, from antimony trioxide, and near the assay yellow, from lead oxide; continued blowing leaves a globule of silver.

**Obs.**—With argentite, siderite, and galena, in the Himmelsfürst mine, at Freiberg in Saxony; at Kapnik in Hungary; at Ratieborzitz, the ore of which locality contains bismuth, according to Zincken; at Felsöbánya; at Hiendelencina in Spain, with argentite, red silver, siderite, galena, etc. In groups of acicular crystals of a bright steely grayish black color from the Augusta Mt., Gunnison Co., Colorado (anal. 6). Formerly regarded as occurring at Přibram, but this mineral is referred to diaphorite (Zeph.).

Named after J. K. Freiesleben (1774–1846).

**Ref.**—[1] Min., p. 208, 1852. [2] See Miller, l. c. [3] Zeph., Ber. Ak. Wien, **63** (1), 130, 1871. [4] Bkg., Spain, Zs. Kr., **2**, 425, 1878.

## D. Ortho- Division. $R_3As_2S_6$, $R_3Sb_2S_6$, etc.; also $\overset{\text{I}}{R}_3AsS_3$, etc.

### Bournonite Group. $3RS.(As,Sb,Bi)_2S_3$. Orthorhombic.

The crystalline form of only a part of the species provisionally included here is definitely known.

| | | | $\breve{a} : \bar{b} : \acute{c}$ |
|---|---|---|---|
| 136. | **Bournonite** | $3(Cu_2,Pb)S.Sb_2S_3$ | 0·9380 : 1 : 0·8969 |
| 137. | **Wittichenite** | $3Cu_2S.Bi_2S_3$ | |
| 138. | **Aikinite** | $3(Pb,Cu_2)S.Bi_2S_3$ | 0·9719 : 1 |
| 139. | **Boulangerite** | $3PbS.Sb_2S_3$ | |
| 140. | **Lillianite** | $3PbS.Bi_2S_3$<br>$3PbS.BiSbS_3$ | |
| 141. | **Stylotypite** | $3(Cu_2,Ag_2,Fe)S.Sb_2S_3$ | 0·941 : 1 |
| 142. | **Guitermanite** | $3PbS.As_2S_3$? | |
| 143. | **Tapalpite** | $3Ag_2(S,Te).Bi_2(S,Te)_3$? | |

### Pyrargyrite Group. $3Ag_2S.(As,Sb)_2S_3$. Rhombohedral, hemimorphic.

| | | | |
|---|---|---|---|
| 144. | **Pyrargyrite** | $3Ag_2S.Sb_2S_3$ | $\acute{c}$ = 0·78916 |
| 145. | **Proustite** | $3Ag_2S.As_2S_3$ | $\acute{c}$ = 0·80393 |

| | | | | $\grave{a} : \bar{b} : \acute{c}$ | $\beta$ |
|---|---|---|---|---|---|
| 146. | **Pyrostilpnite** | $3Ag_2S.Sb_2S_3$ | Monoclinic | 0·3547 : 1 : 0·1782 | 90° |
| 147. | **Rittingerite** | | Monoclinic | 0·5280 : 1 : 0·5293 | 89° 26′ |

### Bournonite Group.

**136. BOURNONITE.** Ore of Antimony (fr. Endellion) *P. Rashleigh* (Spec. Brit. Min., **1**, 34, pl. xix., 1797. Triple Sulphuret of Lead, Antimony, and Copper *Bournon* (with figs.), Phil. Trans., 30, 1804; *Ch. Hatchett* (anal.), ib. 63., Bournonite, Antimonial Lead Ore, *Jameson*, Syst., **2**, 579, 1805, **3**, 372, 1816. Spiessglanzblei *Karst.*, in Klapr. Beitr., **4**, 82, 1807, and Tab., 68, 1808. Plomb sulfuré antimonifère *H.*, Tabl., 1809. Endellione *Bourn.*, Cat. Min., 409, 1813. Schwarz Spiesglanzerz *Wern.* Schwarzspiessglaserz, Antimonbleikupferblende *Germ.* Antimoine sulfuré plumbo-cuprifère *H.*, Tr., **4**, 1822. Rädelerz [= Wheel Ore] *Kapnik miners.* Endellionite *Zippe*, Char. Min., 213, 1859. Cañutillo *Span. S.A.*

Prismatischer Spiesglas-Glanz *Mohs*, Char., 1820; Prismatoidischer Kupfer-Glanz *Mohs*, Grundr., **2**, 559, 1824. Antimonkupfer-Glanz *Breith.* Wölchit *Haid.*, Handb., 564, 1845. Wölchite.

Orthorhombic. Axes: $\breve{a} : \bar{b} : \acute{c}$ = 0·93797 : 1 : 0·89686 Miller[1].

100 $\wedge$ 110 = *43° 10′, 001 $\wedge$ 101 = *43° 43′, 001 $\wedge$ 011 = 41° 53¼′.

**Forms**[2]:
a (100, $i\text{-}\bar{\imath}$)
b (010, $i\text{-}\breve{\imath}$)
c (001, $O$)

η (310, $i\text{-}\bar{3}$)
e (210, $i\text{-}\bar{2}$)
l (320, $i\text{-}\tfrac{3}{2}$)
R (750, $i\text{-}\tfrac{7}{5}$)[6]
Π (11·8·0, $i\text{-}\overline{\tfrac{11}{8}}$)[6]
ϑ (430, $i\text{-}\tfrac{4}{3}$)
M (970, $i\text{-}\tfrac{9}{7}$)[6]
k (540, $i\text{-}\tfrac{5}{4}$)
m (110, $I$)
Ψ (560, $i\text{-}\tfrac{6}{5}$)[6]

ω (340, $i\text{-}\tfrac{4}{3}$)
α (230, $i\text{-}\tfrac{3}{2}$)
f (120, $i\text{-}\breve{2}$)
i (130, $i\text{-}\breve{3}$)
Ξ (3·10·0, $i\text{-}\breve{\tfrac{10}{3}}$)[6]
Φ (140, $i\text{-}\breve{4}$)[6]
L (150, $i\text{-}\breve{5}$)[6]
d (160, $i\text{-}\breve{6}$)

τ (1·0·13, $\tfrac{1}{13}\text{-}\bar{\imath}$)?
β (108, $\tfrac{1}{8}\text{-}\bar{\imath}$)?
∇ (105, $\tfrac{1}{5}\text{-}\bar{\imath}$)[6]
t (104, $\tfrac{1}{4}\text{-}\bar{\imath}$)
ψ (207, $\tfrac{2}{7}\text{-}\bar{\imath}$)?
ϵ (103, $\tfrac{1}{3}\text{-}\bar{\imath}$)

F (205, $\tfrac{2}{5}\text{-}\bar{\imath}$)[6]
x (102, $\tfrac{1}{2}\text{-}\bar{\imath}$)
h (203, $\tfrac{2}{3}\text{-}\bar{\imath}$)
𝔨 (304, $\tfrac{3}{4}\text{-}\bar{\imath}$)?
o (101, $1\text{-}\bar{\imath}$)
σ (504, $\tfrac{5}{4}\text{-}\bar{\imath}$)?
z (201, $2\text{-}\bar{\imath}$)
δ (301, $3\text{-}\bar{\imath}$)
ζ (401, $4\text{-}\bar{\imath}$)

κ (013, $\tfrac{1}{3}\text{-}\breve{\imath}$)
γ (023, $\tfrac{2}{3}\text{-}\breve{\imath}$)
n (011, $1\text{-}\breve{\imath}$)
Σ (031, $3\text{-}\breve{\imath}$)[4]

Ω (114, $\tfrac{1}{4}$)[6]
φ (113, $\tfrac{1}{3}$)
u (112, $\tfrac{1}{2}$)
P (10·10·19, $\tfrac{10}{19}$)[6]
S (559, $\tfrac{5}{9}$)[6]
E (558, $\tfrac{5}{8}$)[6]
p (223, $\tfrac{2}{3}$)
χ (334, $\tfrac{3}{4}$)
y (111, 1)
K (554, $\tfrac{5}{4}$)[6]
Z (443, $\tfrac{4}{3}$)[6]
Θ (17·17·12, $\tfrac{17}{12}$)[6]
μ (332, $\tfrac{3}{2}$)
Γ (885, $\tfrac{8}{5}$)[6]

g (221, 2)
N (11·1·11, 1-11)[6]
υ (7·2·14, $\tfrac{1}{2}\text{-}\tfrac{7}{2}$)[6]
𝔩 (316, $\tfrac{1}{2}\text{-}\bar{3}$)
U (314, $\tfrac{3}{4}\text{-}\bar{3}$)[6]
ξ (214, $\tfrac{1}{2}\text{-}\bar{2}$)
θ (213, $\tfrac{2}{3}\text{-}\bar{2}$)
s (212, $1\text{-}\bar{2}$)
v (211, $2\text{-}\bar{2}$)
Δ (7·4·14, $\tfrac{1}{2}\text{-}\tfrac{7}{4}$)[6]
X (743, $\tfrac{7}{3}\text{-}\tfrac{7}{4}$)[6]
G (326, $\tfrac{1}{2}\text{-}\tfrac{3}{2}$)[3]
D (322, $\tfrac{3}{2}\text{-}\tfrac{3}{2}$)[6]

T (321, $3\text{-}\tfrac{3}{2}$)[6]
W (431, $4\text{-}\tfrac{4}{3}$)[6]
V (454, $\tfrac{5}{4}\text{-}\tfrac{5}{4}$)[6]
Y (355, $1\text{-}\tfrac{5}{3}$)[6]
w (346, $\tfrac{2}{3}\text{-}\tfrac{4}{3}$)
Q (232, $\tfrac{3}{2}\text{-}\tfrac{3}{2}$)[6]
J (123, $\tfrac{2}{3}\text{-}\breve{2}$)[6]
π (122, $1\text{-}\breve{2}$)
ρ (121, $2\text{-}\breve{2}$)
r (134, $\tfrac{3}{4}\text{-}\breve{3}$)
q (131, $3\text{-}\breve{3}$)
H (275, $\tfrac{7}{5}\text{-}\tfrac{7}{2}$)[6]
λ (144, $1\text{-}\breve{4}$)

Miers[6] adds as doubtful forms: (610), (6·13·0), (5·16·0), (270), (350), (580), (190); (907); (0·1·14), (014); (445), (20·20·21), (12·12·11), (14·14·11), (17·17·11); (22·11·34), (19·20·38); (368), (132), (1·10·9), (1·18·19).

ee‴ = 50° 16′
ll‴ = 64° 2′
mm‴ = 86° 20′
ff = 56° 8′
ii = 39° 8′

tt′ = 26° 53′
ϵϵ′ = 35° 21′
xx′ = 51° 6′
oo′ = 87° 26′
zz′ = 124° 47′

δδ′ = 141° 34′

γγ′ = 61° 45′
nn′ = 83° 46½′
ΣΣ′ = 139° 13′

cu = 33° 15′
cp = 41° 9′
cy = 52° 40′
cμ = 63° 3′
cg = 69° 7′

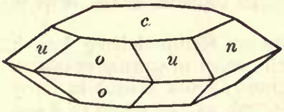
cξ = 27° 50′
cs = 46° 34′
cv = 64° 40′
cρ = 63° 48′

uu′ = 47° 8′
pp′ = 57° 22′
yy′ = 70° 53′
gg′ = 85° 55′
vv′ = 109° 50′
ρρ′ = 49° 56′

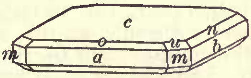
ππ′ = 39° 11′

uu‴ = 44° 3′
pp‴ = 53° 31′
yy‴ = 65° 54′
gg‴ = 79° 28′
ss‴ = 35° 55′
vv‴ = 45° 8′
ρρ‴ = 104° 43′
ππ‴ = 77° 57′

1.



2.



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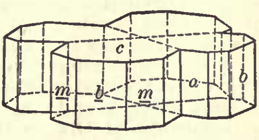

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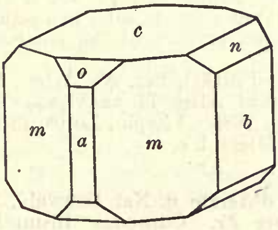
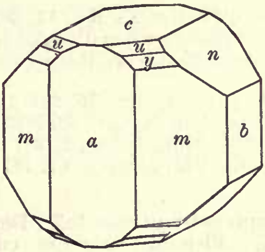


5.



6.

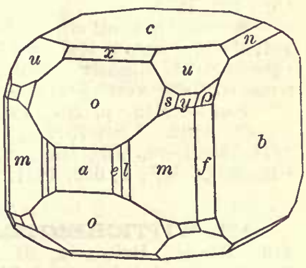


Fig. 1, Harz, Lévy. 2, 5, Nagyág, Zirkel. 3, Kapnik, Hbg.-Schrauf. 4, Harz, Zirkel. 6, Liskeard, Miers.

Twins: tw. pl. *m*, often repeated forming cruciform and wheel-shaped crystals, with also enclosed twin lamellæ. Crystals usually short prismatic to tabular; often aggregated in parallel position; prismatic faces often vertically striated, also macrodomes horizontally. Also massive; granular, compact.

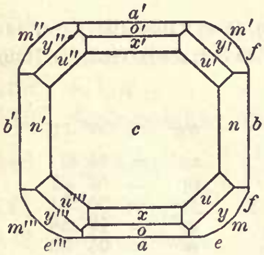
Cleavage: *b* imperfect; *a*, *c* less distinct. Fracture subconchoidal to uneven. Rather brittle. H. = 2·5–3. G. = 5·7–5·9. Luster metallic, brilliant. Color and streak steel-gray, inclining to blackish lead-gray or iron-black. Opaque.

**Comp.**—$(Pb,Cu_2)_3Sb_2S_6$ or $3(Pb,Cu_2)S.Sb_2S_3 = PbCuSbS_3$ (if $Pb : Cu_2 = 2 : 1$) Sulphur 19·8, antimony 24·7, lead 42·5, copper 13·0 = 100.

**Anal.**—1, Wait, Ch. News, **28**, 271, 1873. 2. Helmhacker, Min. Mitth., 86, 1875. 3, 4, Hidegh, Zs. Kr., 8, 534, 1883, ref. 5, Sipöcz, Zs. Kr., **11**, 218, 1885. 6, Lesinsky, J. pr. Ch., **40**, 232, 1889. Also 5th Ed., p. 96.

| | | S | Sb | As | Pb | Cu | Ag | Fe | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Liskeard | G. = 5·826 | 19·36 | 23·57 | 0·47 | 41.95 | 13 27 | — | 0·68 | = 99·30 |
| 2. Přibram | | 19·94 | 24·74 | — | 39·37 | 13·52 | 1·69 | 0·13 | Zn 0·09 = 99·66 |
| 3. Felsöbánya | G. = 5·86 | 19·78 | 23·80 | — | 42·07 | 12.82 | — | 0·20 | = 98·67 |
| 4. Kapnik | G. = 5·737 | 19·37 | 22·42 | 0·41 | 40·98 | 14·75 | 0·40 | 0·81 | = 99 14 |
| 5. Nagyág | G. = 5·766 | 20·22 | 18·42 | 3·18 | 43·85 | 12·87 | — | 0·51 | Mn 0·26, Zn 0·20 = 99·51 |
| 6. Neudorf | | 19·90 | 26 35 | — | 40·20 | 12·55 | — | — | gangue 0·50 = 99·50 |

7.



**Pyr., etc.**—In the closed tube decrepitates, and gives a dark red sublimate. In the open tube gives sulphur dioxide, and a white sublimate of antimony trioxide. B.B. on charcoal fuses easily, and at first coats the coal white; continued blowing gives a yellow coating of lead oxide; the residue, treated with soda in R.F., gives a globule of copper.

Decomposed by nitric acid, affording a blue solution, and leaving a residue of sulphur, and a white powder containing antimony and lead.

**Obs.**—Occurs in the mines of Neudorf in the Harz (which include the Meiseberg localities), where the crystals occasionally exceed an inch in diameter; also at Wolfsberg, Clausthal, and Andreasberg in the Harz; at Přibram in Bohemia; with quartz, tetrahedrite, and phosphorescent sphalerite, at Kapnik in Hungary, in flattened crystals; at Servoz in Piedmont, associated with pearl spar and quartz. Other localities are the parish of Bräunsdorf and Gersdorf in Saxony, Olsa in Carinthia, etc.; Endellion at Wheal Boys in Cornwall, where it was first found, and hence called *endellione*, by Count Bournon, after whom it was subsequently named; in Mexico; at Huasco-Alto in Chili; Mina Beatriz, Sierra Gorda, Atacama; at Machacamarca in Bolivia; in Peru.

In the U. S., at the Boggs mine, Yavapai Co , Arizona (Blake), with pyrite, chalcopyrite, etc.: also from Montgomery Co., Arkansas, with galena, tetrahedrite, etc. (F. W. Gibb). Also reported from the Bear and Anvil Mts., San Juan Co., Colorado. In Canada, in the township of Marmora, Hastings Co., and Darling, Lanark Co., Ontario.

**Alt.**—Occurs altered to cerussite, malachite, azurite, and also (as Rammelsberg has shown) to the mineral called *wölchite* (Antimonkupferglanz *Germ.*), which occurs in similar crystals, with the same hardness and same sp. gr. (5·88–5·94 Rg.). It was originally from Wölch in Carinthia, but occurs also at Olsa, with true bournonite. Rammelsberg found, as the mean of 4 analyses (Min. Ch., 80, 1860), S 16·81, Sb 24·41, Pb 15·59, Cu 42·83, Fe 0·36 = 100, excluding the admixed carbonate, sulphate, and antimonial salts of lead and copper, and some water. See Min. Ch., 102, 1875.

**Artif.**—On synthetic experiments, Doelter, Zs. Kr., **11**, 38, 1885. Also later (Anz. Ak. Wien, 101, 1890), where it is shown that bournonite when digested in water as a fine powder in a sealed tube at 80° is slightly soluble; in connection with these experiments crystals of the common twinned form were obtained.

**Ref.**—[1] Min. p. 201, 1852; cf. Rose, Pogg., **76**, 291, 1849, and Zirkel, Ber. Ak. Wien, **45** (1), 431, 1862. [2] See Zirkel, l. c.; Hbg., Min. Not., **5**, 32, 1863; Schrauf, Atlas, Tf. xxxvi–xxxviii, 1871–72; Miers, Min. Mag., **6**, 59, 1884; Gdt., Index, **1**, 327 et seq., 1886. [3] Zeph., Lotos, 1876. [4] Rath, Zs. Kr., **1**, 602, 1877. [5] Groth, Min.-Samml., 61, 1871. [6] Miers, l. c.

**137. WITTICHENITE.** Kupferwismutherz *Selb.*, Denks. d'Aerzte u. Nat. Schwab., **1**, 419; *Klapr.*, Beitr., **4**, 91, 1807. Bismuth sulphuré cuprifère *Fr.* Cupreous Bismuth; Cupriferous Sulphuret of Bismuth. Wismuth-Kupfererz *Leonh.*, 1826. Wittichit *Kbl.*, Taf., 13, 1853. Wittichenit *Kenng.*, Uebers., 1853, 118, 1855.

Orthorhombic. In crystals resembling bournonite with *a, b, c, m, o, n*, Breith. Massive and disseminated; also coarse columnar, or an aggregate of imperfect prisms.

Fracture conchoidal. H. = 3·5. G. = 5, Hausm.; 4·3, Gallenbach, Hilger. Color steel-gray, tin-white, tarnishing pale lead-gray. Streak black.

**Comp.**—$Cu_3BiS_3$ or $3Cu_2S.Bi_2S_3$ = Sulphur 19·5, bismuth 42·1, copper 38·4 = 100.

**Anal.**—1, Petersen, Pogg., **136**, 500, 1869. 2, G. Lindström, G. För. Förh., **9**, 523, 1887. Also 5th Ed., pp. 98, 99.

| | | S | Bi | Cu | Pb | |
|---|---|---|---|---|---|---|
| 1. Gallenbach | G. = 4·45 | 20·30 | 41·13 | 36·76 | — | As 0·79, Sb 0·41, Ag 0·15, Zn 0·13, Fe 0·35 = 100·02 |
| 2. Gladhammar | G. = 6·70 | 17·70 | 42·94 | 20·86 | 18·04 | Zn 0·06, Fe 0·68, insol. 0·16 = 100·44 |

It is a question whether anal. 2 belongs here; cf. lillianite.

**Pyr.**—In the open tube gives sulphurous fumes and a white sublimate of bismuth sulphate. B.B. on charcoal fuses easily, at first throws out sparks, and coats the coal with bismuth trioxide, the residue with soda in R.F. gives a globule of metallic copper. Soluble in hydrochloric acid, with evolution of hydrogen sulphide; decomposed by nitric acid, with separation of sulphur.

**Obs.**—From cobalt mines with barite, near Wittichen, Baden; also at Zell, near Wolfach; at Christophsau near Freudenstadt. Chiefly at the Neuglück mine, Böckelsbach, also Anton mine in Heubach, David mine in Silberberg, and King David (anal. 1.) in Gallenbach. A related mineral (anal. 2) occurs at Gladhammar, Sweden.

**Alt.**—Undergoes easy alteration, becoming yellowish brown, then red and blue externally, forming apparently covellite; also changing to a greenish earthy mineral, which is a mixture of malachite, bismuth oxide, and hydrated iron sesquioxide; also to an earthy yellow bismutite and bismuth-ochre. Sandberger, Jb. Min., 274, 1865.

**Artif.**—Obtained by Schneider, Pogg., **127**, 302, 1866.

**138. AIKINITE.** Nadelerz *Mohs,* Null's Kab., 3, 726, 1804. Bismuth sulfuré plombo-cuprifère *H.*, Tabl., 105, 1809. Needle Ore; Acicular Bismuth; Cupreous Bismuth. Aikinite *Chapman,* Min., 127, 1843. Patrinite *Haid.*, Handb., 568, 1845. Belonit *Glock.*, Syn., 27, 1847. Aciculite *Nicol,* Min., 487, 1849.

Orthorhombic. Axes: $\breve{a} : \bar{b}$ = 0·9719 : 1 Miers.

**Forms:** *b* (010, *i*-$\breve{i}$), *e* (210, *i*-$\bar{2}$), *m* (110, *I*), *f* (120, *i*-$\breve{2}$), *i* (130, *i*-$\breve{3}$).

Angles: *ee'''* = 51° 50′, *mm'''* = *88° 22′, *ff'* = 54° 27′, *ii'* = 37° 52′; *be* = 64° 5′, *bf* = 27° 13½′, *bi* = 18° 56′, measured 63° 26′, 26° 34′, 19° 4′.

Crystals embedded, acicular, longitudinally striated. Also massive.

Fracture uneven. H. = 2–2·5. G. = 6·1–6·8; 6·757 Frick. Luster metallic. Color blackish lead-gray, with a pale copper-red tarnish. Opaque.

**Comp.**—$3(Pb,Cu_2)S.Bi_2S_3$ or (if Pb : $Cu_2$ = 2 : 1), $PbCuBiS_3$ = Sulphur 16·8, bismuth 36·2, lead 36·0, copper 11·0 = 100.

**Anal.**—1, 2, Frick, Pogg., **31**, 529, 1834. 3, Chapman, Phil. Mag., **31**, 541, 1847. 4, Hermann, J. pr. Ch., **75**, 452, 1858.

| | | S | Bi | Pb | Cu | Ni |
|---|---|---|---|---|---|---|
| 1. Berezov | G. = 6·757 | 16·05 | 34·62 | 35·69 | 11·79 | — = 98·15 |
| 2. " | | 16·61 | 36·45 | 36·05 | 10·59 | — = 99·70 |
| 3. " | G. = 6·1 | 18·78 | 27·93 | 40·10 | 12·53 | — = 99·34 |
| 4. " | | 16·50 | 34·87 | 36·31 | 10·97 | 0·36 Au 0·09 = 99·10 |

**Pyr., etc.**—In the open tube gives sulphurous fumes, and also a white sublimate, which may be fused into clear drops that are white on cooling; the assay becomes surrounded with a black fused oxide, which on cooling is transparent and greenish yellow. B.B. on charcoal fuses and gives a white coating, yellow on the edge nearest the assay; with the fluxes, reactions for copper, and after long blowing a globule of metallic copper.

Decomposed by nitric acid, with separation of sulphur and lead sulphate.

**Obs.**—Occurs at Berezov near Ekaterinburg, Urals, with gold, malachite, and galena, in white quartz. In the United States perhaps at Gold Hill, Rowan Co., N. Carolina (possibly cosalite, Genth).

**Ref.**—[1] Berezov, Min. Mag., 8, 206, 1889; Miers gives 410 instead of 210, but the former does not agree with the measured angle. Hoernes gave a prismatic angle of 70°.

**139. BOULANGERITE.** Plomb antimonié sulfuré *Boulanger*, Ann. Mines, **7**, 575, 1835. Schwefelantimonblei Antimonbleiblende *Germ.* Sulphuret of Antimony and Lead. Boulangerit *Thaulow,* Pogg., **41**, 216, 1837; *Hausm.*, ib., **46**, 281. Embrithite, Plumbostib, *Breith.*, J. pr. Ch., **10**, 442, 1837.

In plumose masses, exhibiting on the fracture a crystalline structure; also granular and compact.

H. = 2·5–3. G. = 5·75–6·0. Luster metallic. Color bluish lead-gray; often covered with yellow spots from oxidation. Opaque.

**Comp.**—$Pb_3Sb_2S_6$ or $3PbS.Sb_2S_3$ = Sulphur 18·3, antimony 22·8, lead 58·9 = 100.

**Anal.**—1, Genth, Am. J. Sc., **45**, 320, 1868. 2, 3, Rath, Pogg., **136**, 430, 1869. 4, 5, Frenzel, J. pr. Ch., **2**, 360, 1870. Also 5th Ed., pp. 99, 795.

| | | S | Sb | Pb | Ag | |
|---|---|---|---|---|---|---|
| 1. Echo Distr., Nevada | | 17·91 | 26·85 | 54·82 | *tr.* | Fe 0·42 = 100 |
| 2. Silbersand | G. = 5·935 | 18·62 | 22·93 | 55·82 | — | = 97·37 |
| 3. " | | 18·51 | 25·65 | 56·14 | — | = 100·30 |
| 4. *Plumbostib* | G. = 6·17 | 18·09 | 20·49 | 59·54 | — | Cu 0·88 = 99·00 |
| 5. *Embrithite* | G. = 6·32 | 18·08 | 21·47 | 59·30 | — | Cu 0·80 = 99·65 |

The last two correspond nearly to $10PbS.3Sb_2S_3$, but the material analyzed may not have been quite pure. Cf. Guitermanite.

**Pyr.**—Same as for zinkenite.

**Obs.**—Quite abundant at Molières, department of Gard, in France; also found at Nasafjeld in Lapland; at Nerchinsk; Ober-Lahr in Sayn-Altenkirchen; Silbersand near Mayen in the Eifel; Wolfsberg in the Harz; Přibram in Bohemia; near Bottino in Tuscany, both massive, acicular, and fibrous. Also in acicular crystals embedded in quartz in Echo District, Union county, Nevada.

Named after C. L. Boulanger (1810–1849).

*Embrithite* is from the locality of boulangerite at Nerchinsk. It is granular in texture, of a lead-gray color. Named from ἐμβριθής, *heavy*. *Plumbostib* is also from Nerchinsk; it is columnar to fibrous in structure. Named from *plumbum* and *stibium*.

### 140. LILLIANITE. *H. F. Keller*, Zs. Kr., **17**, 67, 1889. Kobellite *pt.*

Massive, crystalline.

Luster metallic. Color steel-gray. Streak black. Opaque.

**Comp.**—$Pb_3Bi_2S_6 = 3PbS.Bi_2S_3$ = Sulphur 15·7, bismuth 33·8, lead 50·5 = 100. Also $Pb_3BiSbS_6$ = Sulphur 16·9, bismuth 18·2, antimony 10·5, lead 54·4 = 100. Further the lead may be in part replaced by silver, in anal. 1–3, Pb : Ag = 4 : 1.

**Anal.**—1–3, H. F. & H. A. Keller, J. Am. Ch. Soc., **7**, 194, 1885. 4, Rg., Ber. Ak. Berlin, 237, 1862, after deducting 5·61 cobaltite, 3·67 chalcopyrite. 5, Gent, Rg., Min. Ch., 100, 1875.

| | | S | Bi | Sb | Pb | Ag | Cu | |
|---|---|---|---|---|---|---|---|---|
| 1. Colorado | | 15·21 | 32·62 | — | 43·94 | 5·78 | *tr.* | = 97·55 |
| 2. " | | 15·27 | 33·31 | — | 44·28 | 5·49 | 0·03 | = 98·38 |
| 3. " | | 15·19 | 33·89 | — | 44·03 | 5·72 | *tr.* | = 98·83 |
| 4. Sweden | G. = 6·145 | 16·85 | 18·68 | 10·59 | 52·09 | — | — | Fe 0·43 = 98·64 |
| 5. " | | 17·62 | 17·89 | 10·14 | 50·66 | — | 1·46 | Fe 1·70 = 99·47 |

**Obs.**—From Hvena, Sweden, with cobaltite and chalcopyrite. Cf. Kobellite, p. 123.

In the U. S., an argentiferous variety occurs with galena in the mines of the Lillian Mining Co., Printerboy Hill, near Leadville, Colorado.

### 141. STYLOTYPITE. Stylotyp *v. Kobell*, Ber. Ak. München, **1**, 163, 1865.

Orthorhombic; prismatic angle 86½° approx. Twins: cruciform, angle of intersection near 90°.

Fracture imperfectly conchoidal, uneven. Brittle. H. = 3. G. = 4·79. Luster metallic. Color iron-black; streak black.

**Comp.**—$3(Cu_2,Ag_2,Fe)S.Sb_2S_3$, the species being an iron-silver-copper bournonite (ratio $Cu_2 + Ag_2 : Fe = 2 : 1$, and $Cu_2 : Ag_2 = 6 : 1$) = Sulphur 25·0, antimony 31·3, copper 28·3, silver 8·1, iron 7·3 = 100.

**Anal.**—Kobell, l. c.:

S 24·30 Sb 30·53 Cu 28·00 Ag 8·30 Fe 7·00 Pb, Zn *tr.* = 98·13

**Pyr., etc.**—B.B. decrepitates, and fuses very easily. On charcoal a steel-gray globule, which is magnetic; fumes of antimony.

**Obs.**—From Copiapo in Chili.

Named from στῦλος, *column*, and τύπος, *form*, in allusion to the columnar form, in which it differs from tetrahedrite, although approaching it in composition.

A related mineral from the Great Eastern mine, Park county, Colorado, has been examined by Page.

Structure crystalline. H. = 4. G. = 4·89. Color steel-gray. Streak dark red. Analysis

S 26·88 Sb 34·47 Cu 23·20 Pb 1·19 Zn 7·14 Fe 1·38 gangue 5·86 = 100·12

The copper is stated to be present one half as $Cu_2S$, the rest as CuS (Ch. News, **46**, 215, 1882).

DÜRFELDTITE *Raimondi*, Minéraux du Pérou, p. 125, 1878.

In masses with indistinct fibrous structure, also in fine needles. H. = 2·5. G. = 5·40. Color light gray. Luster metallic. Associated with quartz as gangue. After deduction of impurities (31·3 p. c. gangue), the composition is:

S 24·15, Sb 30·52, Pb 25·81, Ag 7·34, Cu 1·86, Fe 2·24, Mn 8·08 = 100.

From the Irismachay mine, Auquimarca, province Cajatambo, Peru. Named after Richard Dürfeldt.

**142. GUITERMANITE.** *Hillebrand*, Proc. Col. Sc. Soc., **1**, 129, 1884.

Massive, compact.

H. = 3. G. = 5·94. Luster metallic. Color bluish gray. Opaque.

**Comp.**—A sulphide of arsenic and lead, $10PbS.3As_2S_3$ or $3PbS.As_2S_3$.

Analysis, after deducting 2·6 lead sulphate, also free sulphur and pyrite, gangue, etc.:

S 19·49 As 14·33 Pb 65·99 Cu 0·19 = 100

The formula $10PbS.3As_2S_3$ requires: S 19·5, As 14·4, Pb 66·1 = 100; but an analysis of purer material is needed to settle the composition. It may prove to conform to the general formula of the preceding group, i.e., $3PbS.As_2S_3$ = Sulphur 20·0, arsenic 15·6, lead 64·4 = 100.

**Obs.**—Occurs intimately mixed with zunyite at the Zuñi mine, near Silverton, San Juan Co. Colorado. Named for Mr. Franklin Guiterman.

**143. TAPALPITE.** *Pedro L. Monroy*, A. del Castillo, Naturaleza, **1**, 76, 1869. Tellurwismuthsilber *Rammelsberg*, Zs. G. Ges., **21**, 81, 1869.

Granular, massive. Sectile, somewhat brittle. G. = 7·803. Luster metallic. Color pale steel-gray, inclining to lead-gray, tarnished.

**Comp.**—A sulpho-telluride of bismuth and silver, perhaps $3Ag_2(S,Te).Bi_2(S,Te)_3$ (if S : Te = 3 : 2) = Tellurium 20·3, sulphur 7·8, bismuth 28·1, silver 43·8 = 100.

**Anal.**—1, Rg., l. c. 2, 3, Genth, Am. Phil. Soc., **24**, 41, 1887, after deducting 7–8 p. c. galena. These analyses vary widely; the above formula is based on those of Genth.

| | | Te | S | Bi | Ag | Cu |
|---|---|---|---|---|---|---|
| 1. | | 24·10 | 3·32 | 48·50 | 23·35 | *tr.* = 99·27 |
| 2. | | 19·76 | 8·07 | 28·41 | 43·76 | — = 100 |
| 3. | G. = 7·74 | 21·67 | 7·25 | 24·99 | 46·09 | — = 100 |

**Pyr.**—Fuses easily in the closed tube, giving a faint white sublimate. B.B. on charcoal gives off fumes and leaves a white and yellow coating; finally yields a silver globule. Dissolved in the cold by nitric acid forming a green solution, which on heating becomes colorless with a white precipitate.

**Obs.**—Occurs at San Antonio mine, San Rafael district, Sierra de Tapalpa, Jalisco, Mexico.

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## Pyrargyrite Group.

**144. PYRARGYRITE.** Argentum rude rubrum pt. *Germ.* Rothgolderz, *Agric.* 362; Interpr., 462, 1546. Argentum rubri coloris pt., Gemein Rothguldenerz, *Gesner.*, Foss., 62, 1565. Rothgylden pt., Argentum arsenico pauco sulphure et ferro mineralisatum pt., Minera argenti rubra var. opaca, var. nigrescens, *Wall.*, 310, 1747. Mine d'argent rouge *Fr. Trl.* Wall., 1753. Ruby Silver Ore pt., Red Silver Ore pt., *Hill*, Foss, 1771. Dunkles Rothgültigerz, Lichtes id. pt., *Wern.*, 1789. Dark Red Silver Ore; Antimonial Red Silver. Argent antimonié sulfuré pt. *H.*, Tr., 1801. Argent rouge antimoniale *Proust.*, J. Phys., **59**, 407, 1804. Ærosit *Selb*, Denks. Nat. Schwab., **1**, 311, Tasch. Min., 401, 1817. Rubinblende pt. *Mohs.* Antimonsilberblende. Pyrargyrit *Glock.*, Handb., 388, 1831. Argyrythrose *Beud.*, Tr., **2**, 430, 1832. Argento rosso antimoniale *Ital.* Rosicler oscuro *Span.* Petlanque *Mexico.*

Rhombohedral; hemimorphic. Axis: $\acute{c}$ = 0·78916; 0001 ∧ $10\bar{1}1$ = 42° 20½′ Miers[1].

**Forms**[2]:

$c\ (0001,\ O)$
$m\ (10\bar{1}0,\ I)$
$a\ (11\bar{2}0,\ i\text{-}2)$
$x\ (41\bar{5}0,\ i\text{-}\frac{5}{4})$
$\mathfrak{t}\ (31\bar{4}0,\ i\text{-}\frac{4}{3})$
$\beta\ (21\bar{3}0,\ i\text{-}\frac{3}{2})$

$u\ (10\bar{1}4,\ \frac{1}{4})$
$j\ (50\bar{5}8,\ \frac{5}{8})$
$\mathfrak{r}\ (50\bar{5}6,\ \frac{5}{6})$
$\mathfrak{a}\ (30\bar{3}4,\ \frac{3}{4})$
$r\ (10\bar{1}1,\ R)$
$\Pi\ (30\bar{3}2,\ \frac{3}{2})$
$T\ (50\bar{5}2,\ \frac{5}{2})$

$\mu\ (01\bar{1}8,\ -\frac{1}{8})$[3]
$e\ (01\bar{1}2,\ -\frac{1}{2})$
$h\ (03\bar{3}2,\ -\frac{3}{2})$[3]
$s\ (02\bar{2}1,\ -2)$
$\Gamma\ (07\bar{7}2,\ -\frac{7}{2})$
$f\ (05\bar{5}1,\ -5)$

$p\ (11\bar{2}3,\ \frac{2}{3}\text{-}2)$
$A\ (22\bar{4}3,\ \frac{4}{3}\text{-}2)$
$\mathfrak{h}\ (44\bar{8}3,\ \frac{8}{3}\text{-}2)$

$\mathfrak{p}\ (17\cdot1\cdot\bar{1}\bar{8}\cdot1,\ 16^{\frac{9}{8}})$
$X\ (11\cdot1\cdot\bar{1}\bar{2}\cdot1,\ 10^{\frac{6}{5}})$

$G_1\ (71\bar{8}9,\ {\frac{3}{2}}^{\frac{4}{3}})$
$\xi\ (51\bar{6}7,\ {\frac{4}{7}}^{\frac{3}{2}})$
$\mathfrak{w}\ (51\bar{6}4,\ 1^{\frac{3}{2}})$
$\Phi\ (41\bar{5}6,\ {\frac{1}{2}}^{\frac{5}{3}})$
$n\ (41\bar{5}3,\ 1^{\frac{5}{3}})$
$Q\ (14\cdot4\cdot\bar{1}\bar{8}\cdot13,\ {\frac{10}{13}}^{\frac{9}{5}})$
$w\ (31\bar{4}5,\ {\frac{2}{5}}^{2})$
$\psi\ (31\bar{4}2,\ 1^{2})$
$C\ (11\cdot4\cdot\bar{1}\bar{5}\cdot10,\ {\frac{7}{10}}^{\frac{15}{7}})$
$u\ (8\cdot3\cdot\bar{1}\bar{1}\cdot8,\ {\frac{5}{8}}^{\frac{11}{5}})$
$V\ (12\cdot5\cdot\bar{1}\bar{7}\cdot10,\ {\frac{7}{10}}^{\frac{17}{7}})$
$\mathfrak{s}\ (7\cdot3\cdot\bar{1}\bar{0}\cdot4,\ 1^{\frac{5}{2}})$
$\mathfrak{g}\ (11\cdot5\cdot\bar{1}\bar{6}\cdot9,\ {\frac{2}{3}}^{\frac{8}{3}})$
$t\ (21\bar{3}4,\ {\frac{1}{4}}^{3})$
$g\ (21\bar{3}2,\ {\frac{1}{2}}^{3})$?
$k\ (10\cdot5\cdot\bar{1}\bar{5}\cdot8,\ {\frac{5}{8}}^{3})$
$v\ (21\bar{3}1,\ 1^{3})$
$F_1\ (11\cdot6\cdot\bar{1}\bar{7}\cdot12,\ {\frac{5}{12}}^{\frac{17}{5}})$
$\zeta\ (9\cdot5\cdot\bar{1}\bar{4}\cdot4,\ 1^{\frac{7}{2}})$
$\lambda\ (7\cdot4\cdot\bar{1}\bar{1}\cdot15,\ {\frac{1}{5}}^{\frac{11}{3}})$
$x\ (7\cdot4\cdot\bar{1}\bar{1}\cdot8,\ {\frac{3}{8}}^{\frac{11}{3}})$
$Y\ (7\cdot4\cdot\bar{1}\bar{1}\cdot6,\ {\frac{1}{2}}^{\frac{11}{3}})$

$\tau_1\ (5\cdot3\cdot\bar{8}\cdot11,\ {\frac{2}{11}}^{4})$
$\mathfrak{q}\ (53\bar{8}8,\ {\frac{1}{4}}^{4})$
$L\ (53\bar{8}6,\ {\frac{1}{3}}^{4})$
$P_1\ (53\bar{8}5,\ {\frac{2}{5}}^{4})$
$\gamma\ (53\bar{8}2,\ 1^{4})$
$\Xi\ (21\cdot13\cdot\bar{3}\bar{4}\cdot26,\ {\frac{4}{13}}^{\frac{17}{4}})$
$J\ (17\cdot11\cdot\bar{2}\bar{8}\cdot6,\ 1^{\frac{14}{3}})$
$\Upsilon\ (32\bar{5}7,\ {\frac{1}{7}}^{5})$
$\sigma\ (32\bar{5}4,\ {\frac{1}{4}}^{5})$
$y\ (32\bar{5}1,\ 1^{5})$
$\Delta\ (19\cdot13\ \bar{3}\bar{2}\cdot6,\ 1^{\frac{16}{3}})$
$W\ (7\ 5\cdot\bar{1}\bar{2}\ 8,\ {\frac{1}{4}}^{6})$
$\Delta_1\ (17\cdot13\cdot\bar{3}\bar{0}\cdot4,\ 1^{\frac{15}{2}})$
$T_1\ (4\cdot3\cdot\bar{7}\cdot10,\ {\frac{1}{10}}^{7})$
$B\ (43\bar{7}6,\ {\frac{1}{6}}^{7})$
$z\ (43\bar{7}4,\ {\frac{1}{4}}^{7})$
$\mathfrak{c}\ (43\bar{7}1,\ 1^{7})$
$\pi\ (9\cdot7\cdot\bar{1}\bar{6}\cdot2,\ 1^{8})$
$t_1\ (14\cdot11\cdot\bar{2}\bar{5}\cdot15,\ {\frac{1}{5}}^{\frac{25}{3}})$
$Z\ (54\bar{9}1,\ 1^{9})$
$\mathfrak{m}\ (6\cdot5\cdot\bar{1}\bar{1}\ 7,\ {\frac{1}{7}}^{11})$
$\pi_1\ (7\cdot6\cdot\bar{1}\bar{3}\cdot19,\ {\frac{1}{19}}^{13})$
$N_1\ (17\cdot15\cdot\bar{3}\bar{2}\cdot2,\ 1^{16})$
$\Sigma\ (6\cdot7\cdot\bar{1}\bar{3}\cdot20,\ -{\frac{1}{20}}^{13})$
$l\ (45\bar{9}5,\ -{\frac{1}{5}}^{9})$

$\omega\ (23\bar{5}8,\ -{\frac{1}{8}}^{5})$
$\upsilon\ (12\bar{3}5,\ -{\frac{1}{5}}^{3})$
$d\ (12\bar{3}2,\ -{\frac{1}{2}}^{3})$
$\epsilon\ (36\bar{9}8,\ -{\frac{3}{8}}^{3})$
$\eta\ (5\cdot10\cdot\bar{1}\bar{5}\cdot8,\ -{\frac{5}{8}}^{3})$
$\alpha\ (25\bar{7}3,\ -1^{\frac{7}{3}})$
$\pi\ (8\cdot23\ \bar{3}\bar{1}\cdot18,\ -{\frac{5}{6}}^{\frac{31}{15}})$
$\delta\ (13\bar{4}4,\ -{\frac{1}{2}}^{2})$
$E\ (13\bar{4}1,\ -2^{2})$
$\rho\ (27\bar{9}7,\ -{\frac{5}{7}}^{\frac{9}{5}})$
$F\ (4\cdot15\cdot\bar{1}\bar{9}\cdot4,\ -{\frac{11}{4}}^{\frac{19}{11}})$
$\Omega\ (14\bar{5}1,\ -3^{\frac{5}{3}})$
$N\ (2\cdot9\cdot\bar{1}\bar{1}\ 2,\ -{\frac{7}{2}}^{\frac{11}{7}})$
$\mathfrak{z}\ (4\cdot20\cdot\bar{2}\bar{4}\cdot11,\ -{\frac{16}{11}}^{\frac{3}{2}})$
$P\ (15\bar{6}2,\ -2^{\frac{3}{2}})$
$H\ (15\bar{6}1,\ -4^{\frac{3}{2}})$
$q\ (16\bar{7}1,\ -5^{\frac{7}{5}})$
$S\ (2\cdot13\cdot\bar{1}\bar{5}\cdot7,\ -{\frac{11}{7}}^{\frac{15}{11}})$
$\theta\ (2\cdot15\cdot\bar{1}\bar{7}\cdot8,\ -{\frac{13}{8}}^{\frac{17}{13}})$
$G\ (1\cdot9\cdot\bar{1}\bar{0}\cdot1,\ -8^{\frac{5}{4}})$
$D\ (1\cdot12\cdot\bar{1}\bar{3}\cdot1,\ -11^{\frac{13}{11}})$

*cu* = 12° 50′
*c*$\mathfrak{a}$ = 34° 21′
*cr* = 42° 20½′
*cΠ* = 53° 49′
*cT* = 66° 18′
*ce* = 24° 30′
*cs* = 61° 15′
*cΓ* = 72° 35½′
*cf* = 77° 37′

*uu′* = 22° 11′
$\mathfrak{aa}$′ = 58° 30′

*rr′* = *71° 22′
*ΠΠ* = 88° 41′
*TT′* = 104° 56′
*ee′* = 42° 5′
*ss′* = 98° 48′
*ΓΓ′* = 111° 27′
*ff′* = 115° 32′

*cp* = 27° 45′
*pp′* = 26° 55½′
*tt′* = 39° 30′
*tt*$^{\text{v}}$ = 19° 27′

*gg*$^{\text{v}}$ = 29° 11′
*vv′* = 74° 25′
*vv*$^{\text{v}}$ = 35° 12′
*vv*$^{\text{vi}}$ = 49° 48′
*γγ*$^{\text{v}}$ = 41° 29′
*yy′* = 70° 37′
*yy*$^{\text{v}}$ = 45° 20′
*ww*$^{\text{v}}$ = 15° 9′
*zz′* = 55° 0½′
*zz*$^{\text{v}}$ = 40° 32′
*αα′* = 28° 24′

*EE′* = 26° 34′
*PP′* = 16° 38′
*qq′* = 14° 51′

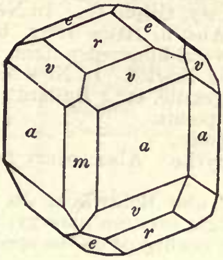
*aγ* = 19° 12
*ay* = 15° 34′
*av* = 24° 54′
*an* = 39° 53′
*ar* = 54° 19′
*at*$^{\text{v}}$ = 70° 15′
*ap* = 76° 32′

Twins: tw. pl. (1) *a*, very common, the axes $\dot{c}$ parallel (f. 6), and *c* the comp. face. (2) *u* ($10\bar{1}4$), also common, the composition-plane usually ⊥ *u*, the axes then being inclined 25° 40′ to each other, sometimes ∥ *u*; repeated, all three faces of *u* as tw. pl. (f. 5), also as twinning lamellæ (in some cases secondary in origin) as shown by fine striations. (3) *r*, not common, the crystals crossing nearly at right angles. (4) *e* ($01\bar{1}2$) rare. Crystals commonly prismatic and hemimorphic[3], as sometimes shown by development of the two ends when distinct; also by the occurrence of *m* as a trigonal prism; also by the unsymmetrical development of striations on *a* due to the form *q* ($16\bar{7}1$). The hemimorphic character is often obscured by twinning. Also massive, compact.

Cleavage: *r* distinct; *e* imperfect. Fracture conchoidal to uneven. Brittle. H. = 2·5. G. = 5·77–5·86; 5·85 if pure. Luster metallic-adamantine. Color black to grayish black, by transmitted light deep-red. Streak purplish red. Nearly opaque, but transparent in very thin splinters. Optically negative. Double refraction strong. Indices, Fizeau (Dx.):

$$\omega = 3{\cdot}084 \qquad \epsilon = 2{\cdot}881$$

**Comp.**—$Ag_3SbS_3$ or $3Ag_2S.Sb_2S_3$ = Sulphur 17·8, antimony 22·3, silver 59·9 = 100. Some varieties contain small amounts of arsenic, see proustite p. 134.



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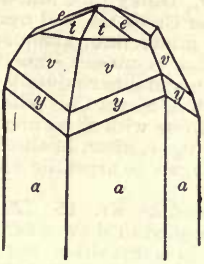

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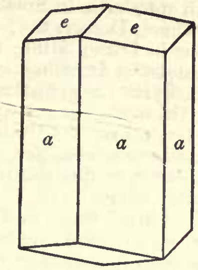

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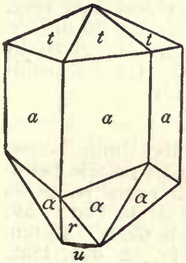

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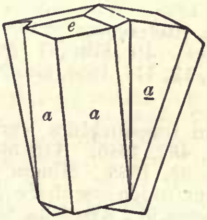

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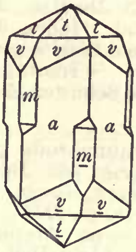

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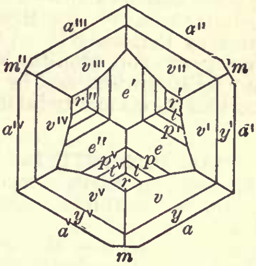


Figs. 1–4, 7, from Miers. 5, Andreasberg, Sbk.

**Anal.**—1, Senfter, J. pr. Ch., **106**, 144, 1869. 2, Petersen, ib., p. 143. 3, 4, 5, Rethwisch, Jb. Min., Beil.-Bd., **4**, 95, 1886. 6, Streng, Jb. Min., 916, 1878. 7–14, G. T. Prior, Min. Mag., **8**, 94, 1888. 15, Traube, Jb. Min., **1**, 286, 1890. Also 5th Ed., p. 95.

| | G. | S | Sb | As | Ag |
|---|---|---|---|---|---|
| 1. Wolfach | 5·90 | 18·28 | 24·81 | — | 57·01 = 100·10 |
| 2. Andreasberg | | 17·70 | 22·35 | 1·01 | 58·03 = 99·09 |
| 3. " | 5·871 | 17·65 | 22·36 | — | 59·73 = 99·74 |
| 4. Freiberg | 5·754 | 17·95 | 18·58 | 2·62 | 60·63 = 99·78 |
| 5. Andreasberg | 5·716 | 17·99 | 18·63 | 3·01 | 60·78 = 100·41 |
| 6. Dolores | 5·68 | 18·17 | 18·47 | 3·80 | 60·53 = 100·97 |
| 7. Andreasberg | 5·82 | 17·81 | 22·45 | — | 59·75 = 100·01 |
| 8. Guanajuato | | 17·79 | 22·09 | 0·12 | 59·91 = 99·91 |
| 9. Zacatecas | 5·83 | 17·74 | 22·39 | 0·27 | 60·04 = 100·44 |
| 10. Andreasberg | 5·86 | 17·74 | 21·69 | 0·44 | 60·24 = 100·11 |
| 11. Freiberg | 5·78 | 17·65 | 21·64 | 0·52 | 60·17 = 99·98 |
| 12. Chañarcillo | 5·77 | 17·89 | 21·20 | 0·79 | 60·07 = 99·95 |
| 13. Harz | 5·81 | 17·78 | 20·69 | 1·02 | 60·21 = 99·70 |
| 14. Andreasberg | 5·805 | 17·99 | 18·36 | 2·60 | 60·85 = 99·80 |
| 15. Kajánel | 5·76 | [17·87] | 20·66 | 1·02 | 60·45 = 100 |

Henckel found arsenic in ruby silver (Pyritol., 169, 1725), and both light and red silver ores were afterwards considered arsenical, until Klaproth's analysis, detecting antimony alone, in 1794 (Beitr., **1**, 141); after this both were supposed to be antimonial, until Proust, in 1804, showed that there were two species, an antimonial and an arsenical. The existence of intermediate compounds is shown by several of the analyses above.

**Pyr., etc.**—In the closed tube fuses and gives a reddish sublimate of antimony oxysulphide; in the open tube sulphurous fumes and a white sublimate of antimony trioxide. B.B. on charcoal fuses with spirting to a globule, coats the coal white, and the assay is converted into silver sulphide, which, treated in O.F., or with soda in R.F., gives a globule of silver. In case arsenic is present it may be detected by fusing the pulverized mineral with soda on charcoal in R.F.

Decomposed by nitric acid with the separation of sulphur and of antimony trioxide.

**Obs.**—Occurs principally with calcite, native arsenic, and galena, at Andreasberg in the Harz; also at Freiberg, Saxony, with proustite, argentite, etc.; Příbram, Bohemia, with argentiferous galena; Schemnitz, Kremnitz, etc., in Hungary; Kajánel, Transylvania; Kongsberg, Norway, with native silver; Gaudalcanal in Spain; in Cornwall. In Mexico it is worked at Guanajuato and elsewhere as an ore of silver. In Chili it is found in crystals with proustite at Chañarcillo near Copiapo.

In Colorado, not uncommon; thus with silver and tetrahedrite in Ruby District, Gunnison Co.; with sphalerite in Sneffle's distr., Ouray Co.; Marshall Creek, San Miguel Co.; near Rico and elsewhere, Dolores Co.; also Clear Creek Co. and near Central City, Gilpin Co. In Nevada, at Washoe in Daney Mine; in Ophir mine, rare; abundant about Austin, Reese river, but no good crystals; at Poorman lode, Idaho, in masses sometimes of several hundred-weight, along with cerargyrite; also at the Monarch and other mines in the Atlanta district. In New Mexico, at Gold Hill near Silver City, Kingston, Sierra Co., with silver, argentite, etc.; Bullard's Peak district, Grant Co. In Utah and Arizona with silver ores at various points.

Named from πῦρ, *fire*, and ἄργυρος, *silver*, in allusion to the color.

**Alt.**—Occurs like proustite, changed to argentite ($Ag_2S$); to pyrite. Also occurs pseudomorph after silver.

**Ref.**—[1] Min. Mag., 8, 37, 1888, and Zs. Kr., **15**, 129, 1888; cf. also Rethwisch, Jb. Min., Beil.-Bd., **4**, 31, 1886: the latter attempted to show a variation in angle between pyrargyrite and proustite corresponding to variation in composition, but this is not confirmed on the specimens examined by Miers and Prior, cf. also Min. Mag., **7**, 196, 1887.

[2] This is chiefly the list of Miers (l. c.), based upon a critical study of the earlier observations of other authors and with many additions; a large number of forms regarded as doubtful are not included here; cf. also Rethwisch, Jb. Min., **2**, 1 ref., 1890. Other lists, also critical, have been given by Rethwisch (l. c.) and Gdt., Index, **3**, 59, 1888. With earlier authors the forms for pyrargyrite and proustite have not been separated. References to the literature are given in full by Rethwisch and by Miers [3] Traube, Kajánel, Jb. Min., **1**, 286, 1890. On the hemimorphic forms and twinning, see Schuster, Zs. Kr., **12**, 117, 1886, also Miers, l. c.

**145. PROUSTITE.** Argentum rude rubrum translucidum carbunculis simile *Germ.* Durchsichtig Rodtguldenerz *Agric.*, 362, Interpr., 462, 1546. Argentum rubri coloris pellucidum, Schön Rubin Rothguldenerz, *Gesner*, Foss., 62, 1565. Minera argenti rubra pellucida *Wall.*, 311, 1747. Ruby Silver Ore pt. *Hill.* Argent rouge arsenicale *Proust*, J. de Phys., **59**, 404, 1804. Lichtes Rothgültigerz pt., Arsenikalisches id., Arseniksilberblende *Germ.* Rubinblende pt. Arsenical Silver Ore; Light Red Silver Ore. Proustite *Beud.*, Tr., **2**, 445, 1832. Argento rosso arsenicale *Ital.* Rosicler claro *Span.*

Rhombohedral; hemimorphic. Axis $\dot{c} = 0{\cdot}80393$; $0001 \wedge 10\bar{1}1 = 42^\circ\ 52\tfrac{1}{4}'$ Miers[1].

**Forms**[1]:
$\varepsilon\ (0001,\ O)$?
$m\ (10\bar{1}0,\ I)$
$a\ (11\bar{2}0,\ i\text{-}2)$
$\tau\ (41\bar{5}0,\ i\text{-}\tfrac{5}{4})$
$u\ (10\bar{1}4,\ \tfrac{1}{4})$

$r\ (10\bar{1}1,\ R)$
$e\ (01\bar{1}2,\ -\tfrac{1}{2})$
$h\ (03\bar{3}2,\ -\tfrac{3}{2})$?
$s\ (02\bar{2}1,\ -2)$
$p\ (11\bar{2}3,\ \tfrac{2}{3}\text{-}2)$

$w\ (31\bar{4}5,\ \tfrac{2}{5}\,^{2})$
$n_1\ (8{\cdot}3{\cdot}\bar{11}{\cdot}2,\ \tfrac{5}{2}^{\frac{11}{8}})$
$\rho\ (52\bar{7}9,\ \tfrac{1}{3}^{\frac{7}{3}})$
$\Phi\ (11{\cdot}5{\cdot}\bar{16}{\cdot}12,\ \tfrac{1}{2}^{\frac{8}{3}})$
$t\ (21\bar{3}4,\ \tfrac{1}{4}\,^{3})$

$v\ (21\bar{3}1,\ 1^{3})$
$\zeta\ (9{\cdot}5{\cdot}\bar{14}{\cdot}4,\ 1^{7})$
$\gamma\ (53\bar{8}2,\ 1^{4})$
$y\ (32\bar{5}1,\ 1^{5})$
$\Delta\ (19{\cdot}13{\cdot}\bar{32}{\cdot}6,\ 1^{\frac{16}{3}})$

$\Psi\ (43\bar{7}7,\ \tfrac{1}{7}\,^{7})$
$d\ (12\bar{3}2,\ -\tfrac{1}{2}\,^{3})$
$M\ (35\bar{8}7,\ -\tfrac{2}{7}\,^{4})$
$\alpha\ (25\bar{7}3,\ -1^{\frac{7}{3}})$
$P\ (15\bar{6}2,\ -2^{\frac{3}{2}})$

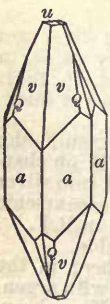
$cu = 13^\circ\ 4'$
$cr = 42^\circ\ 52'$
$ce = 24^\circ\ 54'$
$cs = 61^\circ\ 41\tfrac{1}{2}'$
$uu' = 22^\circ\ 35'$
$rr' = {}^{*}72^\circ\ 12'$

$ee' = 42^\circ\ 46'$
$ss' = 99^\circ\ 22'$
$vv' = 74^\circ\ 39'$
$vv^{\text{v}} = 35^\circ\ 18'$
$vv^{\text{vi}} = 49^\circ\ 8'$

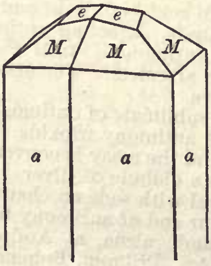
$MM' = 29^\circ\ 15'$
$MM^{\text{v}} = 49^\circ\ 47'$
$\alpha\alpha' = 28^\circ\ 31'$
$\alpha\alpha^{\text{v}} = 76^\circ\ 1'$
$PP' = 16^\circ\ 41'$
$PP^{\text{v}} = 92^\circ\ 59'$

$ay = 15^\circ\ 20'$
$a\gamma = 18^\circ\ 55\tfrac{1}{2}'$
$av' = 24^\circ\ 34'$
$ar' = 53^\circ\ 54'$
$mv = 28^\circ\ 56'$

1.



2.



1, Chañarcillo, Streng. 2, Miers.

Twins: tw. pl. (1) *u* ($10\bar{1}4$), common, sometimes as tw. lamellæ; (2) *r*, also common; (3) *c*, (4) *e*, both rare, cf. pyrargyrite. Crystals often acute rhombohedral or scalenohedral. Also massive, compact.

Cleavage: *r* distinct. Fracture conchoidal to uneven. Brittle. H. = 2–2·5. G. = 5·57–5·64; 5·57 if pure. Luster adamantine. Color scarlet-vermilion; streak same, also inclined to aurora-red. Transparent to translucent. Optically negative. Double refraction strong. Dichroism weak $\parallel \dot{c}$ = cochineal-red, $\parallel a$ blood-red. Indices, Fizeau (Dx.):

$\omega_r = 2{\cdot}9789$ Li $\quad \epsilon_r = 2{\cdot}7113$
$\omega_y = 3{\cdot}0877$ Na $\quad \epsilon_y = 2{\cdot}7924$

**Comp.**—$Ag_3AsS_3$ or $3Ag_2S.As_2S_3$ = Sulphur 19·4, arsenic 15·2, silver 65·4 = 100.

**Anal.**—1, Petersen, J. pr. Ch., **106**, 144, 1869. 2, Rethwisch, Jb. Min., Beil.-Bd., **4**, 94, 1886. 3–7, G. T. Prior, Min. Mag., 8, 98, 1888.

| | G. | S | As | Sb | Ag | |
|---|---|---|---|---|---|---|
| 1. Wittichen | | 20·16 | 15·57 | *tr.* | 63·38 | = 99·11 |
| 2. Chañarcillo | 5·555 | 19·52 | 15·03 | — | 65·10 | = 99·65 |
| 3. Mexico | 5·57 | 19·52 | 14·98 | — | 65·39 | = 99·89 |
| 4. Chañarcillo | 5·59 | 19·24 | 14·81 | 0·59[a] | 65·37 | = 100·01 |
| 5. " | 5·58 | 19·31 | 14·89 | 0·26 | 65·38 | = 99·84 |
| 6. " | 5·64 | 19·64 | 13·85 | 1·41 | 65·06 | = 99·96 |
| 7. Saxony? | | 19·54 | [12·29] | 3·74 | 64·43 | = 100 |

[a] Probably too high.

**Pyr., etc.**—In the closed tube fuses easily, and gives a faint sublimate of arsenic trisulphide; in the open tube sulphurous fumes and a white crystalline sublimate of arsenic trioxide. B.B. on charcoal fuses and emits odors of sulphur and arsenic; by prolonged heating in O.F., or with soda in R.F., gives a globule of pure silver. Some varieties contain antimony.

Decomposed by nitric acid, with separation of sulphur.

**Obs.**—Occurs at Freiberg, Johanngeorgenstadt, Marienberg, and Annaberg in Saxony; at Joachimsthal in Bohemia; Wolfach in Baden; Markirchen in Alsace; Chalanches in Dauphiné; Guadalcanal in Spain; in Mexico; Peru; Chili, near Copiapo, at Chañarcillo in magnificent crystallizations, some crystals 3 inches long.

In Colorado, Ruby Distr., Gunnison Co.; Sheridan mine, San Miguel Co.; Yankee Girl mine, Ouray Co. In Arizona, with silver ores at various points. In Nevada, in the Daney mine, and in Comstock lode, but rare; in veins about Austin, Lander Co.; in microscopic crystals in Cabarrus Co., N. C., at the McMakin mine; in Idaho, at the Poorman lode, with pyrargyrite, native silver and gold, and cerargyrite.

Named after the French chemist, J. L. Proust (1755–1826).

**Ref.**—[1] Cf. references under pyrargyrite; earlier authors have not attempted to separate the forms characteristic of proustite from those of pyrargyrite.

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**146. PYROSTILPNITE.** Feuerblende *Breith.*, Char., 285, 333, 1832. Fireblende *Dana*, Min., 543, 1850. Pyrostilpnite, *Dana*, Min., 93, 1868. Pyrichrolite *Adam*, Tabl. Min., 60, 1869. Pyrochrotit *Breithaupt*, Frenzel, Min. Lex. Sachsen, 252, 1874.

Monoclinic. Axes $\grave{a} : \bar{\grave{b}} : \grave{c} = 0{\cdot}35465 : 1 : 0{\cdot}17819$; $\beta = 90° = 100 \wedge 001$ Luedecke[1].

$100 \wedge 110 = 19°\ 31\tfrac{2}{3}'$, $001 \wedge 101 = 26°\ 40\tfrac{1}{2}'$, $001 \wedge 011 = 10°\ 6\tfrac{1}{4}'$.

**Forms:**
*a* (100, *i*-ī)
*b* (010, *i*-ì)
*c* (001, *O*)
*m* (110, *I*)
*s* (120, *i*-2̀)
*δ* (140, *i*-4̀)
*d* (101, − 1-ī)
*D* (1̄01, 1-ī)
*π* (121, − 2-2̀)
*p* (141, − 4-4̀)
*o* (191, − 9-9̀)
*Π* (1̄21, 2-2̀)
*P* (1̄41, 4-4̀)
*ω* (1̄91, 9-9̀)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *mm'''* | = 39° 3' | *dD* | = 53° 21' | *aω* | = 75° 7' | *pp'* | = 64° 59' |
| *ss'* | = 109° 18' | *aπ* | = 64° 40½' | *oω* | = *29° 46½' | *oo'* | = *110° 11' |
| *δδ'* | = 70° 21' | *ap* | = 67° 45' | *ππ'* | = 35° 20' | | |

Twins: tw. pl. *a*. In slender prismatic crystals, tabular ‖ *b*; faces *b* striated ‖ edges *b*/*ω*, *b*/*ω'*. Usually grouped in small tufts resembling stilbite.

Cleavage: *b* perfect. Somewhat fusible. Fracture conchoidal. H. = 2. G. = 4·2–4·25. Luster adamantine, on *b* pearly. Color hyacinth-red. Translucent. Extinction (*b*) inclined 8°–11° to *ċ*, or extinction-angle 16°–22° in twins.

**Comp.**—Same as pyrargyrite, $Ag_3SbS_3$ or $3Ag_2S.Sb_2S_3$ = Sulphur 17·8, antimony 22·3, silver 59·9 = 100.

**Anal.**—Hampe, Zs. Kr., 6, 572, 1882.

S 18·11 Sb 22·30 Ag 59·44 = 99·85

Plattner's early trials gave 62·3 p. c. silver.

**Pyr.**—Like pyrargyrite.

**Obs.**—A rare mineral at Andreasberg in the Harz, with native arsenic, galena, etc.; also at the Kurprinz and other mines near Freiberg; at Reichstädt, near Altenberg; at Přibram and probably at Schemnitz. Cf. also rittingerite. Named from *πῦρ*, *fire*, and *στιλπνός*, *shining*, in allusion to the color.

**Ref.**—[1] Andreasberg, Zs. Kr., 6, 570, 1882.

**147. RITTINGERITE.** Rittingerit *Zippe*, Ber. Ak. Wien, **9**, 2, 345, 1852.

Monoclinic. Axes $\grave{a} : \overset{1}{\bar{b}} : \dot{c} = 0{\cdot}52801 : 1 : 0{\cdot}52934$; $\beta = {}^{*}89^\circ\ 26' = 100 \wedge 001$ Schrauf[1].

$100 \wedge 110 = 27^\circ\ 50'$, $001 \wedge \bar{1}01 = 45^\circ\ 21\tfrac{1}{3}'$, $001 \wedge 011 = 27^\circ\ 53\tfrac{1}{2}'$.

| | | | | | |
|---|---|---|---|---|---|
| **Forms**[1]: | $d\ (0{\cdot}16{\cdot}3, \tfrac{16}{3}\text{-}\grave{i})$ | $e\ (334, -\tfrac{3}{4})$ | $q\ (16{\cdot}16{\cdot}3, -\tfrac{16}{3})$ | $\eta\ (\bar{3}34, \tfrac{3}{4})$ | $\rho\ (\bar{3}32, \tfrac{3}{2})$ |
| $c\ (001, O)$ | $f\ (115, -\tfrac{1}{5})$ | $p\ (111, -1)$ | $\phi\ (\bar{1}15, \tfrac{1}{5})$ | $\pi\ (\bar{1}11, 1)$ | $Q\ (\bar{1}\bar{6}{\cdot}16{\cdot}3, \tfrac{16}{3})$ |
| $m\ (110, I)$ | $o\ (112, -\tfrac{1}{2})$ | $r\ (332, -\tfrac{3}{2})$ | $\omega\ (\bar{1}12, \tfrac{1}{2})$ | | |

| | | | |
|---|---|---|---|
| $mm''' = {}^{*}55^\circ\ 40'$ | $cr = 59^\circ\ 10'$ | $c\rho = 59^\circ\ 55'$ | $\pi\pi' = 41^\circ\ 11'$ |
| $dd' = 141^\circ\ 0'$ | $cm = 89^\circ\ 30'$ | $oo' = 26^\circ\ 31'$ | $ap = 48^\circ\ 11'$ |
| $co = 29^\circ\ 25'$ | $c\omega = 29^\circ\ 40'$ | $pp' = 40^\circ\ 49$ | $a'\pi = 48^\circ\ 44'$ |
| $cp = 48^\circ\ 18'$ | $c\pi = {}^{*}48^\circ\ 52'$ | $\omega\omega' = 26^\circ\ 43'$ | $p\pi = 83^\circ\ 5'$ |

In very small crystals, tabular ‖ *c*; sometimes twins with tw. pl. *a* and *c*.

Cleavage: *c* imperfect. Fracture conchoidal. Brittle. H.=2–2·5. G.=5·63. Luster submetallic-adamantine. Color blackish brown to iron-black by reflected light. Translucent and dull honey-yellow to hyacinth-red by transmitted light. Streak orange-yellow.

**Comp.**—A compound of arsenic, selenium, and silver, with 57·7 p. c. Ag, Schrauf, l. c.

**Obs.**—From Joachimsthal, Bohemia, with proustite, argentite, galena. Also from Schemnitz, Hungary, on quartz with pyrargyrite, pyrite, and probably pyrostilpnite. Named after Rittinger, an Austrian mining official.

A mineral from Chañarcillo, Chili, described by Streng (Jb. Min. 917, 1878, 547, 1879) as pyrostilpnite, has the angles of rittingerite (Schrauf, ibid., 144, 1879) and may belong here; for this Streng (Jb. Min., **1**, 57, 1886) suggests the composition $Ag_3As(S,Se)_3$ analogous to pyrostilpnite. Groth places rittingerite near stephanite, basing his conclusion upon the silver percentage given above, and a certain resemblance in form noted by Schrauf.

**Ref.**—[1] Ber. Ak. Wien, **65** (1), 227, 1872.

## E. Basic Division.

**Tetrahedrite Group.** $4RS.(Sb,As)_2S_3$. Isometric, tetrahedral.

| | | |
|---|---|---|
| 148. | **Tetrahedrite** | $4Cu_2S.Sb_2S_3$<br>$4Cu_2S.(Sb,As)_2S_3$ |
| 149. | **Tennantite** | $4Cu_2S.As_2S_3$ |

Also $4Cu_2S.(Sb,Bi)_2S_3$ $4(Cu_2,Ag_2)S.Sb_2S_3$ $4(Cu_2,Hg_2)S.Sb_2S_3$ $4(Cu_2,Pb)S.Sb_2S_3$

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| | | | | $\breve{a} : \bar{b} : \dot{c}$ |
|---|---|---|---|---|
| 150. | **Jordanite** | $4PbS.As_2S_3$ | Orthorhombic | 0·5375 : 1 : 2·0305 |
| 151. | **Meneghinite** | $4PbS.Sb_2S_3$ | " | 0·5289 : 1 : 0·3632 |

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| | | | | |
|---|---|---|---|---|
| 152. | **Geocronite** | $5PbS.Sb_2S_3$ | " | 0·5805 : 1 : 0·5028 |
| 153. | **Stephanite** | $5Ag_2S.Sb_2S_3$ | " | 0·6291 : 1 : 0·6851 |

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| | | |
|---|---|---|
| 154. | **Kilbrickenite** | $6PbS.Sb_2S_3$ |
| 155. | **Beegerite** | $6PbS.Bi_2S_3$ |
| | Richmondite | |

| | | | $\breve{a} : \bar{b} : \dot{c}$ |
|---|---|---|---|
| 156. | **Polybasite** | $9Ag_2S.Sb_2S_3$ | 0·5793 : 1 : 0·9131 |

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**157. Polyargyrite** $12Ag_2S.Sb_2S_3$

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### 148–149. TETRAHEDRITE—TENNANTITE.

**Tetrahedrite.** Argentum arsenico cupro et ferro mineralisatum, Falerts, Grauerts, Minera argenti grisea, *Wall.*, 313, 1747. Falerz, Argentum cupro et antimonio sulph. mineralisatum, *Cronst.*, 157, 1758; Pyrites cupri griseus, Fahlkupfererz, *Cronst.*, 175, 1758. Argentum cinereum crystallis pyramidatis trigonis *v. Born*, Lithoph., **1**, 82, 1772. Cuprum cinereum cryst. trigonis, etc., *v. Born*, ib., 108. Fahlerz, Kupferfahlerz, Schwarzerz pt., Antimonfahlerz, *Germ.* Graugiltigerz *Germ.* pt. Mine de cuivre grise *de Lisle*, Crist., **3**, 315 (with figs. cryst.), 1783. Cuivre gris *Fr.* Cobre gris, Pavonado *Span.* Gray Copper Ore. Panabase *Beud.*, Tr., **2**, 438, 1832. Tetraëdrit *Haid.*, Handb., 563, 1845. Clinoedrit pt., Fahlit, *Breith.*, B. H. Ztg., **25**, 181.

*Argentif.:* Argentum rude album pt. *Agric.*, Foss., 362, 1546. Weisgylden, Minera argenti alba pt., *Wall.*, 312, 1747; Cronstedt, 156, 1758. Weissgültigerz pt., Silberfahlerz, Graugiltigerz pt., Schwarzgiltigerz pt., *Germ.* Aphthonite *Svanberg* Berz. JB., **27**, 236, 1848. Freibergit *Kenng.*, Min., 117, 1853. Polytelit *Kbl.*, Taf., 10, 1853 [not of *Glock.*, Syn., 31, 1847]. Leukargyrit *Weisbach*, Synops. Min., 62, 1875.

*Mercurial:* Schwarzerz pt. *Wern.* Quecksilberfahlerz *Germ.* Graugiltigerz pt. *Hausm.* Spaniolith *Kbl.*, Min. Namen, 98, 1853. Schwatzit *Kenng.*, Min., l. c., 1853. Hermesit *Breith.*, B. H. Ztg., **25**, 182.

Malinowskite *Raimondi*, Domeyko Min. Chili, 5 App. 1876; Min. Pérou, 122, 1878. Nepaulite *Piddington*, J. Asiat. Soc., **23**, 170, 1854. Studerite *Fellenberg*, Mitth. Ges. Bern, 178, 1864. Coppite *Bechi*, *A. D'Achiardi*, Min. Tosc., **2**, 341, 1873. Frigidite *A. D'Achiardi*, Att. Soc. Tosc., 172, 1881. Nickelfahlerz *Arzruni*, Zs. Kr., **7**, 629, 1884. Kobaltfahlerz *Sandberger*, Jb. Min., 584, 1865.

**Tennantite.** Gray Sulphuret of Copper in dodecahedral crystals *Sowerby*, Brit. Min., 1817. Tennantite *Wm. & R. Phillips*, Q. J. Sc., **7**, 95, 100, 1819. Arsenikalfahlerz *Germ.* Kupferblende *Breith.*, Char., 131, 251, 1823, Pogg., **9**, 613, 1827. Sandbergerit *Breith.*, B. H. Ztg., **25**, 187, 1866. Erythroconite *Adam*, Tabl. Min., 59, 1869. Zinkfahlerz *Germ.* Julianite *Websky*, Zs. G. Ges., **23**, 486, 1871. Fredricit *Hj. Sjögren*, G. För. Förh., **5**, 82, 1880.

Annivite *Brauns*, Mitth. Ges. Bern, 57, 1854. Rionite *Brauns*, *Petersen*, Jb. Min., 590, 1870. Kobaltwismuthfahlerz *Sandberger*, Erzgänge, 392, 1885.

Isometric; tetrahedral. Observed forms[1]:

*a* (100, *i*-*i*)
*d* (110, *i*)
*o* (111, 1)
$o_,$ ($1\bar{1}1$, − 1)
*f* (310, *i*-3)
*e* (210, *i*-2)[3]
*r* (332, $\frac{3}{2}$)
$\Delta$ (774, $\frac{7}{4}$)[5]
*p* (221, 2)
$\mu$ (411, 4-4)
*m* (311, 3-3)
*n* (211, 2-2)
$\psi$ (955, $\frac{9}{5}$-$\frac{9}{5}$)
$\beta$ (322, $\frac{3}{2}$-$\frac{3}{2}$)?[3]
$r_,$ ($3\bar{3}2$, − $\frac{3}{2}$)
$\phi_,$ ($6\bar{1}1$, − 6-6)
$\omega_,$ ($5\bar{1}1$, − 5-5)?
$\mu_,$ ($4\bar{1}1$, − 4-4)
$n_,$ ($2\bar{1}1$, − 2-2)
$j_,$ ($17\cdot\bar{9}\cdot9$, $\frac{17}{9}$-$\frac{17}{9}$)[4]
*s* (321, 3-$\frac{3}{2}$)
*x* (431, 4-$\frac{4}{3}$)[4]
$v_,$ ($5\bar{2}1$, − 5-$\frac{5}{2}$)
$y_,$ ($6\bar{3}1$, − 6-2)[2]
$z_,$ ($12\cdot\bar{7}\cdot5$, − $\frac{12}{5}$-$\frac{12}{7}$)

Twins[1]: (1) tw. pl. *o*, contact-twins with the comp.-face either ∥ or ⊥ to the tw. pl., and penetration-twins, both common, twinning often repeated; also rarely twins (2) with axes parallel and symmetrical with reference to a cubic plane. Habit tetrahedral; crystals sometimes in parallel position[6], as on chalcopyrite, sphalerite. Also massive; granular, coarse or fine; compact.

Cleavage none. Fracture subconchoidal to uneven. Rather brittle. H. = 3–4·5. G. = 4·4–5·1. Luster metallic, often splendent. Color between flint-gray and iron-black. Streak like color, sometimes inclining to brown and cherry-red. Opaque; sometimes subtranslucent (cherry-red) in very thin splinters.

**Comp., Var.**—For TETRAHEDRITE, essentially $Cu_8Sb_2S_7$ or $4Cu_2S.Sb_2S_3$=Sulphur 23·1, antimony 24·8, copper 52·1 = 100.

For TENNANTITE, essentially $Cu_8As_2S_7$ or $4Cu_2S.As_2S_3$ = Sulphur 25·5, arsenic 17·0, copper 57·5 = 100.

Antimony and arsenic are usually both present and thus these two species graduate into each other and no sharp line can be drawn between them. There are also varieties containing bismuth, chiefly at the arsenical end of the series.

Further the copper is replaced by iron, zinc, silver, mercury, lead, and rarely cobalt and nickel, and in traces tin (Sandb.) and perhaps platinum.

**I. Tetrahedrite.** ANTIMONIAL SERIES.

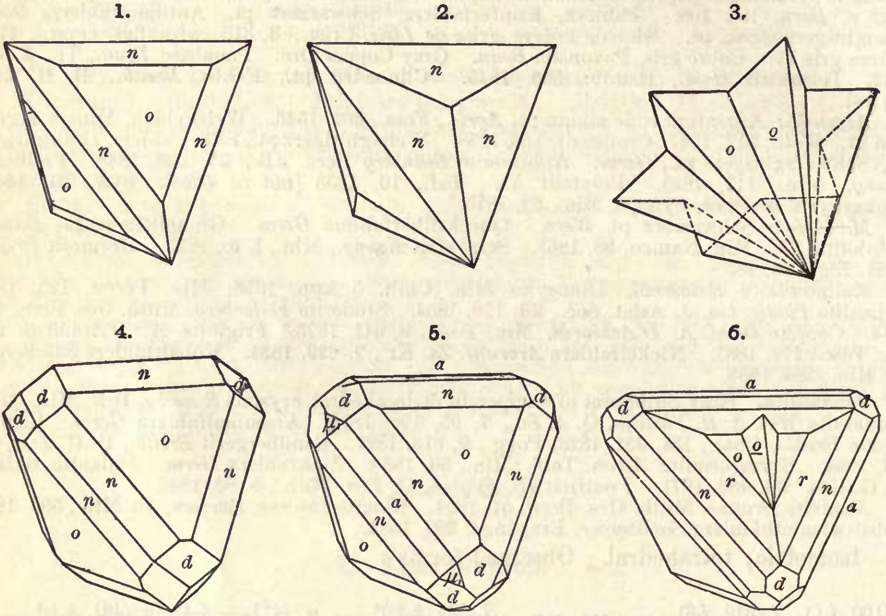
**Var.**—1. *Ordinary;* lichtes Fahlerz *Germ.* Contains little or no silver. Color steel-gray to dark gray and iron-black. G. = 4·75–4·9.

2. *Argentiferous; Freibergite.* Weissgiltigerz *Germ.* Color usually steel-gray, lighter than the ordinary varieties; sometimes iron-black; streak often reddish. G. = 4·85–5·0.

3. *Mercurial; Schwatzite.* Color dark gray to iron-black. Luster often dull. G. = 5·10 chiefly. Breithaupt attempted to distinguish varieties here under the names *spaniolite* and *hermesite.*

4. *Plumbiferous.* Here belongs *malinowskite,* also a variety from Arizona (anal. 34), perhaps also polytelite, p. 141.

Other varieties, more or less closely conforming to the tetrahedrite formula, occur, containing iron, nickel, and cobalt in considerable amount. Platinum occurs in an ore from Guadalcanal, Spain, according to Vauquelin.



Figs. 1, 2, Simple forms. 3, after Sbk. 4, 5, Dillenburg, Cramer. 6, Clausthal, Sbk.

**II. Tennantite.** ARSENICAL SERIES.

**Var.**—1. The original tennantite from Cornwall contains only copper and iron (to 9·75 p. c., Phillips). In crystals, habit dodecahedral, also cleavage *d* in traces. G. = 4·37–4·49. Color blackish lead-gray to iron-black.

2. *Kupferblende Germ., Sandbergerite.* Contains zinc in considerable amount.

*Fredricite* from Sweden has, besides copper, also iron, lead, silver, and tin.

*Rionite* and *annivite* carry bismuth in considerable amount as well as antimony. The *wismuthkobaltfahlerz* of Sandberger with bismuth has also cobalt.

I. ANTIMONIAL SERIES.

**Anal.**—1, Reuter, Rg., Min. Ch., 105, 1875. 2. Ellen H. Swallow. Proc. Bost. Soc., **17**, 465, 1875. 3, Kuhlemann, Zs. Nat. Halle. **8**, 500, 1856. 4, Mutschler, Jb. Min., 275, 1877. 5, Hidegh, Min. Mitth., **2**, 350, 1879. 6, Genth. Am. Phil. Soc., **23**, 38, 1885. 7, Hidegh, l. c. 8, Raimondi, Min. Pérou, 114, 1878. 9. Rg., Min. Ch., 107, 1875. 10, Untchj. Mitth. Ver. Steiermark, p. 60, 1872, Jb. Min., 874, 1872. 11, Becke. Min. Mitth., 273, 1877. 12, 13, Bibra, J. pr. Ch., **96**, 204. 1865. 14, Hidegh, l. c. 15, Genth, Am. J. Sc., **45**, 320, 1868. 16, Comstock, ib., **17**, 401, 1879. 17, 18. Nilson, Zs. Kr., **1**, 417, 1877. 19 Hidegh, l. c. 20, 21, Rg. Pogg., **77**, 251, 1849. 22, Forbes, Phil. Mag., **34**, 350, 1867. 23, Burton, Am. J. Sc., **45**, 320, 1868. 24. H. Rose, Pogg., **15**, 579, 1829 (also other anals.). 25, Mann. Babanek, Min. Mitth., **6**, 82, 1884. 26, H. Rose, l. c. 27, 28. Carl v. Hauer, Jb. G. Reichs., 98. 1852 (and other analyses). 29. Kersten, Pogg., **59**, 131, 1843. 30, Weidenbusch, Pogg., **76**, 86. 1849. 31, Rath, ib., **96**, 322, 1855. 32, Œllacher, Jb. Min., 596, 1865. 33, Raimondi, Domeyko. Min. Chili, 5th App., 1876, and Min. Pérou, 122, 1878; 29·3 p. c. gangue have been deducted, other analyses on still more impure material are given. 34, F. W. Clarke and Mary E. Owens. Am. Ch. J., **2**, 173, 1880 35, Bechi, l. c. 36, Funaro, quoted by D'Achiardi, l. c. 37, Fellenberg. l. c. 38, 39, Hilger, Jb. Min., 586, 592. 1865.

| | | | | S | Sb | As | Cu | Fe | Zn | Ag | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1. *Ordinary.* | | | | | | | | | | |
| 1. | Liskeard | G. = 5·09 | | 23·95 | 23·97 | — | 44·08 | 2·17 | 3·64 | 1·31 | = 99·12 |
| 2. | Newburyport | | | 27·60 | 25·87 | *tr.* | 35·85 | 2·66 | 5·15 | 2·30 | = 99·43 |
| 3. | Andreasberg | G. = 4·90 | $\frac{2}{2}$ | 25·22 | 27·38 | 0·67 | 37·18 | 3·94 | 5·00 | 1·58 | = 100·97 |
| 4. | Kahl | G. = 4·75 | | 25·9 | 24·9 | 2·6 | 36·3 | 3·6 | 4·5 | 0·5 | Co 0·5, Bi *tr.* = [98·8 |
| 5. | Kapnik | G. = 4·91 | | 25·31 | 24·21 | 2·88 | 37·83 | 0·94 | 7·25 | 1·32 | = 99·74 |
| 6. | Lake City, Col. | G. = 4·885 | $\frac{2}{2}$ | 25·97 | 25·51 | 3·22 | 37·68 | 0·64 | 7·15 | 0·60 | Bi 0·37, Mn 0·10 [= 101·24 |
| 7. | Herrengrund | G. = 4·77 | | 25·75 | 22·82 | 4·75 | 39·81 | 4·75 | 1·44 | 0·05 | = 99·37 |
| 8. | Cajabamba | | | 23·51 | 17·21 | 7·67 | 42·00 | 8·28 | 0·49 | 0·55 | = 99·71 |
| 9. | Müsen | G. = 4·793 | | 25·46 | 19·15 | 4·93 | 39·88 | 3·43 | 3·50 | 0·60 | Ni, Co 1·64 = 98·59 |
| 10. | Brixlegg | | | 25·59 | 20·44 | 6·96 | 39·37 | 3·26 | 4·43 | — | = 100·05 |
| 11. | " | G. = 4·721 | | 26·55 | 15·80 | 8·50 | 40·84 | 1·44 | 6·26 | 0·23 | = 99·62 |
| 12. | Algodon, | | | 21·14 | 11·64 | 20·05 | 38·72 | 6·33 | — | 0·45 | Pb, Hg *tr.* = 98·33 |
| 13. | " | | | 19·66 | 18·00 | 19·30 | 36·35 | 4·29 | — | 0·58 | Hg *tr.* = 98·18 |
| 14. | Nagyág | G. = 4·61 | | 26·52 | 11·35 | 12·07 | 39·75 | 1·77 | 5·55 | 0·29 | Mn 1·23 = 98·53 |
| | 2. *Argentiferous.* | | | | | | | | | | |
| 15. | Prescott, Arizona | | | 26·97 | 24·67 | *tr.* | 38·16 | 1·05 | 6·23 | 3·21 | = 100·29 |
| 16. | Huallanca, Peru | G. = 4·70 | $\frac{2}{2}$ | 26·74 | 9·06 | 13·49 | 39·09 | 5·46 | 2·14 | 3·86 | = 99·84 |
| 17. | Gärdsjö, *aphthonite* | G. = 4·53 | | 24·16 | 27·48 | — | 36·53 | 0·79 | 4·73 | 6·15 | = 99·84 |
| 18. | " " | | | 22·78 | 26·13 | — | 36·96 | 2·84 | 4·72 | 6·07 | = 99·50 |
| 19. | Kapnik | G. = 4·885 | | 24·25 | 25·63 | 1·08 | 32·59 | 0·90 | 5·77 | 6·76 | Mn 0·83 = 97·81 |
| 20. | Meiseberg, *mass.* | G. = 4·53 | | 24·69 | 25·74 | — | 32·46 | 4·19 | 3·00 | 7.55 | = 97·63 |
| 21. | " *cryst.* | G. = 4·852 | | 24·80 | 26·56 | — | 30·47 | 3·52 | 3·39 | 10·48 | Pb 0·78 = 100 |
| 22. | Isle of Man | G. = 4·97 | | 27·48 | 24·85 | — | 22·62 | 4·80 | 4·65 | 13·57 | Pb 1·43, insol. 0·34 [= 99·74 |
| 23. | Star City, Nevada | G. = 5·0 | $\frac{2}{2}$ | 24·44 | 27·60 | — | 27·41 | 4·27 | 2·31 | 14·54 | = 100·57 |
| 24. | Wolfach | | | 23·52 | 26·63 | — | 25·23 | 3·72 | 3·10 | 17·71 | = 99·91 |
| 25. | Přibram, *Weissgiltigerz* | | | 24·9 | 23·0 | — | 10·8 | 2·4 | 2·0 | 26·1 | Pb 10·8 = 100 |
| 26. | Freiberg " | | | 21·17 | 24·63 | — | 14·81 | 5·98 | 0·99 | 31·29 | = 98·87 |

| | | | | S | Sb | As | Cu | Fe | Zn | Ag | Hg | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3. *Mercurial.* | | | | | | | | | | | |
| 27. | Poratsch | G. = 4·733 | | 24·89 | 30·18 | *tr.* | 32·80 | 5·85 | — | 0·07 | 5·57 | = 99·36 |
| 28. | " | G. = 5·107 | | 24·37 | 25·48 | *tr.* | 30·58 | 1·46 | — | 0·09 | 16·69 | = 98·67 |
| 29. | V. di Castello | G. = 5·092 | $\frac{2}{2}$ | 24·17 | 27·47 | — | 35·80 | 1·89 | 6·05 | 0·33 | 2·70 | = 98·41 |
| 30. | Schwatz | G. = 5·107 | | 22·96 | 21·35 | — | 34·57 | 2·24 | 1·34 | — | 15·57 | gang. 0·80 = 98·83, |
| 31. | Kotterbach | G = 5·356 | $\frac{3}{3}$ | 22·53 | 19·34 | 2·94 | 35·34 | 0·87 | 0·69 | — | 17·27 | Pb 0.21, Bi 0·81 [= 100 |
| 32. | Moschellandsberg | G. = 5·095 | | 21·90 | 23·45 | 0·31 | 32·19 | 1·41 | 0·10 | — | 17·32 | Co 0·23, Bi 1·57, [gang. 1·39 = 99·87 |

| | | | | S | Sb | As | Cu | Fe | Zn | Ag | Pb | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4. *Plumbiferous.* | | | | | | | | | | | |
| 33. | Peru, *Malinowskite* | | | 24·27 | 24·74 | 0·56 | 14·38 | 9·12 | 1·93 | 11·92 | 13·08 | = 100 |
| 34. | Arizona | G. = 4·35 | | 21·67 | 24·72 | — | 33·53 | 0·56 | — | 1·80 | 16·23 | = 98·51 |
| | *Other Varieties.* | | | | | | | | | | | |
| 35. | *Coppite* | G. = 4·713 | $\frac{3}{3}$ | 27·01 | 29·61 | — | 30·10 | 13·08 | — | — | | = 99·80 |
| 36. | *Frigidite* | G. = 4·8 | | 29·60 | 25·59 | — | 19·32 | 12·67 | *tr.* | 0·04 | | Ni 7·55, $SiO_2$ 2·20 [= 96·97 |
| 37. | *Studerite* | G. = 4·657 | | 24·97 | 15·58 | 11·49 | 38·17 | 2·76 | 5·11 | 0·96 | | Pb 0·38, Bi 0·58 = 100 |
| 38. | Schwarzwald | G. = 4·9 | | 26·40 | 14·72 | 6·98 | 33·83 | 6·40 | — | 1·37 | | Co 4·21, Ni *tr.*, Bi [4·55 = 98·46 |
| 39. | Kaulsdorf | G. = 4·8 | | 28·34 | 15·05 | 10·19 | 32·04 | 4·85 | 3·84 | 0·22 | | Co 2·95, Pb 0·43, [Bi 1·83 = 99·74 |

II. ARSENICAL SERIES.

**Anal.**—1, Rg., Min. Ch., 88, 1860. 2, Wackernagel, ibid. 3, Plattner, Pog., **67**, 422, 1846. 4, Merbach, B. H. Ztg., **25**, 187, 1866. 5, 6, Orosi, quoted by A. D'Achiardi, N. Cim., II, **3**, May, 1870. 7, Websky, l. c. 8, Hidegh, Min. Mitth., **2**, 355, 1879. 9, Petersen, Jb. Min, **1**, 262, 1881. 10, Harrington, Trans. R. Soc. Canada, **1**, 80, 1883. 11, Orosi, quoted by Raimondi, Min. Pérou, 116, 1878. 12, Hj. Sjögren, G. För. Förh., **5**, 82, 1880. 13, Brauns, quoted by Petersen, l. c. 14, Brauns, l. c. 15, Petersen, Jb. Min., 464, 1870.

| | | | S | As | Sb | Bi | Cu | Fe | Zn | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Tennantite.* | | | | | | | | | |
| 1. | Cornwall, *cryst.* | | 26·61 | 19·03 | — | — | 51·62 | 1·95 | — | = 99·21 |
| 2. | " " | G. = 4·69 | 26·88 | 20·53 | — | — | 48·68 | 3·09 | — | = 99·18 |
| 3. | Freiberg, *Kupferblende* | | 28·11 | 18·88 | *tr.* | — | 41·07 | 2·22 | 8·89 | Pb 0·34, Ag *tr.* [= 99·51 |
| 4. | Morococha, *Sandbergerite.* | G. =4·37 | 25·12 | 14·75 | 7·19 | — | 41·08 | 2·38 | 7·19 | Pb 2·77 = 100·48 |
| 5. | Jucud mines, *cryst.* | | 26·05 | 16·78 | 6·12 | — | 43·20 | 4·00 | 2·00 | Pb *tr.* = 98·15 |
| 6. | " " *mass.* | | 29·52 | 15·60 | 4·54 | — | 38·45 | 6·22 | 3·40 | Pb 2·15 = 99·88 |
| 7. | *Julianite* | G. = 5·12 | 26·50 | 16·78 | 1·42 | — | 52·30 | 0·79 | — | Ag 0·54 = 98·33 |
| 8. | Szaska | G. = 4·92 | 25·98 | 19·11 | 0·10 | — | 53·60 | 0·39 | — | Ag 0·08 = 99·26 |
| 9. | Wilhelmine mine | G. = 4·87 | 27·45 | 20·63 | *tr.* | 0·98 | 46·66 | 3·03 | 0·88 | Ni,Co 0·30=99·93 |
| 10. | Capelton, Quebec | G. = 4·622 | 27·99 | 15·34 | 4·52 | — | 42·09 | 3·77 | 4·56 | Ag 0·21, Pb 0·25 [=98·73 |
| 11. | Cajamarca | | 26·05 | 16·78 | 6·12 | — | 43·30 | 4·00 | 2·00 | *tr.* = 98·25 |
| 12. | Falun, *Fredricite* | G. = 4·65 | 27·18 | 17·11 | *tr.* | — | 42·23 | 6·02 | | Sn 1·41, Pb 3·34, Ag [2·87 = 100·16 |
| | *Bismuthiferous.* | | | | | | | | | |
| 13. | Cremenz, *Rionite* | | 29·10 | 11·44 | 2·19 | 13·07 | 37·52 | 6·51 | — | Ag 0·04, Co 1·20 [= 101·07 |
| 14. | Val d'Anniviers, *Annivite* | | 23·75 | 10·96 | 8·80 | 4·94 | 35·57 | 3·85 | 2·01 | insol. 9·40 = [100·28 |
| 15. | Neubulach | G. = 4·908 | 24·85 | 13·53 | 4·28 | 6·33 | 41·43 | 3·74 | 3·82 | Ag *tr.*, Pb 1·52 [Co,Ni *tr.*=99·50 |

**Pyr., etc.**—Differ in the different varieties. In the closed tube all the antimonial kinds fuse and give a dark red sublimate of antimony oxysulphide; when containing mercury, a faint dark gray sublimate appears at a low red heat; and if much arsenic, a sublimate of arsenic trisulphide first forms. In the open tube fuses, gives sulphurous fumes and a white sublimate of antimony; if arsenic is present, a crystalline volatile sublimate condenses with the antimony; if the ore contains mercury it condenses in the tube in minute metallic globules. B.B. on charcoal fuses, gives a coating of the oxides of antimony and sometimes arsenic, zinc, and lead; the arsenic may be detected by the odor when the coating is treated in R.F.; the oxide of zinc assumes a green color when heated with cobalt solution. The roasted mineral gives with the fluxes reactions for iron and copper; with soda yields a globule of metallic copper. To determine the presence of a trace of arsenic by the odor, it is best to fuse the mineral on charcoal with soda. The presence of mercury is best ascertained by fusing the pulverized ore in a closed tube with about three times its weight of dry soda, the metal subliming and condensing in minute globules. The silver is determined by cupellation.

Decomposed by nitric acid, with separation of sulphur and antimony trioxide.

**Obs.**—*Tetrahedrite* is often associated with chalcopyrite, pyrite, sphalerite, galena, and various other silver, lead, and copper ores; also siderite. It occurs at many Cornish mines; thus at the Herodsfoot mine, Liskeard, in tetrahedral crystals often coated with iridescent chalcopyrite; at the Levant mine near St. Just; the Condurrow mine; near St. Austell. Prominent localities are Andreasberg and Clausthal in the Harz; Freiberg in Saxony; Dillenburg and Horhausen in Nassau; at Müsen; various mines in the Black Forest; Kahl in the Spessart; Přibram in Bohemia; Kogel near Brixlegg in Tyrol; Kapnik, Kremnitz, and Herrengrund in Hungary; Baigorre near St. Etienne in the Pyrenees. In Mexico, at Durango, Guanajuato; Chili; Bolivia, etc. The *argentiferous* variety occurs especially at Freiberg; Přibram; the Foxdale mine, Isle of Man; Huallanca in Peru and elsewhere in South America and Mexico. The *mercurial* variety at Schmölnitz, Hungary; Poratsch, Zavatka, and Kotterbach near Iglo; Schwatz in Tyrol; and the valleys of Angina and Castello in Tuscany. *Coppite* and *frigidite* are from the mines in the Val del Frigido, in the Apuan Alps. *Studerite* is from Ausserberg, Ober-Wallis, Switzerland; named after Prof. Bernhard Studer.

In the U. S., tetrahedrite occurs at the Kellogg mines, 10 m. N. of Little Rock, Arkansas, with galena. In Colorado, near Central City, Gilpin Co., in fine crystals, often in parallel position coating chalcopyrite; also in Clear Creek and Summit Cos.; the Ulay mine, Lake Co.; further in Hinsdale, San Juan, Ouray, and Miguel Cos.; with pyrargyrite in Ruby District, Gunnison Co. In Nevada, abundant at the Sheba and De Soto mines, Humboldt Co., massive and rich in silver (the De Soto containing 16·4 p. c. of silver, Allen); near Austin in Lander Co.; Isabella mine, Reese river. In Utah. In Arizona at the Heintzelman mine, containing 1½ p. c. of silver; at the Santa Rita mine; at various points in British Columbia.

*Tennantite* has been found at the Cornish mines, particularly at Wheal Jewel in Gwennap, and Wheel Unity in Gwinear, usually in splendent crystals investing other copper ores; also at the East Relistian mine; at Freiberg (Kupferblende); at the Wilhelmine mine in the Spessart. Also at Skutterud in Norway. At Capelton, Pr. Quebec, Canada. Named after the chemist, Smithson Tennant (1761–1815). See further p. 1049.

*Julianite* is from the Friedrich-Julian mine, at Rudelstadt, Silesia. *Annivite* from the Val d'Anniviers, Switzerland. *Fredricite* from Falun, Sweden.

**Alt.**—Chalcopyrite, malachite, azurite, amalgam, bournonite, erythrite, cinnabar, covellite, occur as pseudomorphs after tetrahedrite.

**Artif.**—Obtained by Durocher in tetrahedral crystals and of varying composition. C. R., 32. 823, 1851.

Occurs as a recent formation at Plombières and at Bourbonne-les-Bains (Daubrée).

**Ref.**—[1] Sadebeck, monograph with authorities, description of methods of twinning, etc., Zs. G. Ges., **24**, 427, 1872. [2] Slg., Horhausen, Zs. Kr., **1**, 335, 1877. [3] Groth, Min.-Samml., 66, 1878. [4] Cathrein, Brixlegg, Zs. Kr., **9**, 353, 1884, Min. Mitth., **10**, 56, 1888. [5] Rath, Bolivia, Ber. nied. Ges., June 7, 1886. [6] Sbk, l. c., also Becke, Min. Mitth., **5**, 331, 1882.

Nepaulite *H. Piddington*, J. Asiat. Soc., **23**, 170, 1854. Described as a carbonate of bismuth, copper, etc.; shown by Mallet (Rec. G. Surv. India, **18**, 235, 1885, Min. India, 30, 1887) to be simply tetrahedrite. From near Khatmandu, Nepál.

Fieldite. An ore from mine Altar, 30 leagues from Coquimbo, afforded F. Field (J. Ch. Soc., **4**, 332, 1851), S 30·35, As 3·91, Sb 20·28, Cu 36·72, Zn 7·26, Fe 1·23, Ag 0·075, Au 0·003. It is soft, of greasy appearance, greenish-gray, slightly reddish, with powder bright red. Domeyko considers it impure with sphalerite, pyrite, and galena. Ettling observes (ib., **6**, 140, 1854) that the constitution is analogous rather to enargite than tetrahedrite. Kenngott has named it *Fieldite.*

Polytelite *Glock.*, Syn., 31, 1847. Weissgültigerz *Germ.* pt. Consists mainly of lead, silver, antimony, and sulphur. Glocker cites the following analysis by Rammelsberg (Pogg., **68**, 515, 1846) of an ore from the Hoffnung Gottes mine near Freiberg, a fine-granular ore, having G. = 5·438–5·465, apparently homogeneous but somewhat mixed with sphalerite and pyrite. Klaproth also analyzed a related *weissgültigerz* from the Himmelsfürst mine near Freiberg (Beitr., **1**, 166, 1795; cf. 5th Ed., p. 104). Analysis, Rg.:

S 22·53 Sb [22·39] Cu 0·32 Fe 3·83 Zn 6·79 Pb 38·36 Ag 5·78 = 100

Rammelsberg makes the mineral, from his analysis, a silver-lead tetrahedrite, with the formula $4(Pb,Ag,Fe,Zn)S.Sb_2S_3$, in which the ratio Fe : Zn : Pb + Ag = 2 : 3 : 6, and Pb : Ag = 7 : 1. Cf. malinowskite, p. 137.

Clayite *W. J. Taylor*, Proc. Ac. Philad., p. 306, Nov. 1859. In tetrahedrons with dodecahedral planes. Crystals small. Also massive, incrusting. H. = 2·5. Luster metallic. Color and streak blackish lead-gray. Opaque. Analysis—W. J. Taylor:

S 8·22 As 9·78 Sb 6·54 Pb 68·51 Cu 7·67 Ag *trace* = 100·72

From Peru. Probably a result of alteration. Requires further investigation. Named after Messrs. Joseph A. Clay and J. Randolph Clay.

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### 150. JORDANITE. *Rath*, Ber. nied. Ges., **21**, 34, 1864; Pogg., **122**, 387, 1864.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·53747 : 1 : 2·0305$ Rath[1].

$100 \wedge 110 = 28° 15\frac{1}{3}'$, $001 \wedge 101 = 75° 10\frac{1}{2}'$, $001 \wedge 011 = 63° 46\frac{5}{6}'$.

**Forms:**
$c$ (001, $O$)
$m$ (110, $I$)
$n$ (130, $i$-$\breve{3}$)$^3$
$u$ (103, $\frac{1}{3}$-$\bar{\imath}$)
$v$ (205, $\frac{2}{5}$-$\bar{\imath}$)$^3$

$w$ (102, $\frac{1}{2}$-$\bar{\imath}$)
$x$ (203, $\frac{2}{3}$-$\bar{\imath}$)$^3$
$y$ (101, 1-$\bar{\imath}$)
$d$ (029, $\frac{2}{9}$-$\breve{\imath}$)
$e$ (014, $\frac{1}{4}$-$\breve{\imath}$)
$f$ (027, $\frac{2}{7}$-$\breve{\imath}$)

$g$ (013, $\frac{1}{3}$-$\breve{\imath}$)
$h$ (025, $\frac{2}{5}$-$\breve{\imath}$)
$i$ (012, $\frac{1}{2}$-$\breve{\imath}$)
$k$ (047, $\frac{4}{7}$-$\breve{\imath}$)
$l$ (023, $\frac{2}{3}$-$\breve{\imath}$)
$p$ (011, 1-$\breve{\imath}$)
$q$ (021, 2-$\breve{\imath}$)

$\alpha$ (119, $\frac{1}{9}$)
$\beta$ (118, $\frac{1}{8}$)
$\gamma$ (117, $\frac{1}{7}$)
$\delta$ (116, $\frac{1}{6}$)
$\epsilon$ (115, $\frac{1}{5}$)
$\zeta$ (114, $\frac{1}{4}$)
$\eta$ (227, $\frac{2}{7}$)

$\vartheta$ (113, $\frac{1}{3}$)
$\kappa$ (112, $\frac{1}{2}$)
$\iota$ (225, $\frac{2}{5}$)$^3$
$\lambda$ (111, 1)
$\mu$ (332, $\frac{3}{2}$)$^2$
$\nu$ (441, 4)$^2$

$A$ (137, $\frac{3}{7}$-$\breve{3}$)
$B$ (136, $\frac{1}{2}$-$\breve{3}$)
$C$ (134, $\frac{3}{4}$-$\breve{3}$)
$D$ (133, 1-$\breve{3}$)
$E$ (132, $\frac{3}{2}$-$\breve{3}$)$^3$
$F$ (131, 3-$\breve{3}$)

$mm''' = 56° 31'$
$nn' = 63° 37'$

$uu' = 103° 6'$
$ww' = 124° 12\frac{1}{2}'$
$yy' = 150° 21'$

$ee' = 53° 50'$
$gg' = 68° 11'$
$ii' = 90° 52'$
$ll' = 107° 5\frac{1}{3}'$
$pp' = 127° 34'$
$qq' = 127° 34'$

$c\delta = 35° 33\frac{1}{2}'$
$c\zeta = 47° 0'$
$c\vartheta = 55° 2'$
$c\kappa = {*}65° 0'$
$c\lambda = 76° 52\frac{1}{2}'$
$c\mu = 81° 10'$
$c\nu = 86° 40'$

$cB = 50° 4'$
$cC = 60° 50'$
$cD = 67° 17'$
$cE = 74° 24\frac{1}{2}'$
$cF = 82° 3\frac{1}{2}'$

$\zeta\zeta' = 80° 12'$
$\vartheta\vartheta' = 92° 24'$
$\kappa\kappa' = 105° 56'$
$\lambda\lambda' = 118° 9'$

$\zeta\zeta''' = 40° 31'$
$\vartheta\vartheta''' = 45° 39'$
$\kappa\kappa''' = {*}50° 49'$
$\lambda\lambda''' = 54° 55'$
$DD' = 58° 11'$
$FF' = 62° 56'$
$DD'' = 103° 15'$
$FF'' = 114° 38'$

Twins: tw. pl. $m$, common; often repeated, producing pseudo-hexagonal forms, like those of aragonite. Crystals six-sided with $c$ predominating, sometimes tabular; the pyramidal planes narrow and often striated.

Cleavage: *b* distinct. Fracture conchoidal. Brittle. H. = 3. G. = 6·393. Luster metallic. Color lead-gray. Streak black. Opaque.

**Comp.**—$Pb_4As_2S_7$ or $4PbS.As_2S_3$ = Sulphur 18·7, arsenic 12·5, lead 68·8 = 100.

**Anal.**—1, Sipöcz, Min. Mitth., 29, 1873. 2, Ludwig, ib., p. 216, material containing a little galena.

| | | S | As | Sb | Pb | |
|---|---|---|---|---|---|---|
| 1. Binnenthal | G. = 6·393 | $\frac{2}{2}$ 18·16 | 12·71 | 0·11 | 69·97 | = 100·95 |
| 2. Nagyág | | 17·06 | 9·90 | 1·87 | 70·80 | = 99·63 |

**Pyr.**—Cf. sartorite.

**Obs.**—From Imfeld in the Binnenthal in cavities in a crystalline dolomite with the related minerals dufrenoysite, sartorite, binnite, also sphalerite, etc. With sphalerite and galena at Nagyág in Transylvania.

Named after Dr. Jordan of Saarbrück.

**Ref.**—[1] Pogg., **122**, 387, 1864, and ib. Erg.-Bd., **6**, 363, 1873. [2] Tsch., Nagyág, Min. Mitth., 215, 1873. [3] Lewis, Binnenthal, Zs. Kr., **2**, 191, 1878. See p. 1039.

### 151. MENEGHINITE. *Bechi*, Am. J. Sc., **14**, 60, 1852.

Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c}$ = 0·52891 : 1 : 0·36317 Miers[1].
$100 \wedge 110 = 27° 52' 29''$, $001 \wedge 101 = 34° 28' 30''$, $001 \wedge 011 = 19° 57' 34''$.

**Forms**[1]:
*a* (100, $i$-$\bar{i}$)
*b* (010, $i$-$\breve{i}$)
*c* (001, *O*)
*e* (320, $i$-$\frac{3}{2}$)
*m* (110, *I*)
*S* (340, $i$-$\frac{4}{3}$)
*l* (230, $i$-$\frac{3}{2}$)

*f* (350, $i$-$\frac{5}{3}$)
*T* (120, $i$-$\breve{2}$)
*g* (130, $i$-$\breve{3}$)
*i* (270, $i$-$\breve{\frac{7}{2}}$)
*U* (140, $i$-$\breve{4}$)
*h* (1·10·0, $i$-$\breve{10}$)
*k* (1·12·0, $i$-$\breve{12}$)
*y* (308, $\frac{3}{8}$-$\bar{i}$)

*δ* (6·0·13, $\frac{6}{13}$-$\bar{i}$)
*d* (102, $\frac{1}{2}$-$\bar{i}$)
*o* (203, $\frac{2}{3}$-$\bar{i}$)
*θ* (405, $\frac{4}{5}$-$\bar{i}$)
*v* (101, 1-$\bar{i}$)
*w* (501, 5-$\bar{i}$)
*n* (011, 1-$\breve{i}$)
*W* (043, $\frac{4}{3}$-$\breve{i}$)

*Q* (021, 2-$\breve{i}$)
*q* (0·24·11, $\frac{24}{11}$-$\breve{i}$)
*r* (111, 1)
*π* (24·24·13, $\frac{24}{13}$)
*s* (344, 1-$\breve{\frac{4}{3}}$)
*x* (18·24·13, $\frac{24}{13}$-$\breve{\frac{4}{3}}$)
*t* (122, 1-$\breve{2}$)
*ψ* (12·24·13, $\frac{24}{13}$-$\breve{2}$)

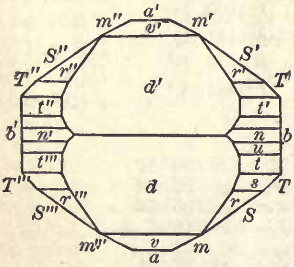
*p* (121, 2-$\breve{2}$)?
*ρ* (12·24·11, $\frac{24}{11}$-$\breve{2}$)
*u* (144, 1-$\breve{4}$)
*λ* (6·24·13, $\frac{24}{13}$-$\breve{4}$)
*β* (142, 2-$\breve{4}$)
*σ* (6·24·11, $\frac{24}{11}$-$\breve{4}$)
*μ* (184, 2-$\breve{8}$)

$ee''' = 38° 51'$
$mm''' = 55° 45'$
$SS' = 109° 37'$
$ll' = 103° 9'$
$TT = 86° 47'$
$UU' = 50° 36'$
$dd' = 37° 54'$

$oo' = 49° 12'$
$vv' = 68° 57'$
$av = {}^*55° 31\frac{1}{2}'$
$nn' = 39° 55'$
$QQ' = 71° 59'$
$mr = 52° 9\frac{1}{2}'$
$Ss = 57° 47'$

$Tt = 63° 27'$
$Tp = 45° 1'$
$Uu = 68° 7'$
$U\beta = 51° 13'$
$rr' = 65° 41'$
$rr''' = 33° 20'$
$as = {}^*64° 10\frac{1}{4}'$

$tt' = 35° 46'$
$tt''' = 37° 55'$
$pp' = 58° 7'$
$pp''' = 61° 50'$
$\beta\beta' = 31° 3'$
$\beta\beta''' = 68° 59'$



Bottino, after Miers.

Crystals slender prismatic, vertically striated. Also massive, fibrous to compact.

Cleavage: *a* perfect, but interrupted; *c* difficult. Fracture conchoidal. Brittle. H. = 2·5. G. = 6·34–6·43; 6·399 Miers, 6·432 Loczka. Luster metallic, bright. Color blackish lead-gray. Streak black, shining. Opaque.

**Comp.**—$Pb_4Sb_2S_7$ or $4PbS.Sb_2S_3$ = Sulphur 17·4, antimony 18·6, lead 64·0 = 100. Copper is usually present in small amount.

**Anal.**—1, E. Bechi, l. c. 2, Rath, Pogg., **132**, 376, 1867. 3, Martini & Funaro, Att. Soc. Tosc., **2**, 116, 1876. 4, Loczka, Földt. Közl., **13**, 356, 1883. 5, 6, Frenzel, Pogg., **141**, 443, 1870. 7, B. J. Harrington, Trans. R. Soc. Canada, **1**, 79, 1883.

| | | S | Sb | Pb | Cu | Fe | |
|---|---|---|---|---|---|---|---|
| 1. Bottino | | 17·52 | 19·28 | 59·21 | 3·54 | 0·35 | = 99·90 |
| 2. “ | G. = 6·342 | 16·97 | 18·37 | 61·47 | 0·39 | 0·23 | insol. 0·82 = 98·25 |
| 3. “ | | 16·98 | 19·50 | 60·37 | — | 2·63 | = 99·48 |
| 4. “ | G. = 6·432 | 17·49 | 16·80 | 61·05 | 2·83 | 0·30 | As 0·23, Ag 0·11 = 98·81 |
| 5. Saxony | G. = 6·367 | 17·04 | 19·60 | 61·33 | 1·38 | *undet.* | = 99·35 |
| 6. “ | | 18·22 | 19·11 | 60·09 | 1·56 | 0·25 | = 99·23 |
| 7. Canada | G. = 6·33 | 16·81 | 19·37 | 61·45 | 1·36 | 0·07 | As *tr.*, Ag 0·08 = 99·14 |

**Pyr.**—Like zinkenite.

**Obs.**—Occurs at Bottino, near Serravezza, in Tuscany, with galena, boulangerite, jamesonite, etc., and also crystals of albite; also in the neighboring valley of Castello. From the Ochsenkopf near Schwarzenberg, Saxony, disseminated through emery; at Goldkronach. Also with quartz and dolomite as a vein in gneiss at Marble Lake, Barrie township, Ontario, Canada.

First observed by Prof. Meneghini, of Pisa (1811–1889), after whom it was named.

**Ref.**—[1] Bottino, Min. Mag., **5**, 325, 1884; Krenner (Földt. Közl., **13**, 297, 350, 1883) obtained nearly the same results. Rath made the species monoclinic, Pogg., **132**, 372, 1867. Cf. also Schmidt, Zs. Kr., **8**, 613, 1884; Hintze, ib., **9**, 294, 1884. The position of Miers is here retained.

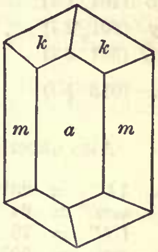
**152. GEOCRONITE.** Geokronit *Svanberg*, Ak. H. Stockholm, 184, 1839. Schulzit *Hausm.*, Handb., 166, 1847.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}5805 : 1 : 0{\cdot}5028$ Kerndt[1].

$100 \wedge 110 = {}^*30° \ 8'$, $001 \wedge 101 = 40° \ 54'$, $001 \wedge 011 = 26° \ 41\frac{1}{2}'$.

**Forms:** *a* (100, *i*-$\bar{i}$); *m* (110, *I*); *k* (211, 2-$\bar{2}$).

Angles: $mm''' = 60° \ 16'$, $kk = 114° \ 16'$, $kk'' = {}^*122°$, $kk''' = 28° \ 13'$



Kerndt.

Crystals rare. Usually massive; granular and earthy.

Cleavage: *m* distinct; *k* less so. Fracture uneven. H. = 2·5. G. = 6·3–6·45. Luster metallic. Color and streak light lead-gray to grayish blue. Opaque.

**Comp.**—$Pb_5Sb_2S_8$ or $5PbS.Sb_2S_3$ = Sulphur 16·7, antimony 15·7, lead 67·6 = 100. Part of the antimony may be replaced by arsenic, and the lead by copper.

**Anal.**—1, Svanberg, l. c. 2, Sauvage, Ann. Mines, **17**, 525, 1840. 3, Kerndt, Pogg., **65**, 302, 1845. 4, Nauckhoff, G. För. Förh. **1**, 88, 1872.

| | | S | Sb | As | Pb | Cu | Fe | |
|---|---|---|---|---|---|---|---|---|
| 1. Sala, Sweden | G. = 5·88 | 16·26 | 9·58 | 4·70 | 65·45 | 1·51 | 0·42 | Zn 0·11 = 99·03 |
| 2. Merido, *Schulzite* | G. = 6·43 | 16·90 | 16·00 | — | 64·89 | 1·60 | — | = 99·39 |
| 3. Tuscany | G. = 6·45–6·47 | 17·32 | 9·69 | 4·72 | 66·55 | 1·15 | 1·73 | = 101·16 |
| 4. Björkskogsnäs | G. = 6·26 | 17·73 | 17·33 | — | 57·95 | 5·93 | 0·11 | = 99·05 |

**Pyr.**—Same as for zinkenite.

**Obs.**—From the silver mines of Sala in Sweden; also in a fine crystalline dolomite at Björkskogsnäs, Örebro; from Galicia, Merido in Spain, in nodules in galena; Val di Castello near Pietro Santo, in Tuscany. Also at Owen's Valley, Inyo Co., Cal.

The name geocronite is derived from *γῆ*, *earth*, and *Κρόνος*, *Saturn*, the alchemistic name for lead.

A mineral found at Tinder's gold mine, Louisa Co., Va., may be this species. It contains, according to Genth (Am. J. Sc., **19**, 9, 1855), S 16, Pb 60, Ag 0·25, with antimony and arsenic. G. = 6·393.

An antimonial ore from between La Paz and Yungas, in Bolivia, is referred here by D. Forbes (Phil. Mag., **29**, 9, 1865).

**Ref.**—[1] From Val di Castello, Pogg., **65**, 302, 1845.

**153. STEPHANITE.** Argentum rude nigrum?, *Germ.* Schwarzerz, pt., *Agric.*, Interpr., 462, 1456. Svartgylden, Schvartsertz, pt. Minera argenti nigra spongiosa (fr. Freiberg) *Wall.*, 313, 1747. Argentum mineralisatum nigrum fragile (fr. Schemnitz, etc.), Röschgewächs (of Hung. miners) *Born.*, Lithoph., **1**, 81; 1772. Sprödglaserz *Wern.*, 1789. Sprödglanzerz. Brittle Silver Ore, or Glance. Brittle Sulphuret of Silver. Argent noir pt. *H.*, Tr., 1801. Argent sulfuré fragile *Fr.* Schwarzgültigerz *Leonh.*, Handb., 638, 1826. Psaturose *Beud.*, Tr., **2**, 432, 1832. Stephanit *Haid.*, Handb., 570, 1845. Antimonsilberglanz *Breith.*, 1830. Schwarzsilberglanz *Glocker*, 1831. Prismatischer Melanglanz *Mohs*, 1824. Tigererz *Germ.* Rosicler negro, Plata agria *Span.*

Orthorhombic; hemimorphic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}629129 : 1 : 0{\cdot}685135$ Vrba[1].

$100 \wedge 110 = 32° \ 10' \ 31''$, $001 \wedge 101 = 47° \ 26' \ 24''$, $001 \wedge 011 = {}^*34° \ 24' \ 59''$.

**Forms**[2]:

$a$ (100, $i\text{-}\bar{i}$)
$b$ (010, $i\text{-}\breve{i}$)
$c$ (001, $O$)

$\lambda$ (310, $i\text{-}\bar{3}$)
$L$ (210, $i\text{-}\bar{2}$)
$m$ (110, $I$)
$\mathbf{u}$ (350, $i\text{-}\frac{5}{3}$)
$U$ (120, $i\text{-}\breve{2}$)
$\pi$ (130, $i\text{-}\breve{3}$)
$J$ (150, $i\text{-}\breve{5}$)
$i$ (1·11·0, $i\text{-}\breve{11}$)

$\beta_1$ (102, $\frac{1}{2}\text{-}\bar{i}$)
$\beta_2$ (203, $\frac{2}{3}\text{-}\bar{i}$)
$\beta$ (101, $1\text{-}\bar{i}$)
$g$ (201, $2\text{-}\bar{i}$)
$G$ (301, $3\text{-}\bar{i}$)

$\alpha$ (013, $\frac{1}{3}\text{-}\breve{i}$)
$s$ (012, $\frac{1}{2}\text{-}\breve{i}$)
$t$ (023, $\frac{2}{3}\text{-}\breve{i}$)
$\mathfrak{a}$ (045, $\frac{4}{5}\text{-}\breve{i}$)
$k$ (011, $1\text{-}\breve{i}$)
$\kappa$ (043, $\frac{4}{3}\text{-}\breve{i}$)
$j$ (032, $\frac{3}{2}\text{-}\breve{i}$)
$d$ (021, $2\ \breve{i}$)
$e$ (041, $4\text{-}\breve{i}$)
$E$ (061, $6\text{-}\breve{i}$)
$\delta_1$ (071, $7\text{-}\breve{i}$)
$\delta_2$ (0·15·2, $\frac{15}{2}\text{-}\breve{i}$)
$\delta_3$ (081, $8\text{-}\breve{i}$)
$\delta_4$ (0·14·1, $14\text{-}\breve{i}$)

$q_1$ (115, $\frac{1}{5}$)
$q$ (114, $\frac{1}{4}$)
$M$ (113, $\frac{1}{3}$)
$h$ (112, $\frac{1}{2}$)
$l$ (223, $\frac{2}{3}$)
$P$ (111, 1)

$p_2$ (554, $\frac{5}{4}$)
$p_1$ (443, $\frac{4}{3}$)
$p$ (332, $\frac{3}{2}$)
$r$ (221, 2)
$r_1$ (773, $\frac{7}{3}$)
$r_2$ (331, 3)

$B$ (916, $\frac{3}{2}\text{-}\bar{9}$)
$\tau$ (512, $\frac{5}{2}\text{-}\bar{5}$)
$A$ (313, $1\text{-}\bar{3}$)
$\xi$ (312, $\frac{3}{2}\text{-}\bar{3}$)
$\zeta$ (311, $3\text{-}\bar{3}$)
$\Sigma$ (211, $2\text{-}\bar{2}$)
$\phi$ (535, $1\text{-}\overline{\tfrac{5}{3}}$)
$\psi$ (532, $\frac{5}{2}\text{-}\overline{\tfrac{5}{3}}$)

$x$ (461, $6\text{-}\breve{\tfrac{3}{2}}$)
$h_1$ (356, $\frac{5}{6}\text{-}\breve{\tfrac{5}{3}}$)
$\Xi$ (354, $\frac{5}{4}\text{-}\breve{\tfrac{5}{3}}$)
$\chi$ (352, $\frac{5}{2}\text{-}\breve{\tfrac{5}{3}}$)

$y$ (351, $5\text{-}\breve{\tfrac{5}{3}}$)
$F$ (591, $9\text{-}\breve{\tfrac{9}{5}}$)
$z$ (7·13·3 $\frac{13}{3}\text{-}\breve{\tfrac{13}{7}}$)
$H$ (122, $1\text{-}\breve{2}$)
$u$ (243, $\frac{4}{3}\text{-}\breve{2}$)
$R$ (121, $2\text{-}\breve{2}$)
$\rho$ (241, $4\text{-}\breve{2}$)
$\Gamma$ (371, $7\text{-}\breve{\tfrac{7}{3}}$)
$\sigma$ (258, $\frac{5}{8}\text{-}\breve{\tfrac{5}{2}}$)
$\omega_1$ (5·15·27, $\frac{5}{9}\text{-}\breve{3}$)
$\omega_2$ (135, $\frac{3}{5}\text{-}\breve{3}$)
$\omega$ (134, $\frac{3}{4}\text{-}\breve{3}$)
$\omega_3$ (3·9·11, $\frac{9}{11}\text{-}\breve{3}$)
$\omega_4$ (267, $\frac{6}{7}\text{-}\breve{3}$)
$\omega_5$ (3·9·10, $\frac{9}{10}\text{-}\breve{3}$)
$\omega_6$ (13·39·40, $\frac{39}{40}\text{-}\breve{3}$)
$f$ (133, $1\text{-}\breve{3}$)
$v$ (132, $\frac{3}{2}\text{-}\breve{3}$)

$w$ (131, $3\text{-}\breve{3}$)
$t_1$ (3·11·6, $\frac{11}{6}\text{-}\breve{\tfrac{11}{3}}$)
$W$ (3·11·3, $\frac{11}{3}\text{-}\breve{\tfrac{11}{3}}$)
$T$ (142, $2\text{-}\breve{4}$)
$\mu$ (281, $8\text{-}\breve{4}$)
$t_2$ (3·13·6, $\frac{13}{6}\text{-}\breve{\tfrac{13}{3}}$)
$n_2$ (156, $\frac{5}{6}\text{-}\breve{5}$)
$K$ (155, $1\text{-}\breve{5}$)
$n$ (153, $\frac{5}{3}\text{-}\breve{5}$)
$\vartheta$ (152, $\frac{5}{2}\text{-}\breve{5}$)
$\gamma$ (151, $5\text{-}\breve{5}$)
$\eta$ (3·15·1, $15\text{-}\breve{5}$)
$\nu_1$ (172, $\frac{7}{2}\text{-}\breve{7}$)
$\nu_2$ (193, $3\text{-}\breve{9}$)
$\nu_3$ (192, $\frac{9}{2}\text{-}\breve{9}$)
$\epsilon$ (2·22·7, $\frac{22}{7}\text{-}\breve{11}$)

Also uncertain (212, $1\text{-}\bar{2}$), (727, $1\text{-}\frac{7}{2}$), $\nu_4$ (4·21·13, $\frac{21}{13}\text{-}\breve{\tfrac{21}{4}}$) or (3·16·10, $\frac{8}{5}\text{-}\breve{\tfrac{16}{3}}$).

$\lambda\lambda''' = 23° 41'$
$mm''' = 64° 21'$
$UU' = 76° 57'$
$\pi\pi' = 55° 50'$

$\beta_1\beta_1' = 57° 8'$
$\beta\beta' = 94° 53'$
$gg' = 130° 41'$

$tt' = 49° 6'$

$kk' = 68° 50'$
$dd' = 107° 45'$
$ee' = 139° 54'$

$cq = 17° 50'$
$cM = 23° 13'$
$ch = 32° 45'$
$cP = {}^{*}52° 8' 40''$
$c\zeta = 73° 19\frac{1}{3}'$

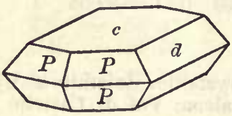
$c\Sigma = 66° 21'$
$cR = 60° 16'$
$cw = 66° 44'$
$c\gamma = 74° 27'$

$MM' = 38° 58\frac{1}{2}'$
$hh' = 54° 30\frac{1}{2}'$
$PP' = 83° 52'$
$a\Sigma = 29° 6'$

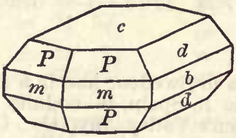
$MM''' = 24° 14'$
$hh''' = 33° 30'$
$PP''' = 49° 44'$
$\Sigma\Sigma''' = 31° 54\frac{1}{2}'$
$\zeta\zeta''' = 22° 41'$

$bw = 35° 44'$
$b\gamma = 23° 21'$
$bv = 47° 56'$

1.



2.



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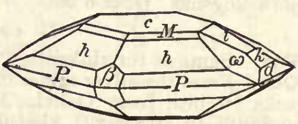

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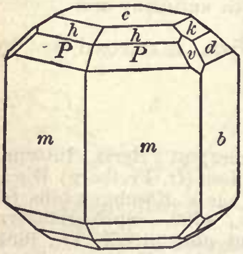

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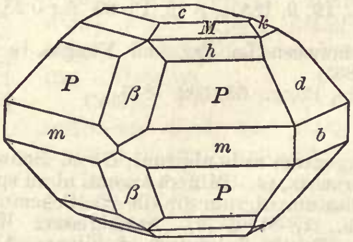
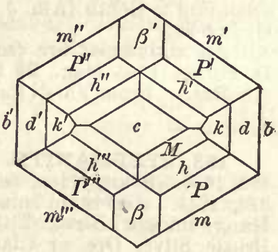


6.



Figs. 1, 2, Simple forms. 3, Přibram. 4, Andreasberg. 5, 6, Přibram. 3–6, Vrba.

Twins: tw. pl. (1) $m$, often repeated, hence pseudo-hexagonal; (2) $\pi$ (130); (3) $a$ or $b$, and comp.-face $c$, observed in hemimorphic crystals. Crystals usually short prismatic ‖ $\dot{c}$; also elongated ‖ $\breve{a}$, and tabular ‖ $c$. Hemimorphism[3] shown by want of symmetry in striations on $m$ ‖ edge $m/\Gamma$. Also massive, compact and disseminated.

Cleavage: *b*, *d* imperfect. Fracture subconchoidal to uneven. Brittle. H. = 2–2·5. G. = 6·2–6·3. Luster metallic. Color and streak iron-black. Opaque.

**Comp.**—$Ag_5SbS_4$ or $5Ag_2S.Sb_2S_3$ = Sulphur 16·3, antimony 15·2, silver 68·5 = 100.

**Anal.**—1, Frenzel, Jb. Min., 788, 1873. 2, Kolár, Zs. Kr., **5**, 435, 1881. Also 5th Ed., p. 106.

| | | S | Sb | Ag |
|---|---|---|---|---|
| 1. Freiberg | G. = 6·28 | 16·49 | 15·76 | 68·64 = 100·89 |
| 2. Přibram | G. = 6·271 | 15·61 | 16·48 | 67·81 Cu, Fe *tr*. = 99·90 |

**Pyr.**—In the closed tube decrepitates, fuses, and after long heating gives a faint sublimate of antimony oxysulphide. In the open tube fuses, giving off antimonial and sulphurous fumes. B.B. on charcoal fuses with projection of small particles, coats the coal with antimony trioxide, which after long blowing is colored red from oxidized silver, and a globule of metallic silver is obtained.

Soluble in dilute heated nitric acid, sulphur and antimony trioxide being deposited.

**Obs.**—In veins, with other silver ores, at Freiberg, Schneeberg, and Johanngeorgenstadt in Saxony (see Frenzel, Min. Lex. Sachs.); at Přibram and Ratieborzitz in Bohemia; at Schemnitz and Kremnitz in Hungary; at Andreasberg in the Harz; Kongsberg, Norway; Wheal Newton, Cornwall; Zacatecas and Guanajuato in Mexico; in Peru; Chañarcillo, Chili.

In Nevada, a rather abundant silver ore in the Comstock lode; at Ophir and Mexican mines in fine crystals; in the Reese river and Humboldt and other regions. In Idaho, at the silver mines at Yankee Fork, Queen's River district and elsewhere.

Named after the Archduke Stephan, Mining Director of Austria.

**Alt.**—Crystals occur altered to silver.

**Ref.**—[1] Přibram, Ber. Böhm. Ges., p. 119, 1886; closely similar results were obtained by Haidinger, Min. Mohs, **2**, 588, 1824; Schröder, Andreasberg, Pogg., **95**, 258, 1855; Morton, Kongsberg. Zs. Kr., **9**, 239, 1884.

[2] See Vrba's monograph for authorities, literature, many new forms, full list of calculated angles, etc.; also, earlier, Schröder, l. c.; Schimper, Min.-Samml. Strassburg, 69, 1878; Vrba, Zs. Kr., **5**, 418, 1881; Lewis, Wheal Newton, Zs. Kr., **7**, 574, 1883; Morton, l. c.; Rath, Mexico, Zs. Kr., **10**, 173, 1885. [3] Miers, Min. Mag., **9**, 1, 1890.

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**154. KILBRICKENITE.** *Apjohn*, L'Institut, **9**, 111, 1841 (read before R. Irish Acad., June 20, 1840).

Massive. G. = 6·407. Luster metallic. Color lead-gray.

**Comp.**—Perhaps $Pb_6Sb_2S_9$ or $6PbS.Sb_2S_3$ = Sulphur 16·3, antimony 13·6, lead 70·1 = 100.

**Anal.**—Apjohn, l. c.

| | S | Sb | As | Pb | Cu | Fe |
|---|---|---|---|---|---|---|
| G. = 6·407 | 16·36 | 14·39 | — | 68·87 | — | 0·38 = 100 |

**Obs.**—From Kilbricken, Co. Clare, Ireland.

**155. BEEGERITE.** *Koenig*, Am. Ch. J., **2**, 379, 1881.

Indistinctly crystallized (isometric ?). Also massive.

Cleavage apparently cubic. G. = 7·273 Koenig. Color light to dark gray. Luster brilliant metallic. Opaque.

**Comp.**—$Pb_6Bi_2S_9$ or $6PbS.Bi_2S_3$ = Sulphur 14·8, bismuth 21·4, lead 63·8 = 100. Silver is sometimes present.

**Anal.**—1, Koenig, l. c., 2·6 p. c. quartz deducted. 2. Id., Am. Phil. Soc., Philad., **22**, 212, 1885. 3, Genth, on 0·03 gr., ib., **23**, 37, 1886.

| | | S | Bi | Pb | Ag | Cu | |
|---|---|---|---|---|---|---|---|
| 1. Park Co. | | 14·97 | 20·59 | 64·23 | — | 1·70 = 101·49 | |
| 2. Ouray Co. | G. = 6·565 | 16·39 | 19·35 | 45·87 | 9·98 | 1·12 | Fe 2·89, insol. 0·12, loss 4·28 |
| 3. Park Co. | | [14·63] | 19·81 | 50·16 | 15·40 | — = 100 | [= 100 |

**Pyr.**—B.B. fuses on charcoal to a globule, giving lead and bismuth coatings; sulphurous fumes in the open tube. Dissolved by hydrochloric acid slowly in the cold, quickly on heating.

**Obs.**—From the Baltic Lode, near Grant P. O., Park Co., Colorado; also the Treasury Vault mine, Park Co. (anal. 3); Poughkeepsie Gulch, Ouray Co. Named after Mr. Hermann Beeger, of Denver.

RICHMONDITE *W. Skey*, Trans. N. Z. Inst., 9, 556, 1877. Massive, crystalline. Brittle H. = 4·5. G. = 4·317. Luster metallic. Color black, inclining to reddish in parts.

**Comp.**—Approximately $6RS.Sb_2S_3$, but needs further examination.

Analysis.—Skey, after deducting 15·4 gangue, $SiO_2$, etc., also some antimony oxysulphide:

| $Sb_2S_3$ | $Bi_2S_3$ | PbS | $Cu_2S$ | $Ag_2S$ | FeS | ZnS | MnS |
|---|---|---|---|---|---|---|---|
| 22·20 | *tr.* | 36·12 | 19·31 | 2·39 | 13·59 | 5·87 | 0·52 = 100 |

From Richmond Hill, New Zealand.

## 156. POLYBASITE.

Sprödglaserz pt. *Wern.* Polybasit *H. Rose*, Pogg., **15**, 573, 1829. Eugenglanz *Breith.*, Char., 266, 1832.

Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c} = 0·5793 : 1 : 0·91305$ Miers[1].

100 ∧ 110 = 30° 5′, 001 ∧ 101 = 57° 36$\frac{1}{3}$, 001 ∧ 011 = 42° 23$\frac{5}{6}$′.

**Forms:** *c* (001, *O*); *m* (110, *I*); *w* (019, $\frac{1}{9}$-ĭ), *n* (011, 1-ĭ), *t* (021, 2-ĭ); *r* (112, $\frac{1}{2}$), *p* (111, 1), *s* (221, 2).

*mm‴* = *60° 10′ *cr* = 42° 19½′ *rr′* = 71° 16′ *rr‴* = 39° 27′
*ww′* = 11° 35′ *cp* = *61° 14′ *pp′* = 98° 40′ *pp‴* = 52° 8′
*nn′* = 84° 48′ *cs* = 74° 39′ *ss′* = 113° 7′ *ss‴* = 57° 49′

In short six-sided tabular prisms, with beveled edges; *c* faces with triangular striations; in part repeated twins with tw. pl. *m*.

Cleavage: *c* imperfect. Fracture uneven. H. = 2–3. G. = 6·0–6·2. Luster metallic. Color iron-black, in thin splinters cherry-red. Streak black. Nearly opaque. Ax. pl. ∥ *a*. Bx ⊥ *c*. Ax. angle variable, 2E = 62° 44′, 78°, 88° 15′, Dx[2].

**Comp.**—$Ag_9SbS_6$ or $9Ag_2S.Sb_2S_3$ = Sulphur 15·0, antimony 9·4, silver 75·6 = 100. Part of the silver is replaced by copper, e.g., Ag : Cu = 8 : 1; also arsenic replaces antimony.

**Anal.**—1, H. Rose, l. c. 2, 3, Id., ibid., **28**, 156, 1833. 4, C. A. Joy, Rg., Min. Ch., 102, 1860. 5, Tonner [Lotos, 85, 1859], Jb. Min., 716, 1860. 6, Genth, Am. Phil. Soc., **23**, 39, 1886.

| | | S | Sb | As | Ag | Cu | Fe | Zn | |
|---|---|---|---|---|---|---|---|---|---|
| 1 Durango Mexico | | 17·04 | 5·09 | 3·74 | 64·29 | 9·93 | 0·06 | — | = 100·15 |
| 2. Schemnitz | | 16·83 | 0·25 | 6·23 | 72·43 | 3·04 | 0·33 | 0·59 | = 99·70 |
| 3. Freiberg | | 16·35 | 8·39 | 1·17 | 69·99 | 4·11 | 0·29 | — | = 100·30 |
| 4. Cornwall | | 15·87 | 5·46 | 3·41 | 72·01 | 3·36 | 0·34 | — | = 100·45 |
| 5. Přibram | G. = 6·03 | 15·55 | 11·53 | — | 68·55 | 3·36 | 0·14 | — | = 99·13 |
| 6. Colorado | G. = 6·01 | [16·70] | 10·18 | 0·78 | 62·70 | 9·57 | 0·07 | — | = 100 |

**Pyr., etc.**—In the open tube fuses, gives sulphurous and antimonial fumes, the latter forming a white sublimate, sometimes mixed with crystalline arsenic trioxide. B.B. fuses with spirting to a globule, gives off sulphur (sometimes arsenic), and coats the coal with antimony trioxide; with long-continued blowing some varieties give a faint yellowish white coating of zinc oxide, and a metallic globule, which with salt of phosphorus reacts for copper, and cupelled with lead gives pure silver. Decomposed by nitric acid.

**Obs.**—Occurs in the mines of Guanajuato and Guadalupe y Calvo in Mexico; also at Guarisamez in Durango, with chalcopyrite and calcite; at Tres Puntos, desert of Atacama, Chili; at Freiberg and Přibram. In Nevada, at the Reese mines and at the Comstock Lode; in Idaho, at the silver mines of the Owhyhee district. In Colorado, at the Terrible Lode, Clear Creek Co., with argentiferous galena and pyrite. In Arizona, at the Silver King mine.

Named from πολύς, *many*, and βάσις, *base*, in allusion to the many metallic bases present.

**Alt.**—Stephanite and pyrite occur as pseudomorphs after polybasite.

**Ref.**—[1] Min. Mag., 8, 204, 1889. [2] N. R., 85, 1867.

## 157. POLYARGYRITE.

*Sandberger*, Jb. Min., 310, 1869. *Petersen*, Pogg., **137**, 386, 1869.

Isometric. In cubo-octahedrons, usually distorted and indistinct; *d* (110, *i*), *x* (*hll*, *m-m*) also observed.

Cleavage: cubic. Fracture uneven. Malleable and sectile. H. = 2·5. G. = 6·974. Luster metallic. Color iron-black to blackish gray. Streak black. Opaque.

**Comp.**—$Ag_{24}Sb_2S_{15}$ or $12Ag_2S.Sb_2S_3$ = Sulphur 14·5, antimony 7·4, silver 78·2 = 100.

**Anal.**—Petersen, l. c.

| | S | Sb | Ag | Pb | Fe | Zn |
|---|---|---|---|---|---|---|
| G. = 6·974 | 14·78 | 6·98 | 76·70[a] | *tr.* | 0·36 | 0·30 = 99·12 |

[a] Mean of 76·63 and 76·77; another sample gave 78·85 p. c.

**Pyr.**—B.B. on charcoal fuses easily to a black globule, giving off antimonial fumes, and yielding a brittle globule of silver. Soluble with difficulty in nitric acid with separation of sulphur, readily by fuming acid.

**Obs.**—Occurs at Wolfach in Baden with argentite, etc.

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## II. Sulpharsenates, Sulphantimonates, etc.

### Enargite Group.

| | | | | |
|---|---|---|---|---|
| 158. | **Enargite**<br>Clarite, Luzonite | $3Cu_2S.As_2S_5$ | Orthorhombic | $\breve{a}:\bar{b}:\dot{c} = 0·8711:1:0·8248$ |
| 159. | **Famatinite** | $3Cu_2S.Sb_2S_5$ | | |
| 160. | **Xanthoconite** | $3Ag_2S.As_2S_5$ | Rhombohedral | $rr' = 108° 25'$ $\dot{c} = 2·3163$ |
| 161. | **Epiboulangerite** | $3PbS.Sb_2S_5$ | | |
| 162. | **Epigenite**<br>Regnolite | $4Cu_2S.3FeS.As_2S_5$? | Orthorhombic | |
| 163. | **Argyrodite** | $3Ag_2S.GeS_2$ | Monoclinic | $\dot{a}:\bar{b}:\dot{c}$ 0·6780 : 1 : 0·6144 $\beta = 70°$ |

**158, 159. ENARGITE—FAMATINITE.**

**158. ENARGITE.** Enargit *Breith.*, Pogg., 80, 383, 1850. Guayacanite *Field*, Am. J. Sc., 27, 52, 1859. Garbyite *W. Semmons*, Min. Mag., 6, pp. xxvi, 49, 124, 1884.

Orthorhombic. Axes: $\breve{a}:\bar{b}:\dot{c} = 0·8711:1:0·8248$ Dauber[1].

100 ∧ 110 = 41° 3½′, 001 ∧ 101 = 43° 26¼′, 001 ∧ 011 = *39° 31′.

**Forms**[2]:
$a$ (100, $i$-$\bar{\imath}$)
$b$ (010, $i$-$\breve{\imath}$)
$c$ (001, $O$)

$r$ (310, $i$-$\bar{3}$)[4]
$x$ (320, $i$-$\bar{\frac{3}{2}}$)[4,5] as tw. pl.
$m$ (110, $I$)
$h$ (120, $i$-$\breve{2}$)[4]

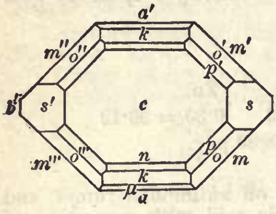
$l$ (130, $i$-$\breve{3}$)[3]
$\lambda$ (103, $\frac{1}{3}$-$\bar{\imath}$)[5]
$n$ (102, $\frac{1}{2}$-$\bar{\imath}$)
$k$ (101, 1-$\bar{\imath}$)

$\mu$ (201, 2-$\bar{\imath}$)
$s$ (011, 1-$\breve{\imath}$)
$\vartheta$ (051, 5-$\breve{\imath}$)[5]

**$q$ (115, $\frac{1}{5}$)**[3]
**$p$ (112, $\frac{1}{2}$)**
**$o$ (111, 1)**

| | | | |
|---|---|---|---|
| $rr'''$ = 32° 23′ | $\lambda\lambda'$ = 35° 2′ | $ss'$ = 79° 2′ | $pp'$ = 47° 17′ |
| $xx'''$ = 60° 17′ | $nn'$ = 50° 40′ | $\vartheta\vartheta'$ = 152° 44′ | $oo'$ = 72° 18′ |
| $mm'''$ = *82° 7′ | $kk'$ = 86° 52½′ | | $pp'''$ = 40° 53′ |
| $hh'$ = 59° 43′ | $\mu\mu$ = 124° 20′ | $cq$ = 14° 6′ | $oo'''$ = 61° 50′ |
| $ll'$ = 41° 53′ | | $cp$ = 32° 7½′ | |
| | | $co$ = 51° 28′ | |

Twins: tw. pl. *x* (320), with *a* *a̲* = 60° 17′, sometimes star-shaped trillings resembling chrysoberyl. Crystals usually small; prismatic planes vertically striated; also *c* ‖ edge *c*/*a*. Also massive, granular, or columnar.



Dauber.

Cleavage: *m* perfect; *a*, *b* distinct; *c* indistinct. Fracture uneven. Brittle. H. = 3. G. = 4·43–4·45. Luster metallic. Color grayish black to iron-black. Streak grayish black. Opaque.

**Comp.**—$Cu_3AsS_4$ or $3Cu_2S.As_2S_5$ = Sulphur 32·6, arsenic 19·1, copper 48·3 = 100. Some antimony is often present, thus graduating toward famatinite.

**Anal.**—1, Quoted by D'Achiardi, Nuov. Cimento, 3, May, 1870. 2, B. S. Burton, Am. J. Sc., **45**, 34, 1868. 3, E. W. Root, ib., **46**, 201. 4, E. S. D., ib., **6**, 127, 1873. 5, Siewert & Döring, Min. Mitth., 242, 1873. 6, Schickendantz, Domeyko, 3d App. Min. Chili, p. 26, 1871. 7, Terrill, Min. Mag., **6**, 50, 1884. Also 5th Ed., p. 108.

| | | S | As | Sb | Cu | Ag | Fe | Zn | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Morococha | | 37·45 | 15·23 | — | 33·25 | 0·04 | 5·66 | 7·72 | Pb *tr.* = 99·35 |
| 2. Willis Gulch, Col. | G.=4·43 | 31·56 | 17·80 | 1·37 | 47·58 | — | 1·04 | — | = 99·35 |
| 3. Alpine Co., Cal. | G.=4·34 | 31·66 | 13·70 | 6·03 | 45·95 | — | 0·72 | — | $SiO_2$ 1·08 = 99·14 |
| 4. Shoebridge mine, Utah | G.=4·861 | 34·35 | 17 20 | 0 95 | 46·94 | *tr.* | 1·06 | *tr.* | = 100·50 |
| 5. Famatina Mts. | G.=4·36 | 30·48 | 17·16 | 1·97 | 47·83 | — | 1·31 | 0·52 | Pb 0·73 = 100 |
| 6. Catamarca | | 33·40 | 18·78 | — | 48·05 | — | 0·36 | — | = 100·59 |
| 7. Montana | G.=4·3 | 32·69 | 19·47 | — | 47·84 | — | — | — | = 100 |

**Pyr.**—In the closed tube decrepitates, and gives a sublimate of sulphur; at a higher temperature fuses, and gives a sublimate of sulphide of arsenic. In the open tube, heated gently, the powdered mineral gives off sulphurous and arsenical fumes, the latter condensing to a sublimate containing some antimony trioxide. B.B. on charcoal fuses, and gives a faint coating of the oxides of arsenic, antimony, and zinc; the roasted mineral with the fluxes gives a globule of metallic copper. Soluble in aqua regia.

**Obs.**—From Morococha, Cordilleras of Peru, at a height of 15,000 feet, in large masses, occasionally with small druses of crystals, along with tennantite, embedded in crystalline limestone; Cordilleras of Chili (*guayacanite*); mine of Hediondas, Prov. Coquimbo; mines of Santa Anna, U. S. of Colombia, in cavities in quartz; Argentine Republic at several mines in the Sierra de Famatina, also in the province of Catamarca; at Cosihuirachi in Mexico. In twin crystals at Matzenköpfl, Brixlegg, Tyrol; and in similar twins from Mancayan, island of Luzon.

In the U. S., at Brewer's gold mine, Chesterfield district, S. Carolina; in Colorado, at mines near Black Hawk and Central City, Gilpin Co.; in Park Co., at the Missouri mine; also on Red mountain in San Juan and Ouray counties. In southern Utah at the Shoebridge mine in crystals and massive; also massive, cleavable at the Mammoth and American Eagle mines in the Tintic district, where it appears as the parent mineral of a number of copper arsenates; at several mines near Butte, Montana, associated with chalcocite, bornite, etc. Morning Star mine, Alpine county, California.

**Ref.**—[1] Pogg., **92**, 237, 1854. [2] Dauber, Peru. l. c., he adds as doubtful (310), (210), (130), (403), (132), but see below. [3] Zeph., Brixlegg, Zs. Kr., 3, 600, 1879. [4] Rath, Argentine Repub., ib., **4**, 426, 1880. [5] Zettler, Luzon, Jb. Min., **1**, 159 ref., 1880.

LAUTITE *Frenzel*, Min. Mitth., 3, 515; **4**, 97, 1881. Described as having the composition (Cu,Ag)AsS, from Lauta, near Marienberg, Saxony. Later shown to be a mechanical mixture of arsenic with a mineral near enargite, cf. Weisbach, Jb. Min., **2**, 250, 1882.

LUZONITE *Weisbach*, Min. Mitth., 257, 1874.

Massive with uneven fracture. Brittle. H. = 3·5. G. = 4·42. Luster metallic. Color dark reddish steel-gray. Streak black.

**Comp.**—$Cu_3AsS_4$ or $3Cu_2S.As_2S_5$ like enargite, with which it is regarded as being dimorphous.

Analysis.—Winkler, l. c.

S 33·14 As 16·52 Sb 2·15 Cu 47·51 Fe 0·93 = 100·25

**Obs.**—Occurs in the copper veins of Mancayan, district of Lepanto, Island of Luzon, associated with the following minerals, named in the order of their deposition: quartz, pyrite (luzonite), enargite, quartz, tetrahedrite, barite. See p. 1041.

CLARITE *Sandberger*, Jb. Min. 960, 1874; 382, 1875. Another mineral having the composition of enargite. Regarded as monoclinic with cleavage *a*, *b*. In tufted groups of crystals. H. = 3·5. G. = 4·46. Luster metallic. Color dark lead-gray. Analysis.—Petersen:

S 32·92 As 17·74 Sb 1·09 Cu 46·29 Fe 0·83 Zn *tr.* = 98·87

Occurs on barite at the Clara mine, near Schapbach, Baden. Sometimes altered to chalcopyrite and covellite.

Note also remarks under binnite, p. 119.

**159. FAMATINITE.** *Stelzner*, Min. Mitth., 242, 1873.

Orthorhombic; isomorphous with enargite. Observed forms[1]: *a*, *c*, *m*, *l*. Also massive, sometimes reniform.

Fracture uneven. Rather brittle. H. = 3·5. G. = 4·57. Color gray with a tinge of copper-red. Streak black. Opaque.

**Comp.**—$Cu_3SbS_4$ or $3Cu_2S.Sb_2S_5$ = Sulphur 29·3, antimony 27·4, copper 43·3 = 100. Arsenic replaces the antimony in part.

**Anal.**—1, 2, Siewert, Min. Mitth., 242, 1873. 3*a*, Frenzel, Jb. Min., 679, 1875. 3*b*, id., after deducting 13·8 pyrite assumed to be present.

| | | | S | Sb | As | Cu | Fe | Zn | Gangue | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Mej. Upulungos mine | G. = 4·59 ⅔ | 29·17 | 21·23 | 4·07 | 44·12 | 0·82 | 0·59 | — | = 100 |
| 2. | Mej. Verdiona mine | G. = 4·52 ⅔ | 29·63 | 20·54 | 3·63 | 45·34 | 0·51 | 0·59 | 0·63 | = 100·87 |
| 3*a*. | Peru | | 33·46 | 10·93 | 7·62 | 41·11 | 6·43 | — | — | = 99·55 |
| 3*b*. | " | | 30·45 | 12·74 | 8·88 | 47·93 | — | — | — | = 100 |

**Pyr.**—In the closed tube decrepitates, giving off sulphur readily, and on stronger heating also some sulphide of antimony. On charcoal gives off white fumes of antimony, leaving a black, brittle metallic globule.

**Obs.**—Occurs with enargite, chalcopyrite, pyrite, etc., in the Sierra de Famatina, Argentine Republic. Also found at Cerro de Pasco, Peru.

**Ref.**—[1] Rath, Zs. Kr., 4, 426, 1880, Ber. nied. Ges., Nov. 4, 1878. See p. 1041.

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**160. XANTHOCONITE.** Xanthokon *Breith.*, J. pr. Ch., 20, 67, 1840.

Rhombohedral. Axis $\dot{c}$ = 2·3163; *cr* = *69° 30′, *rr*′ = 108° 25′ Breith.[1] Observed forms: *c* (0001, *O*), *r* (10$\bar{1}$0, *R*), *e* (02$\bar{2}$1, − 2). *ce* = 79° 25′. In thin tabular crystals. Also reniform masses with granular structure.

Cleavage: *c*, *r*. Brittle. H. = 2. G. = 5·0–5·2; 4·11–4·16 Breith. Luster adamantine. Color orange-yellow to dull red or clove-brown. Streak yellow. Transparent to translucent.

**Comp.**—$Ag_3AsS_4$ or $3Ag_2S.As_2S_5$=Sulphur 24·3, arsenic 14·3, silver 61·4 = 100.

**Anal.**—Plattner, Pogg., 64, 275, 1845.

| | S | As | Ag | Fe | |
|---|---|---|---|---|---|
| 1. *Brown* | 21·36 | [13·49] | 64·18 | 0·97 | = 100 |
| 2. *Yellow* | 21·80 | [14·32] | 63·88 | — | = 100 |

**Pyr.**—In the closed tube, at a gentle heat, the yellow color is changed to dark red, but on cooling it regains its original color; at a higher temperature fuses, and gives a faint sublimate of sulphide of arsenic. In the open tube, and on charcoal, behaves like proustite.

**Obs.**—Occurs with stephanite at the Himmelsfürst mine near Freiberg.

Named in allusion to its yellow powder, from ξανθός, *yellow*, and κονις, *powder*.

**Ref.**—[1] Pogg., 64, 272, 1845.

**161. EPIBOULANGERITE.** *M. Websky*, Zs. G. Ges., 21, 747, 1869.

Orthorhombic? occurring in striated prismatic needles. G. = 6·309. Luster metallic. Color dark bluish gray, almost black. Structure granular, acicular.

**Comp.**—$Pb_3Sb_2S_8$ or $3PbS.Sb_2S_5$=Sulphur 21·5, antimony 23·0, lead 55·5=100.

**Anal.**—1, 2, Websky:

| | S | Sb | Pb | Ni | Fe | Zn | |
|---|---|---|---|---|---|---|---|
| 1. Granular | 21·89 | 20·77 | 56·11 | 0·20 | 0·60 | 0·29 | = 99·86 |
| 2. Needles | 21·31 | 20·23 | 54·88 | 0·30 | 0·84 | 1·32 | = 98·88 |

Websky considers the mineral as probably a product of the decomposition of boulangerite from which it differs in containing more sulphur and correspondingly less antimony

**Obs.**—Found with galena, pyrite, sphalerite, and arsenopyrite at Altenberg in Silesia

**162. EPIGENITE.** Arsenwismuthkupfererz *Sandberger*, Jb. Min., 415, 1868. Epigenit *Id.*, ibid., 205, 1869.

Orthorhombic. In short prisms (69° 10′) with macrodome and brachydome, resembling arsenopyrite.

Fracture uneven. H. = 3·5. Luster metallic. Color steel-gray. Streak black. Opaque.

**Comp.**—Perhaps (Groth) $R_7As_2S_{12}$ with $R_7 = 4Cu_2 + 3Fe$, or $4Cu_2S.3FeS.As_2S_5$ = Sulphur 31·5, arsenic 12·3, copper 41·5, iron 14·7 = 100.

**Anal.**—Petersen, Pogg., **136**, 502, 1869, after deducting 5 p. c. wittichenite.

S 32·34 As 12·78 Cu 40·68 Fe 14·20 = 100

**Pyr.**—In the closed tube gives first sulphur, then sulphide of arsenic. B.B. on charcoal gives an arsenic reaction and a magnetic slag with copper globules. Soluble in nitric acid with separation of sulphur.

**Obs.**—Occurs sparingly at Neuglück mine in the Böckelsbach at Wittichen, Baden. So named from ἐπιγίγνεσθαι, *to follow after*, because always observed implanted upon the barite vein masses.

Regnolite *A. D'Achiardi*, I Metalli, **1**, 293, 294, 1883. Nuovo Cimento, **3**, May 1870. In tetrahedral crystals resembling (as it does in other characters) the sandbergerite with which it is associated.

Analysis:

S 37·45 As 15·23 Cu 33·25 Ag 0·04 Fe 5·66 Zn 7·72 Pb *tr.* = 99·35

Calculated composition essentially $Cu_7As_2S_{12}$ or $5CuS.FeS.ZnS.As_2S_5$ = Sulphur 39·5, arsenic 15·4, copper 32·6, iron 5·8, zinc 6·7 = 100.

From the Jucud mines near the source of the Jucud river, Cajamarca, Peru. Named after Dr. Carlo Regnoli.

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**163. ARGYRODITE.** *Weisbach*, Jb. Berg.-Hütt., 1886; Jb. Min., **2**, 67, 1886.

Monoclinic. Axes: $\grave{a} : \bar{b} : \grave{c} = 0·6780 : 1 : 0·6144$; $\beta = 70° = 001 \wedge 100$ Weisbach[1].

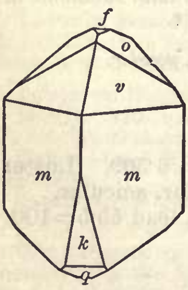
$100 \wedge 110 = 32° 30'$, $001 \wedge 101 = 33° 1\frac{1}{2}'$, $001 \wedge 011 = 30°$.

**Forms:** *m* (110, *I*), *f* ($\bar{1}03$, $\frac{1}{3}$-$\bar{i}$), *q* ($\bar{1}01$, 1-$\bar{i}$), *k* ($\bar{6}01$, 6-$\bar{i}$), *o* (011, 1-$\grave{i}$), *v* (232, $-\frac{3}{2}$-$\frac{3}{2}$)?, *n* ($\bar{6}91$, 9-$\grave{\frac{3}{2}}$)?.

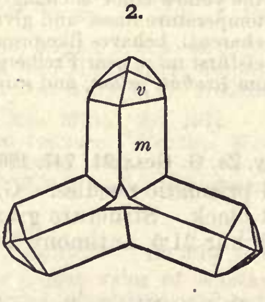
Angles: $mm''' = *65°$, $oo' = *60°$, $vv' = 58°$ (meas 50°), $mv = 31° 49'$, edge $m/m'' \wedge o/o' = *110°$, $\wedge v/v' = 143° 2'$ (141°), $\wedge k' = 169° 33'$ (170°), $\wedge q' = 120° 59'$ ($121\frac{1}{2}°$), $\wedge f = 92° 26'$ (96°).

Twins: tw. pl. ⊥ *k*, geniculated; also as trillings (f. 2). Crystals small and indistinct; usually grouped in verruciform or reniform shapes. Faces *k* brilliant; *f* somewhat less so; *o* smooth but rounded; *m* striated parallel edge *m/m*. Also in rounded forms and compact massive.

1.



2.



No cleavage observed. Fracture uneven to flat conchoidal. Somewhat brittle. H. = 2·5. G. = 6·085–6·111. Luster metallic. Color steel-gray, on a fresh fracture, with a tinge of red turning to violet. Streak grayish black, shining.

**Comp.**—A sulpho-salt containing silver and the rare element germanium, first discovered in this species, $3Ag_2S.GeS_2$ = Sulphur 18·2, germanium 8·3, silver 73·5 = 100.

**Anal.**—Winkler, l. c.

S 17·13 Ge 6·93 Ag 74·72 Fe 0·66 Zn 0·22 = 99·66

On the chemical properties of germanium see Winkler, J. pr. Ch., **34**, 177, 1886; **36**, 177, 1887. This new element has also been identified in euxenite.

**Pyr.**—In the closed tube gives a brilliant black sublimate; in the open tube fumes of sulphur dioxide. On charcoal fuses to a bead, giving near the assay a faint white sublimate; after long blowing an orange-yellow sublimate and a silver globule.

**Obs.**—Found at the Himmelsfürst mine, Freiberg, associated with siderite, marcasite abundant, also sphalerite, pyrite, galena, further argentite, pyrargyrite, polybasite, stephanite; implanted sometimes on argentite and again on marcasite or siderite.

**Ref.**—[1] L. c., the measurements only approximate; the symbols of some of the planes are doubtful because measured and calculated angles vary widely; perhaps *v* should be 454, for which we have $454 \wedge \bar{4}54 = 49° 35'$.

# IV. HALOIDS.—CHLORIDES, BROMIDES, IODIDES; FLUORIDES.

**I. Anhydrous Chlorides, Bromides, Iodides; Fluorides.**
**II. Oxychlorides; Oxyfluorides.**
**III. Hydrous Chlorides; Hydrous Fluorides.**

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## I. Anhydrous Chlorides, Bromides, Iodides; Fluorides.

### Calomel Group. $\overset{\text{I}}{R}_2Cl_2$.

| | | | | $\dot{c}$ |
|---|---|---|---|---|
| **164.** | **Calomel** | $Hg_2Cl_2$ | Tetragonal | 1·7229 |
| **165.** | **Nantokite** | $Cu_2Cl_2$ | Isometric | |

### Halite Group. $\overset{\text{I}}{R}Cl$, $\overset{\text{I}}{R}Br$, $\overset{\text{I}}{R}I$. Isometric.

Chlorides, etc., of sodium, potassium, ammonium, and silver.

| | | |
|---|---|---|
| **166.** | **Halite** | $NaCl$ |
| **167.** | **Sylvite** | $KCl$ |
| **168.** | **Sal Ammoniac** | $(NH_4)Cl$ |
| **169.** | **Cerargyrite** | $AgCl$ |
| **170.** | **Embolite** | $Ag(Cl,Br)$ |
| **171.** | **Bromyrite** | $AgBr$ |
| **172.** | **Iodobromite** | $Ag(Cl,Br,I)$ |
| | Silver Iodide (artif.) | $AgI$ |

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| | | | | |
|---|---|---|---|---|
| **173.** | **Iodyrite** | $AgI$ | Hexagonal | $\dot{c} = 0{\cdot}8196$ |
| | Tocornalite | $(Ag,Hg)I$? | | |
| | Coccinite | $HgI$? | | |

### Fluorite Group. $\overset{\text{II}}{R}Cl_2$, $\overset{\text{II}}{R}F_2$. Isometric.

| | | |
|---|---|---|
| **174.** | **Hydrophilite** | $CaCl_2$ |
| **175.** | **Fluorite** | $CaF_2$ |

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| | | | | |
|---|---|---|---|---|
| **176.** | **Chloromagnesite** | $MgCl_2$ | | |
| **177.** | **Sellaite** | $MgF_2$ | Tetragonal | $\dot{c} = 0{\cdot}6596$ |
| **178.** | **Lawrencite** | $FeCl_2$ | Hexagonal (artif.) | |
| **179.** | **Scacchite** | $MnCl_2$ | | |

| | | | | $\breve{a} : \bar{b} : \acute{c}$ |
|---|---|---|---|---|
| 180. | **Cotunnite** | $PbCl_2$ | Orthorhombic | 0·9976 : 1 : 1·6805 |

| | | | | |
|---|---|---|---|---|
| 181. | **Molysite** | $FeCl_3$ | Hexagonal (artif.) | $\frac{1}{2}\acute{c}$ = 0·6675 |
| 182. | **Tysonite** | $(Ce,La,Di)F_3$ | Hexagonal | $\acute{c}$ = 0·6868 |

| | | | | $\grave{a} : \bar{b} : \acute{c}$ | $\beta$ |
|---|---|---|---|---|---|
| 183. | **Cryolite** | $3NaF.AlF_3$ | Monoclinic | 0·9663 : 1 : 1·3882 | 89° 49′ |
| | Elpasolite | | Isometric | | |
| 184. | **Chiolite** | $5NaF.3AlF_3$ | Tetragonal | $\acute{c}$ = 1·0418 | |
| 185. | **Hieratite** | $2KF.SiF_4$? | Isometric | | |
| | Cryptohalite | $2(NH_4)F.SiF_4$ | | | |
| | Hydrofluorite | HF | | | |
| | Proidonite | $SiF_4$ | | | |

## Calomel Group. $\overset{I}{R}_2Cl_2$.

**164. CALOMEL.** Horn Mercury (fr. Deux Ponts) *Woulfe*, Phil. Trans., 618, 1776. Mine de mercure cornée *de Lisle*, Crist., 3, 161, 1783. Quecksilber-Hornerz *Wern.*, Bergm. J., 381, 1789. Horn Quicksilver; Dichloride of Mercury. Kalomel, Chlorquecksilber, Chlormercur, Quecksilberchlorür *Germ.* Mercure chloruré *Fr.* Calomelano *Ital.* Mercurio corneo *Ital.*, *Span.*

Tetragonal. Axis $\acute{c}$ = 1·72291; 001 $\wedge$ 101 = 59° 52′ 7″ Schrauf[1].

**Forms**[2]:
$c$ (001, $O$)
$a$ (100, $i$-$i$)
$m$ (110, $I$)
$\mu$ (710, $i$-7)
$g$ (610, $i$-6)[5]
$\xi$ (920, $i$-$\frac{9}{2}$)[4]
$q$ (105, $\frac{1}{5}$-$i$)[5]
$\gamma$ (104, $\frac{1}{4}$-$i$)
$z$ (103, $\frac{1}{3}$-$i$)
$t$ (102, $\frac{1}{2}$-$i$)[5]
$e$ (101, 1-$i$)
$\beta$ (504, $\frac{5}{4}$-$i$)[4]
$s$ (201, 2-$i$)
$k$ (401, 4-$i$)[4]
$\zeta$ (119, $\frac{1}{9}$)[3]
$h$ (114, $\frac{1}{4}$)[4]
$\alpha$ (113, $\frac{1}{3}$)
$y$ (559, $\frac{5}{9}$)[2]
$x$ (558, $\frac{5}{8}$)[2]
$i$ (112, $\frac{1}{2}$)
$r$ (111, 1)
$o$ (221, 2)[2]
$\beta$ (552, $\frac{5}{2}$)[4]
$p$ (331, 3)[2]
$\sigma$ (8·1·10, $\frac{4}{5}$-8)[3]
$f$ (614, $\frac{3}{2}$-6)[3]
$v$ (513, $\frac{5}{3}$-5)
$\phi$ (412, 2-4)[2]
$D$ (18·4·9, 2-$\frac{9}{2}$)[4]
$\rho$ (315, $\frac{3}{5}$-3)
$B$ (313, 1-3)[3]
$n$ (312, $\frac{3}{2}$-3)
$\psi$ (311, 3-3)[3]
$\lambda$ (14·5·10, $\frac{7}{5}$-$\frac{14}{5}$)[2]
$\pi$ (214, $\frac{1}{2}$-2)[2]

$a\mu$ = 8° 8′
$ag$ = 9° 28′
$a\xi$ = 12° 32′
$am$ = 45° 0′

$\gamma\gamma'$ = 32° 29′
$zz'$ = 41° 14′
$ee'$ = 75° 24′
$ss'$ = 85° 33′

$\gamma\gamma''$ = 46° 36′
$zz''$ = 59° 44′

$ee''$ = 119° 44′
$ss''$ = 147° 38′

$\alpha\alpha'$ = 52° 57′
$ii'$ = 66° 16′
$rr'$ = 81° 43′
$oo'$ = 87° 41′
$pp'$ = 88° 57′

$\alpha\alpha''$ = 78° 10′
$ii''$ = 101° 14′
$rr''$ = 135° 22′

$oo''$ = 156° 48′
$pp''$ = 164° 25′

$vv'$ = 63° 20′
$vv^{vii}$ = 21° 23½′
$\rho\rho'$ = 38° 28½′
$\rho\rho^{vii}$ = 26° 57′
$\beta\beta^{vii}$ = 32° 10′
$nn^{vii}$ = 34° 32′
$\psi\psi^{vii}$ = 36° 14½′
$\pi\pi^{vii}$ = 36° 9′

$a\alpha$ = 63° 31½′
$av$ = 21° 53′
$a\rho$ = 45° 39′
$an$ = 27° 3′
$a\pi$ = 51° 39′
$ar$ = 49° 9′
$a\psi$ = 21° 5′
$cv$ = 71° 9′
$c\rho$ = 47° 27½′

1. 2. 3.

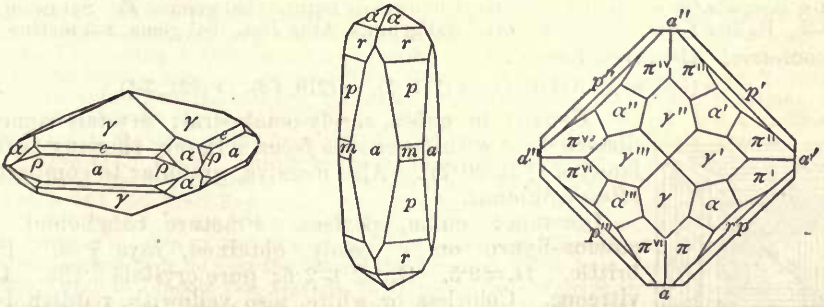

Fig. 1, El Doktor, Mexico, Websky[3]. 2, Moschellandsberg, Websky[3]. 3, Moschellandsberg, after Schrauf[1].

Twins: tw. pl. $e$, contact- and penetration-twins. Crystals sometimes tabular ‖ $c$; also pyramidal; often highly complex.

Cleavage: *a* rather distinct; also *r*. Fracture conchoidal. Sectile. H. = 1–2. G. = 6·482 Haid. Luster adamantine. Color white, yellowish gray, or ash-gray, also grayish, and yellowish white, brown. Streak pale yellowish white. Translucent—subtranslucent. Optically +. Double refraction strong. Indices·

$$\omega_r = 1·96 \qquad \epsilon_r = 2·60 \text{ Senarmont}^6$$

**Comp.**—Mercurous chloride, $Hg_2Cl_2$ = Chlorine 15·1, mercury 84·9 = 100.

**Pyr., etc.**—In the closed tube volatilizes without fusion, condensing in the cold part of the tube as a white sublimate; with soda gives a sublimate of metallic mercury. B.B. on charcoal volatilizes, coating the coal white. Insoluble in water, but dissolved by aqua regia; blackens when treated with alkalies.

**Obs.**—At Moschellandsberg in the Palatinate, coating the cavities of a ferruginous gangue, associated with cinnabar—crystals often large and well-defined; also at the quicksilver mines of Idria in Carniola; Almaden in Spain; Horzowitz in Bohemia; with cinnaber at Mt. Avala near Belgrade in Servia[5]. From El Doktor near Zimapan, Queretaro, Mexico[3].

Calomel is an old term of uncertain origin and meaning, perhaps from καλός, *beautiful*, and μελι, *honey*, the taste being sweet, and the compound the *Mercurius dulcis* of early chemistry; or from καλός and μέλας, *black*.

**Ref.**—[1] Schrauf, Atlas, Tf. XL, 1872; cf. earlier Brooke, Ann. Phil., **6**, 285, 1823; Sbs. artif. cryst., Ber. Ak. Wien, **9**, 394, 1852; Hbg., Abh. Senck. Ges., **1**, 24, 1854–5. [2] See Schrauf, l. c. [3] Websky, El Doktor, Mexico, Ber. Ak. Berlin, 461, 1877; also $\psi_3$ (3·1·11), $\rho_1$ (5·3·11), and $\rho_2$ (419) doubtful. [4] Traube, Mt. Avala, Belgrade, Zs. Kr., **14**, 571, 1888. [5] Vrba, Mt. Avala, ib., **15**, 455, 1885. [6] Quoted by Dx., Propr. Opt., **1**, 40, 1857.

MERCURIC CHLORIDE.—The occurrence of native corrosive sublimate ($HgCl_2$) is reported by Besnou near Iquique, in the desert of Atacama; the determination, however, was based only on some qualitative trials. Assoc. Franc. Adv. Sc., 533, 1878. The artificial salt is orthorhombic, cf. Rg., Kr. Ch., 257, 1881.

**165. NANTOKITE.** Nantoquita *Sieveking, Domeyko*, 2d App., Min. Chili, 51, 1867; 3d App., 22, 1871. Nantokit *Breith.*, B. H. Ztg., **27**, 3, 1868; Jb. Min., 814, 1872.

Isometric. Granular, massive, not in distinct crystals; artificial crystals tetrahedral.

Cleavage: cubic. Fracture conchoidal. H. = 2–2·5. G. = 3·930. Luster adamantine. Colorless to white or grayish. Transparent to translucent.

**Comp.**—Cuprous chloride, $Cu_2Cl_2$ = Chlorine 35·9, copper 64·1 = 100.

An analysis by Sieveking (l. c.) gave: Cl 35·52, Cu 64·17 = 99·69.

**Pyr.**—B.B. on charcoal fuses, coloring the flame intensely azure-blue; a globule of copper finally remains. Easily soluble in hydrochloric and nitric acids, also in ammonia. Gives off chlorine when struck with a hammer. Oxidizes readily on exposure to the air.

**Obs.**—Occurs with cuprite, native copper, and hematite, also chalcocite and other copper minerals at the mine Carmen Bajo, near Nantoko, Chili. Atacamite is sometimes formed by the oxidation of nantokite.

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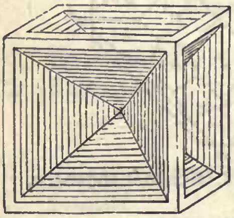
## Halite Group. RCl, etc.

**166. HALITE.** COMMON OR ROCK SALT. Muriate of Soda, Sodium Chloride. Kochsalz, Steinsalz, Bergsalz *Germ.* Soude muriatée, Chlorure de sodium, Sal gemme *Fr.* Sal mare *Beud.*, Tr., 1832 Halites *Glock.*, Syn., 290, 1847. Sal gemma, Alite *Ital.* Sal gema, Sal marina, *Span.*

Isometric. Observed forms[1]:

*a* (100, *i-i*), *d* (110, *i*), *o* (111, 1), *e* (210, *i*-2), *s* (321, 3-$\frac{3}{2}$).



Usually in cubes, rarely octahedral; crystals sometimes distorted, or with cavernous faces. Rarely showing twinning lamellæ (∥ 20·20·7)[2]. Also massive, granular to compact; less often columnar.

Cleavage: cubic, perfect. Fracture conchoidal. Percussion-figure on *a* easily obtained, rays ∥ *d*. Rather brittle. H.=2·5. G.=2·1–2·6; pure crystals 2·135. Luster vitreous. Colorless or white, also yellowish, reddish, bluish, purplish. Transparent to translucent. Soluble; taste saline. Refractive index 1·5442 Na., Langley[3]. Highly diathermanous. Sometimes exhibits anomalous double refraction.

**Comp.**—Sodium chloride, NaCl = Chlorine 60·6, sodium 39·4 = 100. Commonly mixed with calcium sulphate, calcium chloride, magnesium chloride, and sometimes magnesium sulphate, which render it liable to deliquesce.

For analyses quoted and references to others, see 5th Ed., p. 112; also under sylvite for Scacchi's observations on Vesuvian chlorides with KCl (natrikalite *Adam*, Tabl. Min., 69, 1869).

S. W. Johnson attributes the bluish or indigo color of some varieties from Stassfurt to sodium subchloride, Ochsenius to the presence of sulphur; this color disappears on heating. Wittjen & Precht (Ber. Chem. Ges., **16**, 1454, 1883) regard the color as an optical effect due to the presence of thin cavities having parallel surfaces with gas inclusions; they find the color distributed in lines mostly ‖ *o*, seldom ‖ *a*.

**Pyr., etc.**—In the closed tube fuses, often with decrepitation; when fused on the platinum wire colors the flame deep yellow. Added to a salt of phosphorus bead which has been saturated with oxide of copper, it colors the flame a deep azure-blue. Dissolves readily in three parts of water.

**Obs.**—Common salt occurs in extensive but irregular beds in rocks of various ages, associated with gypsum, polyhalite, anhydrite, carnallite, clay, sandstone, and calcite; also in solution forming salt springs; similarly in the water of the ocean and salt seas.

In Europe and England occurs in the Triassic, associated with red marl or sandstone, but not confined to these rocks. At Durham, Northumberland, and Leicestershire, England, salt springs rise from the Carboniferous series; in the Alps, some salt works are supplied from Oolitic rocks; the famous mines of Cardona in Spain and Wieliczka in Poland are referred, the former to the Green Sand formation, and the latter to Tertiary rocks. Salt springs also occur in volcanic regions. In the United States the brines of New York come from Upper Silurian strata; those of Ohio, Pennsylvania, and Virginia, mostly from Devonian and Subcarboniferous beds; those of Michigan, mainly from the Subcarboniferous and Carboniferous; while in Louisiana, at Petit Anse, there is a thick bed of large extent of pure salt in the Post-tertiary or more recent deposits of the coast. Salt also occurs as an essential part of the efflorescences over the dry prairies and shallow ponds or lakes of the Rocky mountains, California, Atacama, etc.; and in most desert or semi-desert regions there are numerous salt lakes.

The principal mines of Europe are at Wieliczka, in Poland; at Hall, in Tyrol; Stassfurt, near Magdeburg; and along the range through Reichenthal in Bavaria, Hallein in Salzburg, Hallstadt, Ischl, and Ebensee, in Upper Austria, and Aussee in Styria; in Hungary, at Marmoros and elsewhere; in Transylvania; Wallachia, Galicia, and Upper Silesia; Vic and Dieuze in France; Valley of Cardona and elsewhere in Spain, forming hills 300 to 400 feet high; Bex in Switzerland; and Northwich in Cheshire, England. At Cheshire it occurs in a basin-shaped deposit, and is arranged in spheroidal masses, from 5 to 8 feet in diameter, which are composed of concentric coats, and present polygonal figures. It is but little contaminated with impurities, and is prepared for use by merely crushing it between iron rollers. At the Austrian mines, where it contains much clay, the salt is dissolved in large chambers, and the clay thus precipitated. After a time the water, saturated with the salt, is conveyed by aqueducts to evaporating houses, and the chambers, after being cleared out, are again filled.

Salt also occurs, forming hills and covering extended plains, near Lake Urumia, the Caspian Lake, etc. In Algeria; in Abyssinia. In India in enormous deposits in the Salt Range of the Punjab; thus at the Mayo mines there are five great beds having an aggregate thickness of 275 feet alternating with another of 275 feet of *Kallar* or impure salt. Also in the Kohát district immense beds, in one place exceeding 1000 feet in thickness; at Mandi in the northwestern Himalayas; also at the salt lakes of Rájputána, and as an important part of a saline efflorescence (*Reh*) in alluvial deposits at various points (Mallet). In China and Asiatic Russia; in South America, in Peru, and at Zipaquera and Nemocon, the former a large mine long explored in the Cordilleras of U. S. of Colombia; clear salt is obtained from the Cerro de Sal, San Domingo. Occasionally formed at the eruptions of Vesuvius, as in 1855, when it was found in cubes, incrustations, and stalactites.

In the United States, salt has been found in large amount in central and western New York. Salt wells (see below) had long been worked in this region, but the presence of rock salt was first discovered by boring in 1878, and since then the industry has been rapidly developed. Salt is now known to exist over a large area from Ithaca at the head of Cayuga lake, Tompkins Co., and Canandaigua lake, Ontario Co., through Livingston Co., also Genesee, Wyoming, and Erie Cos. The salt is found in beds with an average thickness of 75 feet, but sometimes much thicker, and at varying depths from 1000 to 2000 feet and more; the depth increases southward with the dip of the strata. The rocks belong to the Salina period of the Upper Silurian. Salt has also been found near Cleveland, Ohio, associated with gypsum; there are here several beds, the widest 164 feet including shale, at depths from 2154 to 2475 feet. Also in Washington Co., West Virginia, in the Holston and Kanawha valleys; in Kansas, in beds from 10 to 100 feet in thickness at a depth of 700 feet or more in Ellsworth, Rice, Reno, Kingman, and Harper counties; the salt beds lie near the base of the Trias; at Petite Anse, Louisiana (see above); along the Rio Virgin in Lincoln Co., Nevada, in extensive beds of great purity; in Utah, near Nephi, Juab Co., and Salina, Sevier Co.; in Arizona, on the Rio Verde, with thenardite, etc., and mostly impure; the headwaters of Salt river, and Tonto basin, Gila Co.; in California, at Dos Palmas, San Diego Co. In Canada, salts occurs in Bruce, Huron, and Lampton Cos., Ontario, along the eastern shore of Lake Huron; it was first found at Goderich in 1866 at a depth of 964 feet, also at Clinton at a depth of 1180 feet, and later at other points.

Brine springs are very numerous in the Middle and Western States. These springs are worked at Salina, Syracuse, and elsewhere, N. Y.; in the Kanawha Valley, Va.; Muskingum, Ohio; Michigan, at Saginaw and elsewhere; in Kentucky and Tennessee; also at Goderich, Ontario, Canada. The salt water is obtained by boring, and raised by means of machinery, and thence conveyed by troughs to the boilers, where it is evaporated by artificial heat; or to basins for evaporation by exposure to the heat of the sun.

Composition of Syracuse brines, according to analyses by Dr. C. A. Goessmann (private communication):

| | I. | II. | III. | IV. |
|---|---|---|---|---|
| NaCl | 16·7503 | 15·5317 | 18·2465 | 13·3767 |
| $CaSO_4$ | 0·5673 | 0·5772 | 0·5117 | 0·5234 |
| $CaCl_2$ | 0·1594 | 0·1533 | 0·1984 | 0·1037 |
| $MgCl_2$ | 0·1464 | 0·1444 | 0·1784 | 0·1336 |
| $MgBr_2$ | 0·0022 | 0·0024 | 0·0025 | 0·0017 |
| KCl | 0·0110 | 0·0109 | 0·0119 | 0·0086 |
| $FeCO_3$ | 0·0034 | 0·0044 | 0·0036 | 0·0015 |
| $H_2O$ | 82·3600 | 83·5757 | 80·8470 | 85·8508 |
| | 100 | 100 | 100 | 100 |

No. I has G. = 1·1300 at 16° Baumé and 20° C. No. II has G. = 1·1225 at 15° Baumé and 21° C. The Saginaw brines, Michigan, afford about 19·250 of salt.

Vast lakes of salt water exist in many parts of the world. Lake Timpanogos in the Rocky mountains, 4,200 feet above the level of the sea, now called the Great Salt Lake, is 2,000 square miles in area L. Gale found in this water 20·196 per cent. of sodium chloride (Stansb. Exped., cited in Am. J. Sc., **17**, 129, 1854). The Dead and Caspian seas are salt, and the waters of the former contain 20 to 26 parts of solid matter in 100 parts. Gmelin, who analyzed a portion of these waters of specific gravity 1·212, found them to contain $CaCl_2$ 3·336, $MgCl_2$ 12·167, NaCl 7·039, $CaSO_4$ 0·052, $MgBr_2$ 0·443, KCl 1·086, $AlCl_3$ 0·144, $NH_4Cl$ 0·007, $MnCl_2$ 0·161, = 24·435, with 75·565 water = 100. This result is given as corrected by Marchand.

An analysis of the water of Great Salt Lake (1869) by O. D. Allen (U. S. G. Surv. 40th Par. **2**, 433) gave:

| NaCl | $MgCl_2$ | $Na_2SO_4$ | $K_2SO_4$ | $CaSO_4$ | Cl |
|---|---|---|---|---|---|
| 79·11 | 9·75 | 6·22 | 3·58 | 0·57 | 0·57$^a$ = 100 |

$^a$ Excess.

Salt is obtained on a large scale commercially, in the U. S., by the evaporation of the waters of the Great Salt Lake, and in California from the sea-water in San Francisco Bay.

**Alt.**—Anhydrite, gypsum, polyhalite, occur as pseudomorphs after this species; also celestite, dolomite, quartz, hematite, pyrite; the removal of the salt cubes by their solution leaves a cavity which any mineral may then occupy. The hopper-shaped crystals often leave an impression of their form in clays.

**Ref.**—[1] Luedecke, Neu-Stassfurt, Zs. Nat. Halle, **58**, 662, 1885. [2] Brauns, Jb. Min., **1**, 126, 1889. [3] Am. J. Sc., **30**, 477, 1885, cf. also Lagerborg, Ak. H. Stockh. Bihang, **13** (1), No. 10, 1887. Cf. the researches of Melloni, Magnus, Tyndall; also recently Langley, l. c., et al., Baur, Wied. Ann., **19**, 17, 1883.

On *etching:* cf. Sohncke, Pogg., **157**, 329; Exner, ib., **158**, 319, 1876; Brauns, Jb. Min., **1**, 115, 1889. *Hardness:* Exner, Härte Kryst., p. 11, 1873. *Constants of elasticity:* Voigt, Pogg., Erg.-Bd., **7**, 1, 177, 1876, Jb. Min., Beil.-Bd., **4**, 232, 1885; Groth, Pogg., **157**, 115, 1876. *Double refraction:* Jb. Min., **1**, 165, 1883; by pressure, Wied. Ann., **39**, 440, 1890. *Dispersive power:* Ketteler, Wied. Ann., **31**, 322, 1887.

MARTINSITE *Karsten*, J. pr. Ch., **36**, 127, 1845. Halite containing 9 p. c. $MgSO_4$; from Stassfurt.

HUANTAJAYITE *Raimondi*, Domeyko, Min. Chili, 5th Append., 1876; Min. Pérou, p. 64, 1878. An argentiferous variety of halite, if homogeneous. Described as occurring in cubes, also in incrustations made up of minute cubic crystals, also fibrous. H. = 2. Color white, not altered by exposure. Transparent. Fragile, not sectile like cerargyrite. Composition: 20NaCl + AgCl; an analysis ($\frac{3}{8}$) gave: NaCl 89, AgCl 11 = 100. B.B. decrepitates and fuses easily: on charcoal yields silver with soda. Occurs in a calcareous gangue with cerargyrite, embolite, etc., at the mine of San Simon, Huantajaya, Tarapaca, Chili. Called *lechedor* by the miners.

HYDROHALITE *A lam*, Tabl. Min., p. 69, 1869. A hydrous sodium chloride described by Mitscherlich; see Hausm. Handb., p. 1459, 1847.

**167. SYLVITE.** Muriate of Potash (fr. Vesuvius) *Smithson*, Ann. Phil., **6**, 258, 1823. Chloride of Potassium, Potassium chloride. Chlorkalium, *Germ.* Sylvine *Beud.*, Tr., **2**, 511, 1832. Hoevelit *H. Girard*, Jahrb. Min., 568, 1863. Leopoldit *E. Reichardt*, Jahrb. Min. 331, 1866 Schätzellit and Hövellit (fr. Stassfurt), B. H. Ztg., **24**, 276, Ann. Ch. Phys., **5**, 318, 324.

Isometric. Observed forms[1]:

*a* (100, *i-i*) *q* (540, *i*-$\frac{5}{4}$) *τ* (722, $\frac{7}{2}$-$\frac{7}{2}$) *β* (322, $\frac{3}{2}$-$\frac{3}{2}$) *y* (845, $\frac{8}{5}$-2).
*o* (111, 1) *ξ* (711, 7-7) *n* (211, 2-2) *t* (421, 4-2)

Brauns has obtained by etching faces of 931 (9-3 r) as a trapezohedal hemihedral form[2].

Habit cubic; *a*, also *a* with *o*, most common. Also in granular crystalline masses, rarely columnar; compact.

Cleavage: cubic, perfect. Fracture uneven. Brittle. H. = 2. G. = 1·97-1·99 Prietze, l. c. Luster vitreous. Colorless, white, bluish or yellowish red from inclusions. Transparent when pure. Refractive index[3], $n_y$ = 1·49031 Na. Soluble; taste, much like that of common salt, but somewhat bitter. Sometimes exhibits anomalous double refraction. Highly diathermanous[4].

**Comp.**—Potassium chloride, KCl = Chlorine 47·6, potassium 52·4 = 100. Sometimes contains also sodium chloride.

A. Müller (Vh. Ges. Basel, 113, 1854) found a Vesuvian salt pure with only a trace of sodium. Scacchi (Contrib. Min. Vesuv., II, 23) gives analyses of fifteen varieties with K : Na = 100 : 6·2. 10 : 17·5, etc., up to 10 : 94·8; some of the varieties contained also the alkaline sulphates, with (K.Na)Cl : (K,Na)$_2$SO$_4$ = 100 : 0·43. 100 : 6·45. 100 : 4·50, etc. Prietze, quoted by Huyssen (Zs. G. Ges., **20**, 461, 1868, and Jb. Min., 484, 1868) found in some of the Stassfurt sylvite 12 to 13 p. c. NaCl and 0·5 SO$_3$, but other analyses of material carefully separated from halite showed the pure KCl.

**Pyr., etc.**—B.B. in the platinum loop fuses, and gives a violet color to the outer flame. Added to a salt of phosphorus bead, which has been previously saturated with oxide of copper, colors the O.F. deep azure-blue. Dissolves in water, 100 parts taking up 34·5 at 18·75° C. Heated with sulphuric acid gives off hydrochloric acid gas.

**Obs.**—Occurs at Vesuvius, about the fumaroles of the volcano. Also at Stassfurt, in the carnallite beds of the salt formation; at Leopoldshall (*leopoldite*); at Kalusz in Galicia, where with the accompanying picromerite it has been derived (Tschermak, l. c.) from the alteration of carnallite.

The compound is the *Sal digestivus Sylvii* of early chemistry, whence Beudant's name for the species.

**Ref.**—[1] Tschermak, Kalusz, Anz. Ak. Wien, p. 24, 1868; Ber. Ak. Wien, **63** (1), 308, 1871. [2] Jb. Min., **1**, 224, 1886; also, **1**, 121, 1889. [3] Stefan, Ber. Ak. Wien, **63** (2), 241, 1871. [4] Magnus, Pogg., **134**, 302, 1868.

For experiments in *elasticity*, see Voigt, Nachr. Ges. Gött., 330, 1888; on *hardness*, Exner, Härte Kryst., p. 37, 1873.

**168. SAL-AMMONIAC.** Natürliches Salmiak (fr. Bucharia) *J. G. Model*, Versuch über ein nat. Salmiak, Leipzig, 1758. Muriate of Ammonia; Chloride of Ammonium. Salmiak *Germ.* Ammoniaque muriatée *Fr.* Salmiac *Beud.*, Tr., 1832. Clorammonio *Ital.*

Isometric. Observed planes[1]:

*a* (100, *i-i*) *d* (110, *i*) *o* (111, 1) *n* (211, 2-2) *s* (321, 3-$\frac{3}{2}$)

Artificial crystals show trapezohedral hemihedrism in the form 875 ($\frac{8}{5}$-$\frac{8}{7}$ r) Tschermak[3]. Naumann[2] has described forms with 311 developed with tetragonal symmetry, and others with 411, 310, having rhombohedral symmetry.

Twins: tw. pl. *o*. Also stalactitic, and in globular masses; in crusts, or as an efflorescence.

Cleavage: *o* imperfect. Fracture conchoidal. Rather brittle. H. = 1·5–2. G. = 1·528. Luster vitreous. Color white, yellowish, grayish. Transparent to translucent. Index $n_y$ = 1·6422 Grailich.

**Comp.**—Ammonium chloride, $NH_4Cl$ = Chlorine 66·3, ammonium 33·7 = 100. Chloride of iron is sometimes present giving a yellow color.

**Pyr., etc.**—Sublimes in the closed tube without fusion. Pulverized with calcium hydrate, or heated with a solution of caustic alkali, gives off pungent ammoniacal vapors. Soluble in three times its weight of water.

**Obs.**—Occurs about volcanoes, as at Etna, the island of Vulcano, Vesuvius, Stromboli, Sandwich Islands, and near Hecla after the eruption of 1845, as observed by Bunsen. Observed after the eruption of Vesuvius in 1855, in rhombic dodecahedrons with cavernous faces, and again in the lava of 1868 (Scc., l. c.) in more complex crystals, in part twins. It occurs usually where the lava has spread over soil and vegetation. Also found in small quantities in the vicinity of ignited coal seams, as at St. Etienne in France, and also at Newcastle, and in Scotland; crystallized near Duttweiler in Prussia, where a coal seam has been burning for more than a hundred years. It occurs also in Bucharia; at Kilauea in Hawaii, a variety which contains iron, and becomes rusty yellow on exposure; in guano from the Chincha Islands.

The *ἅλς ἀμμωνιακός*, sal-ammoniac of Dioscorides, Celsius, and Pliny, is proved by Beckmann (Hist. of Inventions, **4**, 360) to be common rock salt, dug in Egypt, near the oracle of Ammon. The name was afterward transferred to this compound, when subsequently manufactured in Egypt. Sal-ammoniac is supposed to have been included by the ancients, with one or two other species, under the name of *nitrum*, which, according to Pliny, gave the test of ammonia when mingled with quicklime.

**Ref.**—[1] Scacchi. Rend. Acc. Napoli, Oct., 1872. [2] Naumann, J. pr. Ch., **50**, 11, 310, 1850. Min. Mitth., **4**, 531, 1881.

**169. CERARGYRITE.** Argentum cornu pellucido simile (fr. Marienberg), *Germ.* Hornfarbs-Silber, *Gesner*, Foss., 63, 1565. Argentum rude jecoris colore, lucem corneam habens (fr. Freiberg, etc.) *G. Fabricius*, De Rebus Met., 1566. Glaserz, dursichtig wie ein Horn in einer Lantern, *Matthesius*, Sarept., 1585. Horn-Silfver, Minera argenti cornea, A. sulphure et arsenico mineralisatum, *Wall.*, 310. 1747. Argento acido salis mineralisatum, Hornerz, *Cronst.*, 159, 1758. Buttermilcherz (first mentioned early in 17th century). Kerargyre *Beud.*, Tr., **2**, 501, 1832. Kerat *Haid.*, Handb., 506, 1845. Argyroceratite *Glock.*, Syn., 249, 1847. Chlorargyrit *Weisbach*, Synops. Min., 37, 1875. Kerargyrite.

Silberhornerz, Silberkerat, Hornsilber, Chlorsilber, *Germ.* Chlorsilfver, Silfverhornmalm *Swed.* Horn Silver, Corneous Silver. Argent muriaté, Argent corné, Chlorure d'argent *Fr.* Cherargirio, Argento cornea *Ital.* Plata cornea *Span.*

Isometric. Observed forms[1]:

*a* (100, *i-i*) *d* (110, *i*) *o* (111, 1) *p* (221, 2) *n* (211, 2-2)

Twins: tw. pl. *o*. Habit cubic. Usually massive and resembling wax; sometimes columnar; often in crusts.

Cleavage none. Fracture somewhat conchoidal. Highly sectile. H. = 1–1·5. G. = 5·552. Luster resinous to adamantine. Color pearl-gray, grayish green, whitish to colorless, rarely violet-blue; on exposure to the light turns violet-brown. Transparent to translucent. Index[2], $n_y$ = 2·0611 Na.

**Comp.**—Silver chloride = Chlorine 24·7, silver 75·3 = 100.

Some varieties contain mercury; Domeyko (Min. Chili, 3d Ed., p. 416, 1879) describes one from the La Julia mine, of the Cerro de Caracoles, Atacama, which yielded: Cl 22·64, Ag 66·68, Hg 2·20 = 91·52, with impurities and loss 8·48. Moesta gives 1·31 p. c. mercury for the cerargyrite of Los Bordos, Copiapo. See also huantajayite under halite (p. 156), and the species which follow.

**Pyr., etc.**—In the closed tube fuses without decomposition. B.B. on charcoal gives a globule of metallic silver. Added to a bead of salt of phosphorus, previously saturated with oxide of copper and heated in O.F., imparts an intense azure-blue to the flame. A fragment placed on a strip of zinc, and moistened with a drop of water, swells up, turns black, and finally is entirely reduced to metallic silver, which shows the metallic luster on being pressed with the point of a knife. Insoluble in nitric acid, but soluble in ammonia.

**Obs.**—Occurs in veins of clay slate, accompanying other ores of silver, and usually only in the higher parts of these veins. It has also been observed with ocherous varieties of brown iron ore; also with several copper ores, calcite, barite, etc.; upon stibiconite.

The largest masses, and particularly those of a green color, are brought from Peru, Chili, and Mexico, where it occurs with native silver. In Chili, at some mines, it is a much less common ore than embolite; often contains, intimately mixed with it, native silver in very minute grains; it occurs at Tres Puntas, Atacama, Chañarcillo near Copiapo, and elsewhere in Chili. Also in Nicaragua near Ocotal; in Dept. of Gracias, Honduras. It was formerly obtained in the mining districts of Johanngeorgenstadt and Freiberg, but is now rare; a mass weighing six and three-quarter pounds, from this region, is in the Zwinger collection at Dresden. It also occurs in the Altai, at the mines of Zmeinogorsk and Krukovskoi; at Kongsberg in Norway; in Alsace; rarely in Cornwall, and at Huelgoet in Brittany. In thin incrustations on stibiconite from Sonora, Mexico.

In the U. S., in Colorado, near Leadville, Lake Co.; near Breckenridge, Summit Co., and elsewhere. In Nevada, about Austin, Lander Co., abundant; at mines of Comstock lode. In Arizona, in the Willow Springs distr., veins of El Dorado cañon, in San Francisco distr. In Idaho, at the Poorman mine, in crystals, some half an inch across, mostly cubes and cubo-octahedrons, but occasionally with other planes, and in twins consisting of two interpenetrating cubes, the angles of one projecting from the faces of the other; also at various mines in Custer Co., Alturas Co., and at the Horn Silver and other mines, Tara Creek. In Utah, in Beaver, Summit and Salt Lake counties.

At Andreasberg in the Harz, an earthy variety is met with, called by the Germans Buttermilk ore (*Buttermilcherz, thonige Hornsilber*), which, according to Klaproth (Beitr., **1**, 137, 1795), contains: Silver 24·64, chlorine 8·28, alumina (Cu *tr.*) 67·08. Funckens describes it as "weiss und dünn wie eine Buttermilch" (Lenz Min., **2**, 101, 1794).

Named from *κέρας*, *horn*, and *ἄργυρος*, *silver*—*Ceratargyrite*, the proper derivative, being contracted to *Cerargyrite*. The Greek *k* becomes *c*, as in other cases.

**Ref.**—[1] Cf. Gdt.. Index, **1**, p. 437, 1886. [2] Wernicke, Pogg., **142**, 560, 1871.

Bordosite *Bertrand*, Ann. Mines, **1**, p. 412, 1872. A mineral substance, color yellow to red, occurring with amalgam and resulting from its decomposition. It becomes dark rapidly on exposure to the air. Analysis: AgCl 31·23, HgCl 45 53, HgO 22·70 = 99·46 Bertrand regards the HgO as adventitious, and proposes for it the name *hydrargyrite;* deducting this there remain: AgCl 40·69, and HgCl 59·31 = 100, or AgCl + HgCl, to which he gives the name of *bordosite*. Both species are very uncertain. Locality Los Bordos, Chili.

**170. EMBOLITE.** Chlorobromure d'argent *Domeyko*, Ann. Mines, **6**, 153, 1844; Berthier, ib., **2**, 540, 1842. Plata cornea verde *Domeyko*, Min., 202, 1845. Embolit *Breith.*, Pogg., **77**, 134, 1849. Chlorobromide of Silver. Chlorbromsilber. Megabromite, Microbromit, *Breith.*, B. H. Ztg., **18**, 449, 1859.

Isometric Observed forms:

*a* (100, *i-i*) *d* (110, *i*) *o* (111, 1) *e* (210, *i*-2)

Usually massive; sometimes stalactitic or concretionary on surface.

Cleavage none. Fracture uneven. Sectile. H. = 1–1·5. G. = 5·31–5·43 Domeyko; 5·53 Yorke; 5·79–5·81 Breith. Luster resinous, somewhat adamantine. Color grayish green and asparagus-green to yellowish green; yellow, often dark and becoming darker on exposure. Transparent to translucent.

**Comp.**—Ag(Cl,Br), the ratio of the chlorine to the bromine varying indefinitely, the yellowish varieties and those of deeper green colors containing the largest proportion of bromine.

**Anal.**—1, W. von Beck, Jb. Min., 165, 1876. 2, Munro, Ch. News, **53**, 99, 1886. 3, C. Wood quoted by Welch, ib., **54**, 94, 162, 1886.

| | Br | Cl | Ag |
|---|---|---|---|
| 1. Orenburg, *cryst.* | 28·44 | 8·20 | 63·36 = 100 |
| 2. St. Arnaud, Victoria | 25·84 | 9·70 | 64·45 = 99·99 |
| 3. " " | 24·16 | 10·73 | 65·14 = 100·03 |

For other analyses, see 5th Ed., p. 116, these show variations from AgCl = 81·4 and AgBr 18·6 to AgCl 51 and AgBr 49. Cf. Welch, l. c., for a discussion of the various analyses published.

The *megabromite* and *microbromite* of Breithaupt are varieties of embolite based on the proportion of bromide to chloride; and are even indistinct as varieties, these extremes being connected by indefinite shadings.

**Obs.**—Abundant in Chili, constituting the principal silver ore of the mines of Chañarcillo, and found also at Agua-Amarga, Tres-Puntas, Rosilla, and at all the new openings in the province of Copiapo; found also at Eulalia in Chihuahua, Mexico; at the mine of Coloal in Gracias, Honduras. At St. Arnaud, Victoria; in New South Wales, at Sunny Corner, Bathurst, and in the Silverton mines.

Named from *ἐμβόλιον, an intermediate*, because between the chloride and bromide of silver.

**171. BROMYRITE.** Bromure d'Argent, Plata verde *Mex.* (fr. Mexico and Huelgoet), *Berth.*, Ann. Mines, **19**, 734, 742, 1841, **2**, 526, 1842. Bromide of Silver; Bromic Silver. Bromsilber *Germ.* Bromit *Haid.*, Handb., 506, 1845. Bromyrite *Dana*, Min., 93, 1854. Bromargyrit *Rg.*, Min. Ch., 196, 1860. Plata cornea amarilla melada *Domeyko*, Min., 214, 1860.

Isometric. Observed forms:

*a* (100, *i-i*) *d* (110, *i*) *o* (111, 1)

Crystals rare. Usually in small concretions.

Cleavage none. Fracture uneven. Sectile. H. = 2–3. G. = 5·8–6. Luster resinous to adamantine. Color, when pure, bright yellow to amber-yellow; slightly greenish; often grass- or olive-green externally; little altered on exposure. Transparent to translucent. Index, $n_y$ = 2·2533 Na, Wernicke.

**Comp.**—Silver bromide, AgBr = Bromine 42·6, silver 57·4 = 100.

**Pyr., etc.**—In the closed tube and with metallic zinc reacts like cerargyrite. B.B. on charcoal emits pungent bromine vapors and yields a globule of metallic silver. Fused with potassium bisulphate in a matrass gives off yellowish brown vapors of bromine. Insoluble in nitric acid. Difficultly soluble in ammonia.

**Obs.**—With other silver ores in the district of Plateros, Mexico, and at the mine of San Onofre, seventeen leagues from Zacatecas, associated with cerargyrite and cerussite; also in crystals at Chañarcillo, Chili, with cerargyrite, sometimes embedded in calcite; also at Huelgoet in Brittany, with cerargyrite.

**172. IODOBROMITE.** Jodobromit *A. von Lasaulx*, Jb. Min., 619, 1878. Jodbromchlorsilber *Germ.*

Isometric. In octahedrons with cubic planes.

Cleavage: *o* indistinct. Sectile. Soft. G. = 5·713. Luster resinous. Color sulphur-yellow, sometimes greenish.

**Comp.**—$2AgCl.2AgBr.AgI$ = Chlorine 7·9, bromine 17·8, iodine 14·1, silver 60·2 = 100.

**Anal.**—Lasaulx, l. c.

Cl 7·09 Br 17 30 I 15·05 Ag 59·96 = 99·40

**Pyr., etc.**—B.B. on charcoal gives off bromine vapors and leaves a silver globule.

**Obs.**—Found in small cavities in ferruginous quartz at the "Schöne Aussicht" mine, near Dernbach, Nassau, associated with beudantite, carminite, and iodyrite.

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**173. IODYRITE.** Iodure d'Argent *Vauquelin*, Ann. Ch. Phys., **29**, 99, 1825; *Domeyko*, Ann. Mines, **6**, 158, 1844. Plata cornea amarilla clara *Domeyko*, Min., 205, 1845. Iodic Silver. Iodsilber *Germ.* Iodit *Haid.*, Handb., 506, 1845. Iodyrite *Dana*, Min., 95, 1854. Iodargyrit *Rg.*, Min. Ch., 197, 1860. Iodsilber, Jodsilber *Germ.* Argent ioduré *Fr.*

Hexagonal; hemimorphic. Axis $\dot{c} = 0·81960$; $0001 \wedge 10\bar{1}1 = 43° 25' 20''$ Zepharovich[1].

**Forms**[2]: *m* ($10\bar{1}0$, *I*) *e* ($30\bar{3}4$, $\frac{3}{4}$) as tw. pl. *g* ($30\bar{3}2$, $\frac{3}{2}$) *f* ($30\bar{3}1$, 3)
*c* (0001, *O*) *μ* ($10\bar{1}2$, $\frac{1}{2}$) *o* ($10\bar{1}1$, 1) *i* ($20\bar{2}1$, 2) *u* ($40\bar{4}1$, 4)

Also on artif. crystals[3]: *a* ($11\bar{2}0$, *i*-2); *ν* ($20\bar{2}3$, $\frac{2}{3}$)?, *e* ($30\bar{3}4$, $\frac{3}{4}$), *π* ($40\bar{4}5$, $\frac{4}{5}$)?; *β* ($9·9·\bar{18}·20$, $\frac{9}{10}$-2)?.

$c\mu = 25° 19'$ $ci = 62° 9'$ $cu = 75° 12'$ $ii' = 52° 28\frac{1}{2}'$
$ce = 35° 22'$ $cf = 70° 36'$ $oo' = 40° 12'$ $uu' = 57° 49'$
$cg = 54° 50'$

Iodyrite is homœomorphous with greenockite. An isometric form is also known,[4] into which the hexagonal form passes on increase of temperature, and conversely. The former change is accompanied by absorption of heat[5].

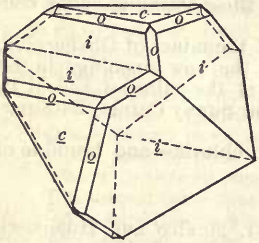
Natural crystals in hexagonal prisms; rarely twins[6] with tw. pl. *e*. Also massive, and in thin plates with a lamellar structure.

Cleavage: *c* perfect. Sectile, plates flexible.

Soft. G. = 5·60–5·70; 5·707 Dmr.; 5·609 Rath. Luster resinous to adamantine. Color citron- and sulphur-yellow to yellowish green, sometimes brownish. Streak yellow. Translucent. Index, $n_y = 2·1816$ Na, Wernicke.

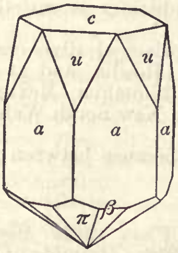
**Comp.**—Silver iodide, $AgI$ = Iodine 54, silver 46 = 100.

1.



New Mexico, Rath[6].

2.



Artif. cryst., Zeph[1].

**Pyr., etc.**—In the closed tube fuses and assumes a deep orange color, but resumes its yellow color on cooling. B.B. on charcoal gives fumes of iodine and a globule of metallic silver. With zinc reacts like cerargyrite and bromyrite. Fused with potassium bisulphate in a matrass, yields violet vapors of iodine.

**Obs.**—Occurs in thin veins or seams in hornstone at Albarradon, near Mazapil, in Mexico; at Algodones, 12 leagues from Coquimbo; less abundantly at Delirio mines of Chañarcillo, Chili, where the crystals are sometimes half an inch broad; also at Guadalajara in Spain. At Dernbach, Nassau, with iodobromite. In Arizona at Cerro Colorado mine. In New Mexico, with vanadinite and descloizite at Lake Valley, Sierra Co.

**Ref.**—[1] Artif. cryst., Zs. Kr., **4**, 119, 1879; Dx. obtained $\dot{c} = 0·81438$, Ann. Ch. Phys., **40**, 85, 1854. [2] See Dx., l. c. Also Slg., Dernbach, hemimorphic crystals with *c o i u* above and *c i* below; Chañarcillo *c m g i f* holohedral, Zs. Kr., **6**, 229, 1881. [3] Zeph., l. c., hemimorphic crystals with *o* above and below and *μ ν π β* only below. [4] Lehmann, Zs. Kr., **1**, 492, 1877. [5] Mallard and Le Chatelier, Bull. Soc. Min., **6**, 181, 1883; J. Phys., **4**, 305, 1885. [6] Rath, Lake Valley, New Mexico, Zs. Kr., **10**, 474, 1885.

TOCORNALITE *Domeyko*, 2d App. Min. Chili, 41, 1867. Plata iodurada mercurial. Granular massive. Color pale yellow, becoming darker on exposure. Streak yellow. An iodide of silver and mercury.

Analysis gave: Ag 33·80, Hg 3·90, I 41·77, siliceous residue 16·65 = 96·12. The loss is due to some water belonging with the residue, and probably some iodine. From the mines of Chañarcillo, Chili. Named after M. A. Tocornal, rector of the Santiago university.

Several minerals, chloro-iodides of silver and mercury but of variable composition, are mentioned by Domeyko, Min. Chili, 3d Ed., 431, 1879.

COCCINITE. Iodure de Mercure *Del Rio*, Ann. Mines, **5**, 324, 1829; *Beud.*, Tr., **2**, 515, 1832. Coccinit *Haid.*, Handb., 572, 1845. Mercure iodure *Fr.* Iodquecksilber *Germ.* Chlorselenquecksilber *del Castillo.*

In particles of a reddish brown color on selenide of mercury, adamantine in luster, at Casas Viejas, Mexico; and supposed by Del Rio to be an iodide of mercury. But Castillo says (Colegio de Min. Mexico, 1865) that specimens labeled by Del Rio contain no iodine, and appear to be largely chlorine and mercury, yet are not calomel. Castillo describes it from Zimapan and Culebras, both massive and in acute, acicular, rhombic pyramids, 2–6 mm. long; color fine red to yellow, and sometimes yellowish green, changing to greenish gray and dark green on exposure; transparent to translucent. In a closed tube affords a sublimate, white when cold, of $Hg_2Cl_2$, and leaves a residuum which is dull red while hot, orange-yellow when cold, and which B.B. turns aurora-red, and is dissipated with an odor like that of selenium.

ZIMAPANITE *Adam*, Tabl. Min., 70, 1869. A hypothetical vanadium chloride, credited to Del Rio.

BUSTAMENTITE *Adam*, Tabl. Min., 67, 1869. Hypothetical lead iodide, $PbI_2$, not known to occur in nature. The artificial compound is hexagonal, cf. Rg., Kr. Ch., 305, 1881.

ZINC IODIDE—ZINC BROMIDE.—Iodine and bromine are stated by Mentzel to occur along with a cadmiferous zinc in Silesia, and hence it is inferred that iodide and bromide of zinc exist in nature, though not yet distinguished. Ann. Mines, **5**, 324, 1829.

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## **Fluorite Group.** $\overset{\text{II}}{R}(Cl,F)_2$. Isometric.

**174. HYDROPHILITE.** Hydrophilit *Hausm.*, Handb., 857, 1813. Chlorure de Calcium, *Beud.*, Tr., **2**, 512, 1832. Clorocalcite *Scacchi*, Rend. Acc. Sc. Napoli, Oct. 12, 1872; Contrib. Min. Vesuv., II, 37 (Mem. Acc. Sc. Napoli, Dec. 13, 1873). Chlorocalcite.

Isometric. In cubic crystals, sometimes with *o* and *d*. As a crystalline or mealy incrustation.

G. = 2·2 artif. Color white, sometimes stained violet. Transparent to translucent. Taste bitter. Deliquesces readily.

**Comp.**—Calcium chloride, $CaCl_2$ = Chlorine 64·0, calcium 36·0 = 100.

The *chlorocalcite* from Vesuvius contained also the chlorides of potassium, sodium, and manganese.

**Pyr., etc.**—B.B. fusible. Very soluble in water, attracting moisture from the air and rapidly deliquescing.

**Obs.**—Occurs at Luneburg in anhydrite and gypsum, and associated with halite (Hausm.). At Vesuvius in crystals (*chlorocalcite*) in bombs of the eruption of April, 1872.

At Guy's Cliffe, Warwickshire, as an impure slimy exudation on sandstone. Mixed with clay in the province of Tarapaca and elsewhere in Peru. From crevices between ejected blocks near the middle of a solfatara in the crater of Barren island, Bay of Bengal, chiefly as a red and orange deliquescent incrustation mixed with ferric oxide and basic aluminium sulphate (Mallet).

Named from ὕδωρ, *water*, and φίλος, *friend*, in allusion to its hygroscopic properties.

The hydrous calcium chloride ($CaCl_2 + 6H_2O$) is known in artificial crystals belonging to the hexagonal system, cf. Rg., Kr. Ch., 265, 1881.

**175. FLUORITE** or FLUOR SPAR. Fluores lapides gemmarum similis sed minus duri—qui ignis calore liquescunt [whence he derives the name]—Colores varii, jucundi, (1) rubri, (2) purpurei (vulgo amethysti), (3) candidi, (4) lutei, (5) cineracei, (6) subnigri, etc. [with mention also of its use as a flux in smelting], *Agric.*, Berm., 458, 1529; *Germ.* Flusse *id.*, Interpr., 464, 1546. Fluor mineralis Stolbergicus, Lithophosphorus Suhlensis, *Woodward*, Cat., 1728. Glas-Spat, Spatum vitreum, *Wall.*, 64, 1747. Fluss, Flussspat, Glasspat, *Cronst.*, 93, 1758. Flussaures Kalk *Scheele*, Ak. H. Stockh., 1771. Calx fluorata *Bergm.*, Sciagr., 1782. Spath fusible, Spath vitreux, *de Lisle*, Crist., 1772, 1783. Fluorite *Napione*, Min., 373, 1797. Fluor Spar, Fluate of Lime, Fluoride of Calcium; Derbyshire Spar, Blue-john *Vulg.* Chaux fluatée *Fr.* Fluorine *Beud.*, Tr., 2, 517, 1832. Liparit *Glock.*, Syn. 282, 1847. Bruiachite *Macadam*, Min. Mag., **7**, 42, 1886. Fluorina, Spato fluore *Ital.* Espato fluor, Fluspat, *Span.*

*Var.*—Chlorophane (fr. Nerchinsk) *Th. De Grotthaus;* Delameth., J. de Phys., **45**, 398, 1794. Ratofkit *Fischer*, John, Ch. Unters., **6**, 232, 1812.

Isometric. Observed forms[1]:

$a$ (100, $i$-$i$)
$d$ (110, $i$)
$o$ (111, 1)
$\zeta$ (32·1·0, $i$-32)?
$\delta$ (610, $i$-6)
$\alpha$ (920, $i\text{-}\frac{9}{2}$)
$h$ (410, $i$-4)
$H$ (11·3·0, $i\text{-}\frac{11}{3}$)[7]?

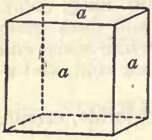
$F$ (10·3·0, $i\text{-}\frac{10}{3}$)[7]?
$f$ (310, $i$-3)
$k$ (520, $i\text{-}\frac{5}{2}$)
$K$ (12·5·0, $i\text{-}\frac{12}{5}$)[6]?
$\epsilon$ (730, $i\text{-}\frac{7}{3}$)
$e$ (210, $i$-2)
$l$ (530, $i\text{-}\frac{5}{3}$)
$N$ (443, $\frac{4}{3}$)[4]

$p$ (221, 2)
$q$ (331, 3)
$\rho$ (441, 4)[2]
$\nu$ (811, 8-8)
$\mu$ (411, 4-4)[9]
$\tau$ (722, $\frac{7}{2}\text{-}\frac{7}{2}$)
$m$ (311, 3-3)
$\omega$ (833, $\frac{8}{3}\text{-}\frac{8}{3}$)

$n$ (211, 2-2)
$\beta$ (322, $\frac{3}{2}\text{-}\frac{3}{2}$)
$z$ (25·6·2, $\frac{25}{2}\text{-}\frac{25}{6}$)
$w$ (821, 8-4)
$y$ (10·4·3, $\frac{10}{3}\text{-}\frac{5}{2}$)
$V$ (15·6·2, $\frac{15}{2}\text{-}\frac{5}{2}$)[10]
$u$ (732, $\frac{7}{2}\text{-}\frac{7}{3}$)[3]

$v$ (731, $7\text{-}\frac{7}{3}$)
$x$ (11·5·3, $\frac{11}{3}\text{-}\frac{11}{5}$)
$T$ (24·12·5, $\frac{24}{5}$-2)[8]?
$t$ (421, 4-2)
$s$ (321, $3\text{-}\frac{3}{2}$)
$\psi$ (20·14·3, $\frac{20}{3}\text{-}\frac{10}{7}$)[2]
$\phi$ (431, $4\text{-}\frac{4}{3}$)[5]

1.



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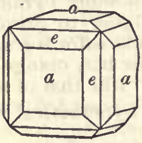

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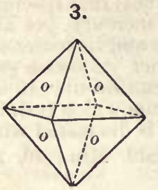

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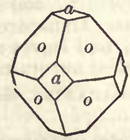

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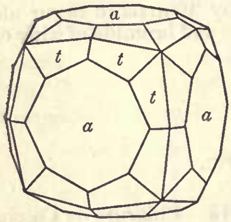

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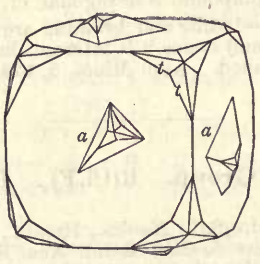

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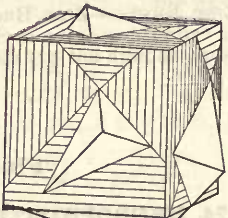


Figs. 1–4, simple forms. 5. Freiberg. 6, 7, Alston Moor, England.

Twins: tw. pl. $o$, commonly penetration-twins (f. 6, 7). Habit cubic, often modified; less frequently octahedral or dodecahedral; forms $f$, $e$ (fluoroids) common; also the vicinal form $\zeta$, producing striations on $a$ (f. 8); hexoctahedron $t$ also common. Cubic crystals sometimes grouped in parallel position, thus forming a pseudo-octahedron. Also massive; granular, coarse or fine; rarely columnar; compact.

Cleavage: $o$ perfect. Fracture flat-conchoidal; of compact kinds splintery. Brittle. H. = 4. G. = 3·01–3·25; 3·180–3·189 Kenngott, mean 3·183. Luster vitreous, sometimes splendent; usually glimmering in massive varieties. Color white, yellow, green, rose- and crimson-red, violet-blue, sky-blue, and brown: wine-yellow, greenish blue, violet-blue, most common; red, rare. Streak white. Transparent—subtranslucent. Sometimes presenting a bluish fluorescence. Phosphoresces when heated gently. Refractive index for Na: $n_y$ = 1·4339 Sarasin; $n_y$ = 1·4324 (gray), 1·4342 (black), Kohlrausch. The index diminishes slightly with increase of temperature. Etching, natural and artificial, develops depressions corresponding usually to faces of $m$ (311) or $f$ (310); also other forms. Exhibits a difference of electrical potential between the faces and angles of a cube, both under the action of heat (pyro-electric) and of light (photo-electric). Sometimes exhibits anomalous double refraction[12]. See also p. 1034.

Hussak finds that all fluorite shows double refraction with varying degrees of intensity, the crystals consisting of a series of lamellæ crossing one another and apparently parallel to the dodecahedral planes. Isotropic spots also occur, though rarely. The structure of the crystals is that of the orthorhombic system with the axis of least elasticity normal to a cubic face. The abnormal double refraction is probably to be regarded as secondary and due to internal tension; it does not disappear at a red heat.

**Comp.**—Calcium fluoride, $CaF_2$ = Fluorine 48·9, calcium 51·1=100. Chlorine is sometimes present in minute quantities.

**Var.**—1. *Ordinary;* (*a*) cleavable or crystallized, very various in colors; (*b*) fibrous to columnar, as the Derbyshire blue-john used for vases and other ornaments; (*c*) coarse to fine granular; (*d*) earthy, dull, and sometimes very soft. A soft earthy variety from Ratovka, Russia, of a lavender-blue color, is the *ratovkite* or *ratofkite*.

The finely colored fluors have been called, according to their colors, *false* ruby, topaz, emerald, amethyst, etc. The colors of the phosphorescent light are various, and are independent of the actual color; the kind affording a green color is the *chlorophane* (fr. χλωρος, *green*, and φαίνεσϑαι, *to appear*) or *pyro-emerald*.

Wyrouboff attributes the various colors to compounds of carbon and hydrogen, derived from a slight infusion of organic matters in the solvent waters; he found (Bull. Soc. Ch., **5**, 334, 1866) that the blue and violet colors changed to purple on heating, and supposes that two CH substances, a blue and a red, were present, the former more volatile, and therefore leaving the color reddish after partial heating.

Breithaupt obtained for fluorite: G. = 3·017, fr. Alston Moor, Cumberland, white; 3·170, Euba, blue; 3·176, ib., white; 3·171, fr. Siberia, blue; 3·183, ib., white; 3·166, fr. near Marienberg, green; 3·172, ib., blue; 3·169, fr. Bösenbrunn in Voigtland, green; 3·186, ib., blue, 3·188, ib., white; 3·185, fr. Cornwall, fluorescent; 3·188, fr. Switzerland, rose-red; 3·193, fr. near Freiberg, green; 3·255, fr. Mexico, emerald-green transparent oct.; 3·324–3·357, fr. Siberia, violet-blue. For Kenngott's observations on specific gravity see Ber. Ak. Wien, **10**, 1853.

2. *Antozonite* of Schönbein. Stinkfluss *Germ.* The dark violet-blue fluor of Wölsendorf, Bavaria, afforded Schrötter 0·02 p. c. of ozone, which Schönbein (J. pr. Ch., **83**, 95, 1861, **89**, 7, 1863) called *antozone*, whence his name for this variety. Its strong odor is said often to produce headache and vomiting in the miners. More recently antozone has been shown to have no real existence, and the odor of this variety has been attributed to free fluorine.

**Pyr., etc.**—In the closed tube decrepitates and phosphoresces. B.B. in the forceps and on charcoal fuses, coloring the flame red, to an enamel which reacts alkaline on test paper. With soda on platinum foil or charcoal fuses to a clear bead, becoming opaque on cooling; with an excess of soda on charcoal yields a residue of a difficultly fusible enamel, while most of the soda sinks into the coal; with gypsum fuses to a transparent bead, becoming opaque on cooling. Fused in an open tube with fused salt of phosphorus gives the reaction for fluorine. Treated with sulphuric acid gives fumes of hydrofluoric acid which etch glass.

**Obs.**—Sometimes in beds, but generally in veins, in gneiss, mica slate, clay slate, and also in limestones, both crystalline and uncrystalline, and sandstones. Often occurs as the gangue of metallic ores, especially of lead. In the North of England, it is the gangue of the lead veins which intersect the coal formation in Northumberland, Cumberland, Durham, and Yorkshire. In Derbyshire it is abundant, and also in Cornwall, where the veins intersect metamorphic rocks. The Cumberland and Derbyshire localities especially have afforded magnificent specimens. Common in the mining district of Saxony; fine near Kongsberg in Norway. In the dolomites of St. Gothard it occurs in pink octahedrons; at Münsterthal in Baden in flesh-red hexoctahedrons. Rarely in volcanic regions, as in colorless octahedrons in the Vesuvian lava; also in massive form with other fluorine compounds in ejected masses inclosed in the tufa of Fiano and at other points in the Campania.

In *Maine*, on Long Island, Blue Hill Bay, in veins. In *N. Hampshire*, at N. village of Westmoreland, 2 m. S. of meeting-house, white, green, purple, constituting a vein in quartz; at the Notch in the White Mts., green oct. in quartz, rare. In *Vermont*, at Putney, in green cubes. In *Massachusetts*, at the Southampton lead mine. In *Connecticut*, at Trumbull, the *chlorophane* var., with topaz; at Plymouth, in octahedral and dodecahedral crystals; at Willimantic, purple, in a vein in gneiss, and also sparingly at the topaz vein; at the Middletown lead mine. In *New York*, in Jefferson Co., at Muscolonge lake, formerly abundant, in gigantic cubes, sometimes modified, of grass-green and pale-green shades, in granular limestone; in St. Lawrence Co., at Rossie and Johnsburgh, rarely in fine crystals; also at Macomb, where a large cave was recently opened (cf. Kunz, Am. J. Sc., **38**, 72, 1889), lined with cubic crystals, of a sea-green color, from 1 to 6 inches in diameter, some of the groups weighing 1000 pounds and the whole cavity estimated to contain 15 tons; at Lockport, occasionally in cubes, with selenite and celestite in limestone; also similarly near Rochester and Manlius; Amity, in thin seams, with spinel and tourmaline; at Brewster, at the iron mine in colorless to purple crystals, sometimes dodecahedral. In *New Jersey*, near the Franklin Furnace, Sussex Co. In *Virginia*, near Woodstock, in limestone; on the Potomac, at Shepardstown, in white limestone; at the mica mines of Amelia Court House, Amelia Co., a finely phosphorescent variety of green or purple color. In *Illinois*, Gallatin Co., for 30 m. along the Ohio, 10 to 15 m. below Shawneetown, and at other places, dark purple, often in large crystals, in Carboniferous limestone, with galena, and through the soil. In *Missouri*, in cavities in limestone at St. Louis, with calcite, dolomite, millerite. In *California*, at Mt. Diablo, rare in white cubes. In *Arizona*, in Castle Dome dist., white, pink, green, purple. In *Nova Scotia*, at Mabou harbor, green. Near Lake Superior, a few miles from the N.E. corner of Thunder Bay, in large violet cubes on amethyst, affording magnificent specimens.

**Alt.**—Fluorite is slightly soluble in waters containing calcium bicarbonate in solution. The alkaline carbonates decompose it, producing calcium carbonate or *calcite*, and a subsequent change of the calcite may produce other forms of pseudomorphs. Fluorite occurs changed to quartz, by substitution, and also to limonite, hematite, lithomarge, psilomelane, calamine, smithsonite, cerussite, kaolinite.

**Artif.**—Made by Scheerer and Drechsel in crystallized forms, J. pr. Ch., **7**, 63, 1873.

**Ref.**—[1] Klocke, monograph, Ber. Ges. Freib., **6**, No. 4, 1876, who gives early authorities, etc. Dx. adds the vicinal (40·1·0); Gdt. includes also $\epsilon$ (510), $\nu$ (12·1·1). Index, **2**, 51, 1888. Cf. Grailich, Kr. Opt. Unt., 70, 1858, on peculiar distorted forms. [2] Lsx., Jb. Min., 134, 1875. [3] Id., Zs. Kr., **1**, 359 seq., 1877. [4] Groth, Breitenbrünn, Min.-Samml., 16, 1878. [5] Busatti, Att. Soc. Tosc., **6**, 12, 1883. [6] Van Calker, Zs. Kr., **7**, 451, 1883. [7] Hintze, Riesengrund, Zs. Kr., **14**, 74, 1888. [8] Hoefer, Sarnthal, Min. Mitth., **10**, 158, 1880. [9] Flink, Nordmark, Ak. H. Stockh., Bihang, **13** (2), No. 7, 46, 1888. [10] Busz, Cornwall, Zs. Kr., **17**, 553, 1890.

[11] Bibl. Univ., **10**, 303, 1883; cf. Kohlrausch, Zs. Kr., **2**, 101, 1877, and Dufet, Bull. Soc. Min., **8**, 257, 1885. [12] Anomalous optical characters, Mld., Ann. Mines, **10**, 115, 1876; Hussak, Zs. Kr., **12**, 552, 1887.

On *fluorescence*, Bohn, Phil. Mag., **34**, 109, 1867. On *etching*, cf. Baumh., Jb. Min., 605, 1876; Lsx., Zs. Kr., **1**, 363, 1877; Werner, Jb. Min., **1**, 14, 1881; van Calker, Zs. Kr., **7**, 449, 1883. *Hardness*, Exner, Härte Kryst., 31, 1873. *Pyro-electricity*, *Photo-electricity*, etc., Hankel, Wied., **2**, 66, 1877, **11**, 269, 1880. *Elasticity*, Klang, Wied., **12**, 321, 1881; Voigt, Jb. Min., Beil.-Bd., **4**, 236, 1885.

Bruiachite *Macadam*, Min. Mag., **7**, 42, 1886. Incrusts barite at Loch Bruithaich, Inverness-shire, Scotland. It was first noted by T. D. Wallace, ib., **6**, 169, 1885; its identity with fluorite was shown by Heddle, ib., **8**, 274, 1889.

Gunnisonite *Clarke* and *Perry*, Am. Ch. J., **4**, 140, 1882. Massive, deep purple; color of powder the same. Easily scratched by a knife. G. = 2·85. Analysis by E. A. Kebler, after deducting 12·75 p. c. admixed $CaCO_3$: $CaF_2$ 74·89, CaO 11·44, $SiO_2$ 6·87, $Al_2O_3$ 5·95, $Na_2O$ 0·85 = 100. From near Gunnison, Colorado. Probably an altered or impure fluorite.

**176. CHLOROMAGNESITE.** Cloruro di Maguesio *A. Scacchi*, Mem. Incend. Vesuv., 181, 1855. Cloromagnesite *Id.*, Att. Acc. Napoli, **6**, 1873.

Magnesium chloride, $MgCl_2$; found with other deliquescent salts of Vesuvius.

**177. SELLAITE.** *Strüver*, Att. Acc. Torino, **4**, 35, 1868.

Tetragonal. Axis $\dot{c} = 0·6596$; 001 ∧ 101 = 33° 24½′ A. Sella[1].

| | | | | | |
|---|---|---|---|---|---|
| **Forms**[2]: | *r* (320, $i$-$\frac{3}{2}$)$^3$ | *v* (301, 3-$i$)$^3$ | *s* (111, 1) | *α* (525, 1-$\frac{5}{2}$)$^3$ | *b* (212, 1-2)$^3$ |
| *a* (100, $i$-$i$) | | | *n* (221, 2) | *ϵ* (733, $\frac{7}{3}$-$\frac{7}{3}$)$^3$ | *f* (323, 1-$\frac{3}{2}$)$^3$ |
| *m* (110, *I*) | *e* (101, 1-$i$) | *β* (112, $\frac{1}{2}$)$^3$ | *w* (551, 5)$^3$ | *δ* (944, $\frac{9}{4}$-$\frac{9}{4}$)$^3$ | *A* (972, $\frac{9}{2}$-$\frac{9}{7}$)$^3$ |
| *h* (210, $i$-2) | *f* (605, $\frac{6}{5}$-$i$)$^3$ | *u* (558, $\frac{5}{8}$)$^3$ | | | |
| | *g* (502, $\frac{5}{2}$-$i$)$^3$ | *V* (334, $\frac{3}{4}$)$^3$ | | | |

| | | | |
|---|---|---|---|
| *ss′* = 57° 40½′ | *nn″* = 123° 37′ | *vv″* = 126° 23′ | *bb*$^{vii}$ = 30° 47′ |
| *ss″* = 86° 1′ | *ee′* = 45° 50′ | *αα*$^{vii}$ = 24° 50½′ | *ff*$^{vii}$ = 40° 19′ |
| *ββ″* = 50° 0½′ | *ee″* = 66° 49′ | | |

The form of sellaite is near that of the species of the Rutile Group, p. 233.

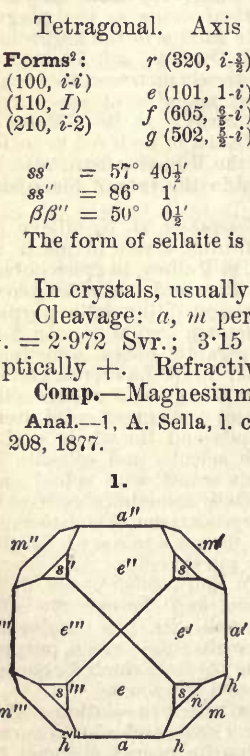
In crystals, usually prismatic in habit and somewhat fibrous in structure.

Cleavage: *a*, *m* perfect; also *e* (Mld.). Fracture conchoidal. Brittle. H. = 5. G. = 2·972 Svr.; 3·15 Sella. Luster vitreous, brilliant. Colorless, transparent. Optically +. Refractive indices: $\omega_D = 1·3780$, $\epsilon_D = 1·3897$, Sella.

**Comp.**—Magnesium fluoride, $MgF_2$ = Fluorine 61·4, magnesium 38·6 = 100.

**Anal.**—1, A. Sella, l. c. 2, 3, A. Cossa, on the corresponding artificial compound, Zs. Kr., **1**, 208, 1877.

1.



Sellaite, after Strüver.

| | | | F | Mg | |
|---|---|---|---|---|---|
| 1. | Gebroulaz glacier | G. = 3·15 | [61·58] | 38·42 | = 100 |
| 2. | *Artif.* | G. = 2·857 | [60·79] | 39·21 | = 100 |
| 3. | “ | | [61·06] | 38·94 | = 100 |

The natural mineral gave Strüver 39·64 p. c. Mg.

**Pyr., etc.**—B.B. in small fragments fuses with intumescence. Insoluble in water; also in acids, except concentrated sulphuric acid: with this it evolves hydrogen fluoride.

**Obs.**—Found embedded in anhydrite or in sulphur, also associated with albite, dolomite, magnesite, fluorite, celestite; from the moraine of the Gebroulaz glacier in Savoy near Moutiers, north of Modane.

Named after the Italian mineralogist and statesman, Quintino Sella (1827–1884).

**Artif.**—Formed artificially by A. Cossa (l. c.) in short prismatic or tabular crystals, with *a*, *m*; sometimes twins ‖ *e*. H. = 6. G. = 2·857. Phosphorescent, with a violet light in a powerful induction-current, which is also true of the natural compound. Difficultly fusible.

**Ref.**—[1] Mem. Acc. Linc., **4**, 455, 1887; Strüver obtained $\dot{c} = 0·6619$, Att. Acc. Torino, **12**, 59, 1876. Cf. also Mld., Bull. Soc. Min., **11**, 302, 1888. [2] Cf. Strüver. [3] A. Sella, l. c., also some other doubtful forms.

**178. LAWRENCITE.** *Daubrée,* C. R., **84**, 69, 1877. Eisenchlorür *Germ.*

Solid, becoming soft on exposure. Color green to brown.

**Comp.**—Ferrous chloride, $FeCl_2$ = Chlorine 55·9, iron 44·1 = 100.

**Obs.**—Present in meteoric irons, as those of Tazewell Co., Tenn., and Rockingham Co., N. C., as identified by J. Lawrence Smith (1818–1883), Am. J. Sc., **19**, 159, 1855, ib., **13**, 214, 1877, after whom the species is named. Probably also present in the Greenland native iron (Daubrée). Drops of ferric chloride, $FeCl_3$ (cf. molysite), formed from lawrencite, often exude in drops (*stagmatite*, Daubrée) from the surface of meteoric irons.

The existence of this substance at Vesuvius was announced by Monticelli and Covelli. The artificial $FeCl_2$ is hexagonal, uniaxial.

**179. SCACCHITE.** Protocloruro di Manganese *A. Scacchi,* Mem. Incend. Vesuv., 181, 1855. Scacchite *Adam,* Tabl. Min., 70, 1869.

Manganese protochloride, $MnCl_2$ = Chlorine 56·4, manganese 43·6 = 100. A deliquescent salt observed with magnesium chloride and other salts at Vesuvius.

Chloralluminite. Cloralluminio *A. Scacchi,* Att. Accad. Napoli, **6** (read Dec. 13, 1873). Aluminium chloride ($AlCl_3 + xH_2O$), produced with molysite and chloromagnesite, at Vesuvius, at the eruption of April, 1872.

**180. COTUNNITE.** Cotunnia *Monticelli & Covelli,* Prodr. Min. Vesuv., 1825. Cotunnite *Kbl.,* Char., **2**, 179, 1830. Lead chloride. Chlorblei *Germ.*

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·9976 : 1 : 1·6805 Schabus[1].
100 ∧ 110 = 44° 56′, 001 ∧ 101 = 59° 18¼′, 001 ∧ 011 = 59° 14¾′.

**Forms:** *b* (010, $i\text{-}\breve{i}$) *e* (120, $i\text{-}\breve{2}$) *μ* (102, $\frac{1}{2}\text{-}\bar{i}$) *p* (111, 1)
*a* (100, $i\text{-}\bar{i}$) *c* (001, *O*) *u* (104, $\frac{1}{4}\text{-}\bar{i}$) *v* (101, $1\text{-}\bar{i}$) *q* (122, $1\text{-}\breve{2}$)

*ee′* = 53° 14½′ *vv′* = 118° 37′ *pp′* = 81° 29′ *qq′* = 46° 36′
*uu′* = 45° 40½′ *ap* = *49° 15½′ *pp″* = 134° 24½′ *qq″* = 123° 58½′
*μu′* = 80° 13′ *pp‴* = *81° 15′ *qq‴* = 104° 14′

In acicular crystals. Also in semi-crystalline masses. Cleavage: *a*, perfect. Soft; scratched by the nail. G. = 5·238; 5·83 Rg. Luster adamantine; inclining to silky or pearly. Color white, also yellowish or with a tinge of green. Streak white.

**Comp.**—Lead chloride, $PbCl_2$ = Chlorine 25·5, lead 74·5 = 100.

**Anal.**—1, 2, Scacchi, Not. Min., I, p. 39 (Att. Acc. Nap., March 12, 1870): 1, wax-yellow var.; 2, white laminæ. Traces of fluorine are present.

| | Cl | Pb | |
|---|---|---|---|
| 1. | 25·36 | 74·98 | = 99·65 |
| 2. | 25·33 | 73·98 | = 99·31 |

**Pyr., etc.**—B.B. on charcoal fuses readily, spreading out on the coal and volatilizing, gives a white coating, the inner edge of which is tinged yellow from lead oxide; the coating in R.F. disappears, tingeing the flame azure; with soda gives metallic lead. Added to a salt of phosphorus bead, previously saturated with copper oxide, gives the reaction for chlorine (see cerargyrite). Soluble in about 22 parts of hot water.

**Obs.**—Found by Monticelli and Covelli, in the crater of Vesuvius, after the eruption of 1822, accompanied by sodium chloride, and chloride and sulphate of copper; also by Scacchi and Guiscardi on the lava of 1855, and by Scacchi on that of 1868 (l. c.). Occurs massive with other lead minerals, Mt. Challacollo, Tarapacá, Chili.

Named after Dr. Cotugno of Naples.

**Ref.**—[1] On artif. cryst., Ber. Ak. Wien, **4** (1), 456, 1850; with Miller (Min., p. 616), *μ* = 110, *e* = 011, *q* = 111, etc.; the crystals deviate at most but 3 or 4 minutes from the tetragonal type, and are near calomel in angle, as noted by Schrauf.

Pseudocotunnite. Pseudocotunnia *A. Scacchi,* Att. Accad. Napoli, **6**, 1873 (Contrib. Min., II, 38). Observed in acicular yellow opaque crystals, destitute of luster, accompanying cotunnite, at Vesuvius, as a result of the eruption of 1872. Composition believed to be $PbCl_2.KCl$, but uncertain.

**181. MOLYSITE.** Eisenchlorid *Hausm.,* 1819, Handb., 1463, 1847. Molisite *Scacchi.* Molysite *Dana,* Min., 5th Ed., 1868, p. 118.

Incrusting. Color brownish red, light or dark, and yellow.

**Comp.**—Ferric chloride, $FeCl_3$ = Chlorine 65·5, iron 34·5 = 100.

**Obs.**—Noticed by Hausmann at Vesuvius in 1819, forming a brownish red incrustation on lavas; and by Scacchi in the same region, as a result of recent eruptions (Eruz. Vesuv., 1850–55, Min. Contrib. Vesuv., II, 43, 1873), who attributes the yellow color of the lavas about the fumaroles or steam-holes partly to this species; by its decomposition a reddish brown deposit, insoluble in water, is formed.

Named from μόλυσις, *stain*, in allusion to its staining the lavas.

The artificial salt, $FeCl_3$, is hexagonal.

**182. TYSONITE.** *Allen* and *Comstock*, Am. J. Sc., **19**, 390, 1880. Fluocerite pt.

Hexagonal. Axis $\dot{c} = 0{\cdot}68681$; $0001 \wedge 10\bar{1}1 = {}^*38° 25'$ E. S. Dana[1].

**Forms:** *c* (0001, *O*); *a* (11$\bar{2}$0, *i*-2), *m* (10$\bar{1}$0, *I*); *p* (10$\bar{1}$1, 1), *q* (20$\bar{2}$1, 2); *s* (11$\bar{2}$1, 2-2).

Angles: *cq* = 57° 46′, *cs* = 53° 57′, *pp′* = 36° 12′, *ms* = 45° 34′, *ps* = 26° 20′.

In thick prisms with *c a m*, also tabular; crystals mostly altered to bastnäsite. Also massive, cleavable.

Cleavage: *c* perfect. Fracture subconchoidal. Brittle. H. = 4·5–5. G = 6·12–6·14. Luster vitreous to resinous, on cleavage surface somewhat pearly. Color pale wax-yellow, when fresh, changing to yellowish and reddish brown. Transparent to translucent. Optically negative.

**Comp.**—A fluoride of the cerium metals, $(Ce,La,Di)F_3$, ratio of Ce : La(Di) = 14 : 11.

**Anal.**—Allen and Comstock, l. c.

| | | |
|---|---|---|
| $\frac{2}{3}$ Ce 40·19[a] | La,Di 30·37[b] | F [29·44] = 100·00 |
| [a] Atomic weight 141·2. | [b] Joint atomic weight 138. | |

**Pyr., etc.**—B.B. blackens, but does not fuse. In closed tube decrepitates, changes color to a light pink. Insoluble in hydrochloric and nitric acids, but soluble in sulphuric acid, with evolution of hydrogen fluoride.

**Obs.**—Tysonite occurs in feldspar in the Pike's Peak region, El Paso Co., Colorado.

The original *fluocerite* occurs at Finbo and Broddbo near Falun, in Sweden, embedded in quartz and albite, accompanying pyrophysalite and allanite; it is described as being hexagonal with basal cleavage. The Broddbo mineral occurs in crystals with *cq* = 61° 2′ (A.Nd.). There seems every probability that this mineral is identical with tysonite, although the imperfect analysis of Berzelius (5th Ed., p. 126) has left its composition in doubt. The fluocerite from Österby, analyzed by Weibull and Tedin, seems to be quite distinct, see p. 175.

**Alt.**—Commonly altered to the fluocarbonate called bastnäsite (hamartite, or hydrofluocerite), p. 291.

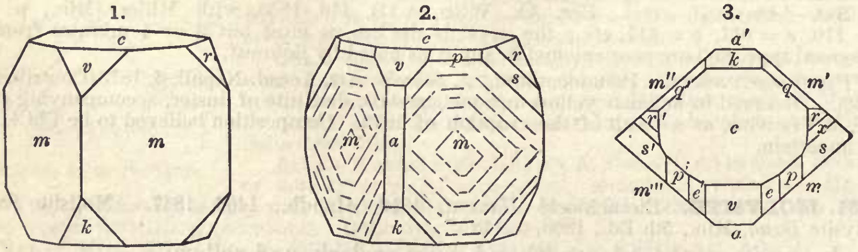
**Ref.**—[1] Am. J. Sc., **27**, 481, 1884. The mineral from Broddbo, Sweden, called fluocerite by Nordenskiöld (see above) probably belongs here; he found $0001 \wedge 20\bar{2}1 = 61° 2'$, Öfv. Ak. Stockh., **27**, 550, 1870.

**183. CRYOLITE.** Chryolith, Thonerde mit Flussäure *Abildgaard*, Scherer's J., **2**, 502, 1799; d'Andrada, ib., **4**, 37, 1800. Kryolith *Karst.*, Tab., 28, 73, 1800; id. (with anal.), *Klapr.*, J. de Phys., **51**, 473, 1800, Beitr., **3**, 207, 1802; *Vauq.*, Ann. Ch., **37**, 89, 1801. Alumine fluatée alcaline, *H.*, Tr., **2**, 1801. Cryolite. Eisstein *Germ.*

Monoclinic. Axes $\grave{a} : \bar{b} : \dot{c} = 0{\cdot}96626 : 1 : 1{\cdot}38824$; $\beta = 89° 49' = 001 \wedge 100$ Krenner[1].

$100 \wedge 110 = 44° 1'$, $001 \wedge 101 = 55° 2\frac{1}{6}'$, $001 \wedge 011 = {}^*54° 14'$.

**Forms**[2]:
*a* (100, *i*-$\bar{i}$)
*c* (001, *O*)
*m* (110, *I*)
*v* (101, −1-$\bar{i}$)
*k* ($\bar{1}$01, 1-$\bar{i}$)
*r* (011, 1-$\grave{i}$)
*z* (112, −$\frac{1}{2}$) as tw. pl.
*p* (111, −1)
*q* ($\bar{1}$11, 1)
*e* (323, −1-$\frac{3}{2}$)
*s* (121, −2-$\grave{2}$)
*t* ($\bar{1}$21, 2-$\grave{2}$)
*x* (176, −$\frac{7}{6}$-7)



Figs. 1–3, Greenland, Krenner.

$mm''' = {}^*88^\circ\ 2'$
$av = 34^\circ\ 47'$
$ck = 55^\circ\ 17'$
$rr' = 108^\circ\ 28'$
$cz = 44^\circ\ 54'$
$mz = 44^\circ\ 58'$
$mp = 26^\circ\ 34'$
$cp = 63^\circ\ 18'$

$cm = {}^*89^\circ\ 52'$
$cq = 63^\circ\ 31'$
$cs = 72^\circ\ 11'$
$ct = 72^\circ\ 20'$
$cx = 58^\circ\ 34'$
$ap = 49^\circ\ 55'$
$ar = 89^\circ\ 53\frac{1}{2}'$

$a'q = 50^\circ\ 2\frac{1}{2}'$
$as = 63^\circ\ 59\frac{1}{2}'$
$at = 64^\circ\ 5\frac{1}{2}'$
$ae = 43^\circ\ 25'$
$pp' = 76^\circ\ 45'$
$qq' = 76^\circ\ 55'$
$ss' = 115^\circ\ 27'$

$tt' = 115^\circ\ 37'$
$ee' = 55^\circ\ 40'$
$ms = 25^\circ\ 28'$
$mx = 47^\circ\ 21'$
$mr = 55^\circ\ 35'$
$vm = 53^\circ\ 48'$
$km' = 53^\circ\ 51'$

Twins[3]: tw. pl. (1) *m*, contact-twins with $m\underline{m} = 3^\circ\ 56'$, also as polysynthetic lamellæ resembling plagioclase; (2) *z* (112) contact-twins, and since $cz = mz$ nearly, the prism of one individual sensibly coincides with the base of the other, while the other prismatic faces unite in a diagonal line at a very obtuse angle; also (with tw. pl. $\bar{1}12$) shown as enclosed lamellæ, which may be produced by application of heat. (3) *a*, with *c*-face nearly ‖ *m*, seen in enclosed lamellæ; and perhaps also (4) *c*. Crystals often cubic in aspect and grouped in parallel position. Faces *m* striated ‖ edges *m*/*r*, *m*/*v*, also *m*/*c*. Massive, cleavable.

Cleavage: *c* most perfect, also *m*, *k* somewhat less so. Fracture uneven. Brittle. H. = 2·5. G. = 2·95–3·0. Luster vitreous to greasy; somewhat pearly on *c*. Colorless to snow-white, sometimes reddish or brownish to brick-red or even black. Transparent to translucent.

Optically +. Double refraction weak. Ax. pl. ⊥ *b*; $Bx_a \wedge \dot{c} = -43^\circ\ 54'$ in white light. Dispersion $\rho < v$; also horizontal. Axial angles:

$$2E_r = 58^\circ\ 50' \quad 2E_y = 59^\circ\ 24' \quad 2E_{bl} = 60^\circ\ 10' \text{ Krenner}^4.$$

Refractive index (for a prism with edge ‖ $Bx_o$) = 1·364 Na, Knr.; also 1·3343 Websky[5], or differing but little from that of water. On etching-figures, cf. Baumhauer[6].

**Comp.**—A fluoride of sodium and aluminium, $Na_3AlF_6$ or $3NaF.AlF_3$ = Fluorine 54·4, aluminium 12·8, sodium 32·8 = 100. A little iron sesquioxide is sometimes present as impurity.

**Anal.**—1, 2, Brandl, Zs. Kr., **7**, 386, 387, 1883. 3, Hillebrand, Bull. **20**, U. S. G. Surv., p. 48, 1885.

| | | F | Al | Na | |
|---|---|---|---|---|---|
| 1. Greenland | | 54·15 | 13·07 | 32·56 | = 99·78 |
| 2. " | | 54·28 | 13·01 | 32·41 | = 99·70 |
| 3. Colorado | G. = 2·972 | 53·55¼ | 12·81 | 32·40 | $Fe_2O_3$ 0·40, Ca 0·28, $H_2O$ = 0·30 = 99·74 |

**Pyr., etc.**—Fusible in small fragments in the flame of a candle. B.B. in the open tube heated so that the flame enters the tube gives off hydrofluoric acid, etching the glass; the water which condenses at the upper end of the tube reacts for fluorine with Brazil-wood paper. In the forceps fuses very easily, coloring the flame yellow. On charcoal fuses easily to a clear bead, which on cooling becomes opaque; after long blowing, the assay spreads out, the fluoride of sodium is absorbed by the coal, a suffocating odor of fluorine is given off, and a crust of alumina remains, which, when heated with cobalt solution in O.F., gives a blue color. Soluble in sulphuric acid, with evolution of hydrofluoric acid. Slightly soluble in water, 1 part in 2730 at 12° C., Johnstrup.

**Obs.**—Occurs in a bay in Arksuk-fiord, in West Greenland, at Ivigtut (or Evigtok), about 12 m. from the Danish settlement of Arksuk, where it constitutes a large bed in a granitic vein in a gray gneiss. The crystals occur in cracks in the massive mineral. The first specimens of cryolite came through Denmark from Greenland, and the earliest notice of it was by Schumacher in the Abh. Nat. Ges. Copenhagen, **4**, 1795. The locality was described from personal observation by Giesecke in Ed. Encyc., **10**, 97, and Ed. Phil. J., **6**, 141, 1822; by J. W. Tayler in the Q. J. G. Soc., **12**, 140; and more recently by Johnstrup (Förh. Skand. Nat., **12**, 234, 1880). Johnstrup finds the cryolite limited to the granite; he distinguishes a central and a peripheral part; the former has an extent of 500 feet in length and 1000 feet in breadth and consists of cryolite chiefly, with quartz, siderite, galena, sphalerite, pyrite, chalcopyrite, and wolframite irregularly scattered through it. The peripheral portion forms a zone about the central mass of cryolite; the chief minerals are quartz, feldspar, and ivigtite, also fluorite, cassiterite, molybdenite, arsenopyrite, columbite. Its inner limit is rather sharply defined, though there intervenes a breccia-like portion consisting of the minerals of the outer zone enclosed in cryolite; beyond this it passes into the surrounding granite without distinct boundary. Also occurs sparingly near Miask, in the Ilmen Mts., in a topaz mine with chiolite (and chodneffite).

Cryolite and its alteration products, pachnolite, thomsenolite, prosopite, etc., also occur in very limited quantity at the southern base of Pike's Peak, El Paso county, Colorado, north and west of Saint Peter's Dome; they are found in vein-like masses of quartz and microcline embedded in granite; zircon, astrophyllite, and columbite are associated minerals. Also reported from the Yellowstone Park (Min. Res. U. S., 1886, p. 693).

Named from κρύος, *frost*, λίθος, *stone*, hence meaning *ice-stone*, in allusion to the translucency of the white cleavage masses.

**Artif., Alt.**—On artificial alteration products, showing that the sodium may be replaced by the alkaline earths (Ca, Mg, etc.), see Noellner, Zs. G. Ges., **33**, 139, 1881. The related minerals, pachnolite, thomsenolite, etc., are largely secondary products due to the alteration of the original cryolite.

**Ref.**—[1] Nat. Ber. aus Ungarn, **1**, 151, 1883. Cryolite, at first regarded as orthorhombic, was made triclinic by Des Cloizeaux, Propr. Opt., **1**, 64, 1857, N. R., p. 201, 1867, and by Websky, Jb. Min., 810, 1867; cf. also Dx., Bull. Soc. Min., **6**, 254. 1883, and Groth, Zs. Kr., **10**, 642, 1886. [2] Knr., l. c. [3] See Mgg., Jb. Hamb., **1**, 67. 1883–84, Zs. Kr., **11**, 167, 170, 1885; also Cross and Hillebrand, Bull. **20**, U. S. Geol. Surv., 45, 1885. [4] Knr., l. c. [5] Websky, l. c. [6] Zs. Kr., **11**, 133, 1885.

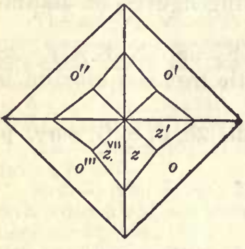
ELPASOLITE *Cross* and *Hillebrand*, Am. J. Sc., **26**, 283, 1883; Bull., **20**, U. S. Geol. Surv. p. 57, 1885. Massive or showing an indistinct isometric form; optically isotropic. Colorless to white. An imperfect analysis (Hillebrand) gave:

F 46·98 (calc.) Al 11·32 Ca 0·72 Mg 0·22 K 28·94 (approx.) Na 9·90 (approx.) = 98·08

This suggests a composition analogous to cryolite with sodium in part replaced by potassium. Occurs sparingly in cavities in the massive pachnolite from the Pike's Peak region, El Paso county, Colorado.

**184. CHIOLITE.** Chiolith (fr. Miask) *Hermann & Auerbach*, J. pr. Ch., **37**, 188, 1846. Arksutite *G. Hagemann*, Am. J. Sc., **42**, 94, 1866.

Tetragonal. Axis $\dot{c}$ = 1·0418; 001 ∧ 101 = 46° 10⅓′ Koksharov[1].



In small pyramidal crystals, *o* (111, 1), with an undetermined zirconoid, *z*, and rarely *c* (001, *O*). Angles: *oo′* =*71° 37′, *oo″* = 111° 40⅙′.

Twins: tw. pl. *o*, contact-twins sometimes prismatic in aspect. Distinct crystals rare and very small. Usually massive granular, resembling cryolite; structure crystalline.

Cleavage: *o*? H. = 3·5–4. G. = 2·84–2·90 Rg.; 2·99 Lindström. Color snow-white. Luster vitreous. Transparent to translucent. Optically negative, Dx., Knr.

**Comp.**—A fluoride of aluminium and sodium, $5NaF.3AlF_3$ = Fluorine 57·7, aluminium 17·5, sodium 24·8 = 100, Groth-Brandl.

**Anal.**—1, Brandl, Zs. Kr., **7**, 478, 1883. 2, 3, G. Lindström, G. För. Förh., **8**, 172, 1886.

| | | F | Al | Na |
|---|---|---|---|---|
| 1. Miask | | 57·30 | 17·66 | 24·97 = 99·93 |
| 2. Ivigtut | G. = 2·994 | 57·16[a] | 17·28 | 24·72 Ca 0·22, Mg 0·05 = 99·43 |
| 3. " | | 57·74[a] | 17·68 | 24·49 Mg 0·11 = 100·02 |

[a] Calculated.

Earlier analyses (5th Ed., p. 128) on less pure material were made by Hermann and Rammelsberg. The analysis of Hagemann, upon which "arksutite" was based, was shown by Groth (Zs. Kr., **7**, 479, 1883) to be untrustworthy, and the identity of the mineral with chiolite was later established by Nordenskiöld on the strength of Lindström's analysis (l.c.); cf. also Krenner, who noted the resemblance in form, Nat. Ber. aus Ungarn, **1**, 170, 1883.

**Pyr.**—Like cryolite, but somewhat more fusible.

**Obs.**—From the Ilmen Mts., near Miask, where it occurs in granite, with topaz, fluorite, phenacite, and cryolite. Also with cryolite at Ivigtut, Greenland, in white granular masses, occasionally showing cleavage.

Named from χιών, *snow*, λίθος, *stone*, in allusion to its appearance and similarity to cryolite (= *ice-stone*).

**Ref.**—[1] Vh. Min. Ges., p. 1, 1850–51; Min. Russl., **4**, 393. Cf. Kenng., Ber. Ak. Wien, **11**, 980, 1853, who made the crystals orthorhombic.

CHODNEFFITE. Chiolith (fr. Miask) *v. Wörth & Chodnev*, Vh. Min. Ges., 1845–46, 208, 216, 1846. Chodneffite *Dana*, Min., 234, 1850; Cryolite, ib., 97, 1854. Chodnewit. Nipholith *Naum.*, Min., 219, 1864.

Separated from chiolite on the basis of analyses by Chodnev and Rammelsberg (5th Ed., p.

129); but as shown by Groth, the differences are almost certainly due to want of purity in the material analyzed. The formula deduced (and still preferred, Rg.) for chiolite was $3NaF.2AlF_3$; that for chodneffite, $2NaF.AlF_3$.

**185. HIERATITE.** *A. Cossa*, Trans. Acc. Linc., **6**, 141, 1882; Bull. Soc. Min., **5**, 61, 1882.

Isometric. In octahedrons or cubo-octahedrons forming, with scales of sassolite, stalactitic concretions of grayish color and spongy texture.

The concretions contain also selen-sulphur, arsenic sulphide, and the alums of potassium, cæsium, rubidium, and, in small quantities, thallium. They are four-fifths soluble in boiling water, from which, on cooling, a gelatinous precipitate, later becoming crystalline, separates out; the latter consists of isotropic crystals, cubes with octahedral faces.

For these the composition $2KF.SiF_4$ was obtained on analysis = Fluorine 51·9, silicon 12·7, potassium 35·4 = 100.

**Obs.**—From the fumaroles of the crater of Vulcano (Greek name, Hiera), one of the Lipari Islands.

The following fluorides are mentioned by Scacchi as occurring at Vesuvius, Att. Acc. Napoli, **6**, 1873 (Contr. Min., II, 1874):

HYDROFLUORITE. Idrofluore *A. Scc.* Hydrofluoric acid gas (HF) observed especially after the eruptions of 1870, 1872.

PROIDONITE. Proidonina, *A. Scc.* Silicon tetrafluoride ($SiF_4$) observed in the exhalations at the time of the eruption of 1872.

CRYPTOHALITE. Criptoalite, *A. Scc.* A fluo-silicate of ammonium, perhaps $2NH_4F.SiF_4$, observed with sal ammoniac at a Vesuvian fumarole.

## II. Oxychlorides, Oxyfluorides.

### A. Oxychlorides.

| | | | | |
|---|---|---|---|---|
| **186. Matlockite** | $PbCl_2.PbO$ | Tetragonal | ć = 1·7627 | |
| **187. Mendipite** | $PbCl_2.2PbO$ | " | ć = 0·8005 | |
| **188. Schwartzembergite** | $Pb(I,Cl)_2.2PbO$ | Rhombohedral | | |
| | | | ă : b̄ : ć | |
| **189. Laurionite** | $PbCl_2.Pb(OH)_2$ | Orthorhombic | 0·7328 : 1. 0·8315 | |
| **190. Daviesite** | | " | 0·7940 : 1 : 0·4777 | |
| | | | à : b̄ : ć | β |
| **191. Fiedlerite** | | Monoclinic | 0·8192 : 1 : 0·8915 | 77° 20′ |
| **192. Percylite** | $CuCl_2.Pb(OH)_2$? | Isometric | | |
| | | | ă : b̄ : ć | |
| **193. Atacamite** | $CuCl_2.3Cu(OH)_2$ | Orthorhombic | 0·6613 : 1 : 0·7515 | |
| Melanothallite | $CuCl_2.Cu(OH)_2.H_2O$? | | | |
| **194. Daubréeite** | | | | |

### B. Oxyfluorides.

| | | | |
|---|---|---|---|
| **195. Nocerite** | $2(Ca,Mg)F_2.(Ca,Mg)O$ | | Hexagonal |
| **196. Fluocerite** | $R_2O_3.4RF_3$ | R = Ce, etc. | |

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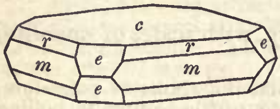
### A. Oxychlorides.

**186. MATLOCKITE.** *R. P. Greg*, Phil. Mag., **2**, 120, 1851. *Rg.*, Pogg., **85**, 144, 1852.

Tetragonal. Axis ć = 1·7627; 001 ∧ 101 = *60° 26′ Miller.

**Forms:** *c* (001, *O*); *m* (110, *I*); *e* (101, 1-*ĭ*); *r* (111, 1).
Angles: *ee'* = 75° 54½', *ee''* = 120° 52', *cr* = 68° 8½', *rr'* = 82° 2', *rr''* = 136° 17', *me* = 52° 3'.

Crystals tabular ‖ *c*. Cleavage: *c* imperfect. Fracture uneven, slightly conchoidal.



H. = 2·5–3. G. = 7·21. Luster adamantine, occasionally pearly. Color clear yellowish, sometimes a little greenish. Transparent to translucent.

**Comp.**—An oxychloride of lead, $Pb_2OCl_2$ or $PbCl_2.PbO$ = Chlorine 14·2, oxygen 3·2, lead 82·6 = 100, or Lead chloride 55·5, lead oxide 44·5 = 100.

**Anal.**—1, R. A. Smith, Phil. Mag., **2**, 120, 1851. 2, Rg., l. c.; he gives Cl 13·38, Pb 82·16, and G. = 5·395; the last cannot be correct.

| | $PbCl_2$ | PbO | | |
|---|---|---|---|---|
| 1. | 55·18 | 44·30 | ign. 0·07 | = 99·55 |
| 2. | 52·45 | 46·42 | | = 98·87 |

**Pyr., etc.**—Like mendipite.

**Obs.**—From an old mine at Cromford near Matlock in Derbyshire, with phosgenite; also, as a sublimation-product, at Vesuvius after the eruption of 1858, R. Cappa, C. R., **50**, 955, 1860. Probably from Mt. Challacollo, Tarapaca, Peru, in crystalline crusts in a quartzose gangue; an analysis, after deducting 32 p. c. quartz, gave: $PbCl_2$ 65·37, PbO 34·63. The excess of lead chloride is attributed to cotunnite, but the identification is incomplete. Raimondi, Min. Pérou, 170, 1878.

**Ref.**—[1] Min., p. 620, 1852.

**187. MENDIPITE.** Saltsyradt Bly (Salzsaures Blei) *Berz.*, Ak. H. Stockh., 184, 1823; Ed. J. Sc., **1**, 379, 1824. New ore of lead from Mendip, Peritomous Lead-baryte, *Haid.*, Min. Mohs, **2**, 151, 1825. Muriate of Lead, Chloride of Lead. Plomb chloruré, pt., *Fr.* Kerasine pt. [rest phosgenite] *Beud.*, Tr., **2**, 502, 1832. Chlor-Spath *Breith.*, Char., 61, 1832. Berzelite *Lévy*, Min. Heul., **2**, 448, 1837. Mendipit *Glock.*, Grundr., 604, 1839.

Orthorhombic. Axes: $\breve{a} : \bar{b}$ = 0·8005 : 1. 100 ∧ 110 = 38° 42' Miller[1].

**Forms:** *a* (100, *i*-*ĭ*), *b* (010, *i*-*ĭ*), *c* (001, *O*), *m* (110, *I*).
Angles: *am* = 38° 42', *mm'''* = 77° 24'.

Occurs in fibrous or columnar masses, often radiated.

Cleavage: *m* highly perfect; *a*, *b* less perfect. Fracture conchoidal to uneven. H. = 2·5–3. G. = 7–7·1. Luster pearly, inclining to adamantine upon cleavage face. Color white, with a tinge of yellow, red, or blue. Streak white. Feebly translucent to opaque.

**Comp.**—$Pb_3O_2Cl_2$ or $PbCl_2.2PbO$ = Chlorine 9·8, oxygen 4·4, lead 85·8 = 100, or Lead chloride 38·4, lead oxide 61·6 = 100. Analyses see 5th Ed., p. 120.

**Pyr., etc.**—In the closed tube decrepitates and becomes more yellow. B.B. on charcoal fuses easily, and is reduced to metallic lead with elimination of acid vapors, giving the coal a white coating of lead chloride, the inner edge of which is yellow from lead oxide. With salt of phosphorus bead, previously saturated with oxide of copper, colors the O.F. azure-blue. Soluble in nitric acid.

**Obs.**—Formerly found near Churchill in the Mendip Hills, Somersetshire, in small radiated crystalline masses with galena on earthy black manganese; also occurs at mine Kunibert near Brilon in Westphalia. Reported in opaque white crystals from Tarnowitz, Silesia; these, however, have been shown to be altered phosgenite.

**Ref.**—[1] Mlr., Min., 621, 1852.

**188. SCHWARTZEMBERGITE.** Oxychloroïodure de plomb (fr. Atacama) *Domeyko*, Ann. Mines, **5**, 453, 1864; Plomo oxichloro-ioduro, Min. Chili. Schwartzembergite *Dana*, 1868. Plumbiodite *Adam*, Tabl. Min., 67, 1869.

Rhombohedral. Optically uniaxial, negative, Btd.[1] In druses of small crystals. Also in thin amorphous crusts, compact, passing into earthy.

Brittle. H. = 2–2·5. G. = 6·2–6·3 Liebe. Luster adamantine. Color honey-yellow, when purest; also straw-yellow, inclining to lemon-yellow, sometimes a little reddish. Streak straw-yellow.

**Comp.**—Probably $Pb(I,Cl)_2.2PbO$, with I : Cl = 3 : 2. This requires: Lead chloride 13·4, lead iodide 33·1, lead oxide 53·5 = 100.

**Anal.**—Liebe, Jb. Min., 159, 1867:

| $PbCl_2$ | $PbI_2$ | $PbO$ | $PbSO_4$ | $PbCO_3$ | $Sb_2O_3$ |
|---|---|---|---|---|---|
| 11·40 | 30·89 | 48·92 | 5·51 | 1·88 | 0·91 = 99·51 |

Liebe regards all the ingredients as impurities except the iodide and oxide of lead.

**Pyr., etc.**—Very fusible, like cerargyrite; in fusing loses its color; on charcoal metallic globules. In a matrass abundant violet vapors of iodine. No effervescence with nitric acid, but loses color, becoming first brownish and then white, and, if some water be added, it dissolves completely on heating.

**Obs.**—Forms crusts on galena at a mine 15 leagues from the port of Paposo in the desert of Atacama, where it was discovered by Mr. Schwartzemberg. At the San Rafaël mine in Bolivia; Sierra Gorda, in Peru.

**Ref.**—[1] Bull. Soc. Min., 4, 87, 1881.

### 189. LAURIONITE. *Köchlin*, Ann. Mus. Wien, 2, 188, 1887.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·7328 : 1 : 0·8315$ Köchlin[1].

$100 \wedge 110 = 36° 14'$, $001 \wedge 101 = 48° 36\frac{2}{3}'$, $001 \wedge 011 = 39° 44\frac{2}{3}'$.

**Forms:** *a* (100, *i*-ī), *b* (010, *i*-ĭ), *c* (001, *O*); *l* (210, *i*-2̄), *m* (110, *I*), *n* (120, *i*-2̆); *d* (012, ½-ĭ); *p* (151, 5-5̆); also uncertain 410, 320, 340, 160, and a pyramid near 141.

*ll'''* = 40° 15'  *nn'* = 68° 37'  *bd* = *67° 25½'  *pp''* = 153° 52'
*mm'''* = 72° 28'  *dd'* = 45° 9'  *pp'* = 29° 44'  *pp'''* = 140° 1'
*bm* = *53° 46'

In minute prismatic crystals flattened ∥ *b*; faces *b* with feather-like striations ∥ edge *b*/*p*.

Cleavage: *a* distinct; perhaps also *c*. H. = 3–3·5. Luster adamantine, on *a* silky. Colorless. Transparent.

**Comp.**—$PbClOH$ or $PbCl_2.Pb(OH)_2$ = Chlorine 13·7, oxygen 3·1, lead 79·7, water 3·5 = 100, or Lead chloride 53·5, lead oxide 43·0, water 3·5 = 100.

**Anal.**—Bettendorff, Ber. nied. Ges., p. 153, 1887.

| Cl | O | Pb | $H_2O$ | |
|---|---|---|---|---|
| 13·77 | 3·17 | 79·38 | 3·68 | = 100 |

**Pyr.**—B.B. fuses easily and quietly to a yellowish opaque bead; on charcoal with soda a lead globule. Soluble in nitric acid, also in part in hot water when in powder. The water is driven off above 142° C.

**Obs.**—Occurs in groups of crystals together with phosgenite and cerussite in cavities of lead slag at Laurion, Greece, as a result of the action of sea-water to which the slag had been exposed for some 2000 years.

**Ref.**—[1] L. c., and ib., 2, 83, 127 (Notizen); the symbol of *p* is erroneously given as (2·10·1). Cf. also Rath, Ber. nied. Ges., p. 150, June 6, 1887.

### 190. DAVIESITE. *L. Fletcher*, Min. Mag., 8, 174, 1889.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·7940 : 1 : 0·4777$ Fletcher.

$100 \wedge 110 = *38° 27'$, $001 \wedge 101 = *31° 2'$, $001 \wedge 011 = 25° 32'$.

**Forms:**
*b* (010, *i*-ĭ)
*c* (001, *O*)
*m* (110, *I*)
*d* (101, 1-ī)
*e* (301, 3-ī)
*f* (011, 1-ĭ)
*g* (031, 3-ĭ)
*h* (051, 5-ĭ)
*v* (221, 2)
*t* (211, 2-2̄)
*s* (121, 2-2̆)
*r* (251, 5-$\frac{5}{2}$)

*mm'''* = 76° 54'  *ee'* = 122° 1'  *cv* = 56° 56½'  *br* = 33° 13½'
*dd'* = 62° 4'  *gg'* = 110° 11'  *bt* = 73° 1'  *vv'* = 62° 49'
*ff'* = 51° 4'  *hh'* = 134° 33'  *bv* = 58° 35'  *ss'* = 78° 37'

In minute prismatic crystals; faces *b* sometimes striated horizontally.

No cleavage observed. Fracture subconchoidal. Luster vitreous to adamantine. Colorless. Optically +. Ax. pl. ∥ 100. Bx ⊥ *c*.

**Comp.**—An oxychloride of lead, but exact composition doubtful.

**Pyr.**—Yields metallic lead on charcoal with soda. Readily dissolved in nitric acid, more so than mendipite.

**Obs.**—Occurs sparingly, associated with caracolite and percylite, on a matrix of massive anglesite at the Mina Beatriz, Sierra Gorda, Atacama. Near mendipite in prismatic angle, but without its perfect cleavage, and more easily dissolved in nitric acid.

Named after Thomas Davies, Esq., of the Mineral Department, British Museum.

**191. FIEDLERITE.** *G. vom Rath*, Ber. nied. Ges., p. 154, June 7, 1887.

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c} = 0{\cdot}81918 : 1 : 0{\cdot}89153$; $\beta = {}^*77° \; 20' = 001 \wedge 100$ Rath.

$100 \wedge 110 = {}^*38° \; 38'$, $001 \wedge 101 = 40° \; 36\frac{1}{3}'$, $001 \wedge 011 = 41° \; 7'$.

**Forms**: *a* (100, $i$-$\bar{\imath}$), *c* (001, *O*); *n* (650, $i$-$\frac{6}{5}$); *m* (110, *I*); *x* ($\bar{5}06$, $\frac{5}{6}$-$\bar{\imath}$), *y* ($\bar{5}03$, $\frac{5}{3}$-$\bar{\imath}$); *o* (111, −1), *u* (544, $-\frac{5}{4}$-$\frac{5}{4}$), *i* (577, $-1$-$\frac{7}{5}$), *p* (5·12·12, $-1$-$\frac{12}{5}$), *e* (5·24·24, $-1$-$\frac{24}{5}$).

Angles: *cx* = 47° 50½′, *cy* = 71° 12′, *co* = 47° 56′, *oo′* = 56° 8′, *ao* = 44° 59′, *mo* = *32° 12′.

Crystals minute, tabular ∥ *a*; twins with tw. pl. *a*. Faces *a* smooth, or with fine striations ∥ edge *a*/*o*; *c* dull.

Cleavage: *c* distinct. Luster adamantine. Colorless. Transparent.

**Comp.**—Contains lead and chlorine, perhaps an oxychloride.

Soluble completely in nitric acid, but less readily than laurionite.

**Obs.**—Occurs with laurionite, wh. see p. 171.

Named after the Saxon Commissioner of Mines, Fiedler, director of the Grecian exploration.

**192. PERCYLITE.** *H. J. Brooke*, Phil. Mag., **36**, 131, 1850.

Isometric. Observed forms:

*a* (100, $i$-$i$) *d* (110, $i$) *o* (111, 1) *e* (210, $i$-2)

Crystals minute cubes, other forms rare. Also massive.

H. = 2·5. Color and streak sky-blue.

**Comp.**—A hydrated oxychloride of lead and copper, perhaps $PbCuO_2H_2Cl_2$ = Chlorine 18·9, oxygen 4·3, lead 55·1, copper 16·9, water 4·8 = 100.

An analysis by Flight, but of very impure material, gave: Cl 13·37, Cu 8·78, Pb 37·64, $H_2O$ 2·87, Ag 8·98, $PbSO_4$ 22·98, O *undet.*, $CO_2$ 1·39 = 96·01. J. Ch. Soc., **25**, 1051, 1872.

**Pyr.**—In the closed tube yields water and odorless fumes. B.B. tinges the flame green with blue on the edges. With borax reacts for copper.

**Obs.**—The original mineral was found with gold, and supposed to be from Sonora, Mexico. Since obtained from South Africa with anglesite, cerussite, and cerargyrite. Also at the Mina Beatriz, Sierra Gorda, Atacama, with caracolite, daviesite, and numerous other lead salts, and perhaps Mina San Rafaël, Galeria del Norte, Bolivia, and Mt. de Challacolla, Tarapacá, Chili.

Named after Dr. John Percy, the English metallurgist (1817–1889). See Boléite, p. 1028.

**193. ATACAMITE.** Sable vert cuivreux du Pérou, Chaux cuivreuse unie à un peu d'acide muriatique et d'eau, *Rochefoucauld, Baumé & Fourcroy*, Mem. Ac. Paris, 1786 (pub'd in 1788); *Berthollet*, ib., 474 (note added in 1788). Kupfersand, Salzsaures Kupfer, *Karst.*, Tab., 46, 76, 1800. Cuivre muriaté *H.*, *Tr.*, 1801. Muriate of copper. Atacamit, Salzkupfererz, *Blumenbach*, Handb. Nat., 1805. Kupferhornerz, Atacamit, *Ludwig*, Min., 2, 178, 1804. Smaragdochalcit *Hausm.*, Handb., 1039, 1813. Halochalzit *Breith.*, Handb., 165, 1841. Remolinite *B. & M.*, Min., 618, 1852. Marcylite *Shep.*, Marcy's Expl. Red River, 135, 800, Washington, 1854, Am. J. Sc., **21**, 206, 1856; *Dana*, ib., **24**, 122, 1857. Botallackite *A. H. Church*, J. Ch. Soc., **18**, 212, 1865.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}66126 : 1 : 0{\cdot}75149$ Zepharovich-Klein[1].

$100 \wedge 110 = 33° \; 28\frac{1}{2}'$, $001 \wedge 101 = 48° \; 39\frac{1}{4}'$, $001 \wedge 011 = 36° \; 55\frac{1}{2}'$.

**Forms**[2]:
*a* (100, $i$-$\bar{\imath}$)
*b* (010, $i$-$\breve{\imath}$)
*c* (001, *O*)

*m* (110, *I*)
*t* (560, $i$-$\frac{6}{5}$)
*l* (230, $i$-$\frac{3}{2}$)
*s* (120, $i$-$\breve{2}$)
*k* (130, $i$-$\breve{3}$)

*x* (140, $i$-$\breve{4}$)
*u* (101, 1-$\bar{\imath}$)
*d* (201, 2-$\bar{\imath}$)[3]
*δ* (023, $\frac{2}{3}$-$\breve{\imath}$)

*e* (011, 1-$\breve{\imath}$)
*i* (0·10·9, $\frac{10}{9}$-$\breve{\imath}$)
*o* (021, 2-$\breve{\imath}$)
*g* (031, 3-$\breve{\imath}$)

*r* (111, 1)
*q* (221, 2)
*z* (331, 3)
*w* (992, $\frac{9}{2}$)
*f* (211, 2-$\bar{2}$)

*y* (321, 3-$\frac{3}{2}$)
*v* (762, $\frac{7}{2}$-$\frac{7}{6}$)?
*n* (121, 2-$\breve{2}$)
*ξ* (142, 2-$\breve{4}$)[3]?

*mm‴* = 66° 57′
*ss′* = 74° 11′
*xx′* = 41° 25′
*uu′* = 97° 18½′
*dd′* = 132° 30′

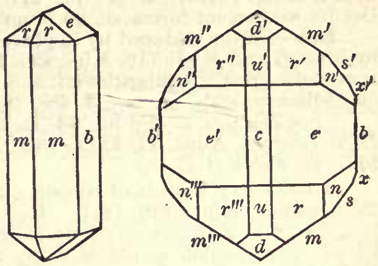
*ee′* = *73° 50′ 56″
*oo′* = 112° 43½′
*er′* = *42° 15′ 19″
*rr′* = 84° 31′
*rr″* = 107° 27′

*rr‴* = 52° 48′
*qq′* = 103° 5′
*qq″* = 139° 42′
*qq‴* = 62° 22′
*zz′* = 108° 14′
*zz″* = 152° 30′

*zz‴* = 64° 47½′
*sn* = 27° 57′
*nn′* = 64° 23′
*nn‴* = 89° 35′
*mn* = 33° 35½′
*me* = 70° 39′

Twins: tw. pl. *m*. Commonly in slender prismatic crystals, vertically striated, with terminal planes (*e*, *r*) bright; also tabular ‖ *b*. In confused crystalline aggregates; also massive, fibrous or granular to compact; as sand.

Cleavage: *b* highly perfect; *u* (101) imperfect. Fracture conchoidal. Brittle. H. = 3–3·5. G. = 3·75–3·77. Luster adamantine to vitreous. Color bright green of various shades, dark emerald-green to blackish green. Streak apple-green. Transparent to translucent. Optically —. Ax. pl. ‖ *a*. Bx ⊥ *b*. Dispersion $\rho < v$. Axial angles, Dx.[4]



Chili, Brögger.

$2H_r = 91° 50'$ $2H_y = 93° 11'$ $2H_{bl} = 100° 23'$ Chili

$2H_r = 91° 33'–94° 30'$ $2H_{bl} = 102° 30'–105° 1'$ Australia

**Comp.**—$Cu_2ClH_3O_3$ or $CuCl_2.3Cu(OH)_2$ = Chlorine 16·6, copper 14·9, cupric oxide 55·8, water 12·7 = 100.

**Anal.**—1, J. A. Cabell, Ch. News, **28**, 271, 1873. 2, Ludwig, Min. Mitth., 35, 1873. 3, T. C. Cloud, Ch. News, **34**, 254, 1876. 4, Hiortdahl, Nyt Mag., **13**, 153, 1864. 5–11, Darapsky, Jb. Min., **2**, 1, 1889. Also Genth, Am. J. Sc., **40**, 207, 1890; for earlier analyses see 5th Ed., p. 121.

| | | | Cl | Cu | CuO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. | Australia, *cryst.* | G. = 4·314 | 16·44 | 14·67 | 56·64 | 12·02 | = 99·77 |
| 2. | " " | G. = 3·769 | 16·17 | 14·76 | 55·47 | 13·59 | = 99·99 |
| 3. | So. Australia | | 15·38 | 13·73 | 55·91 | [13·51] | insol. 1·47 = 100 |
| 4. | Chili | | 16·78 | 15·00 | 55·26 | 12·47 | insol. 0·21 = 99·72 |
| 5. | Copiapo | | 13·79 | 12·11 | 57·01 | 17·09 | = 100 |
| 6. | El Cobre | G. = 3·11 | 15·77 | 14·10 | 54·77 | 15·36 | = 100 |
| 7. | Llano de Chueca | | 16·24 | 14·52 | 55·26 | 13·98 | = 100 |
| 8. | Copiapo | | 16·15 | 14·45 | 55·04 | 14·50 | = 100·14 |
| 9. | Los Bordos | | 15·21 | 13·61 | 56·77 | 14·41 | = 100 |
| 10. | Atacama | | 16·45 | 14·72 | 55·26 | 13·57 | = 100 |
| 11. | " | | 15·83 | 14·16 | 55·70 | 14·31 | = 100 |

From anal. 5–11, the impurities have been deducted. Darapsky (l. c.) gives a discussion of the variation in composition.

Analyses of an ore from Cobija, Bolivia, and of botallackite give half more water (see 5th Ed.). Liversidge obtained for a crystallized specimen from New South Wales 69·9 p. c. CuO and 14·3 $CuCl_2$ (Proc. Roy. Soc., N. S. W., Nov. 3, 1880).

**Pyr., etc.**—In the closed tube gives off much water, and forms a gray sublimate. B.B. on charcoal fuses, coloring the O.F. azure-blue, with a green edge, and giving two coatings, one brownish and the other grayish white; continued blowing yields a globule of metallic copper; the coatings, touched with the R.F., volatilize, coloring the flame azure-blue. In acids easily soluble.

**Obs.**—This species was originally found in the state of sand in the Atacama province, northern part of Chili. It occurs in different parts of Chili, especially at Los Remolinos; also in veins in the district of Tarapaca, Bolivia; at Tocopilla, 16 leagues north of Cobija, an important locality, in Bolivia; with malachite at Wallaroo in South Australia; in New South Wales, probably at the Cobar mines, Robinson Co.; in the Nellore district, India; at the malachite locality in the Serra do Bembe, near Ambriz, on the west coast of Africa; at the Estrella mine in southern Spain· at St. Just in Cornwall, in crusts and stalactitic tubes. In large pseudomorphous crystals, 2 inches long, altered to malachite, at the Medno-Rondiansky mine near Nizhni Tagilsk and in the Turginsk mines. In the U. S., with cuprite, gerhardtite, etc., at the United Verde mine, Jerome, Arizona.

Botallackite occurs at the Botallack mine, Cornwall, in thin crusts of minute interlacing crystals, closely investing killas; Schwarzenberg in Saxony; also supposed to invest some of the lavas of Vesuvius, but questioned by Scacchi, the mineral so called being a basic sulphate (Mem. Incend. Vesuv., 1855).

Atacamite is sometimes ground up in Chili, and sold under the name of *Arsenillo* as sand for letters.

**Alt.**—Occurs altered to malachite, cf. Tschermak (Min. Mitth., 39, 1873), who has imitated this result; also Kk., Bull. Soc. St. Pet., **18**, 186, 1872. Also altered to chrysocolla, cf. Rose, Reis. Ural., **1**, 409, 412, 1837, and Bärwald, Zs. Kr., **7**, 169, 1882.

**Artif.**—On artificial atacamite, see Field, Phil. Mag., **24**, 123, 1862; Debray, Bull. Soc. Ch. **7**, 104, 1866; Friedel, C. R., **77**, 211, 1873; on analogous oxybromide, C. R., 109, 266, 1889. Occurs as a recent formation on bronze coins at Bourbonne-les-Bains (Daubrée).

**Ref.**—[1] Mean deduced by Zepharovich (Ber. Ak. Wien, **68** (1), 120, 1873) from measurements by himself and Klein (Jb. Min., 495, 1871) on Australian crystals; the angles in the prismatic zone show great irregularities (cf. E.S.D., Min. Mitth., 103, 1874); compare also Brögger's results on Chilian crystals, Zs. Kr., **3**, 488, 1879. With Dx., $u = 110$, $b = 001$, etc.

[2] See Zeph., l. c. and ib., **63** (1), 6, 1871, for authorities, etc.; cf. also Miller, Min., p. 618, 1852; Schrauf, Atlas, Tf. XXIV; Gdt., Index, **1**, p. 261, 1886. [3] Bgr., Chili, l. c. [4] N. R., p. 39, 1867; cf. also Bgr., l. c.

A black oxychloride of copper, differing somewhat from atacamite, is described by Domeyko (3d Append., Min. Chili, 1871). It was amorphous, grayish black, without luster. Compact to granular. Fracture even or subconchoidal. It takes a semi-metallic polish under the knife. Composition as obtained by Stuven, deducting impurities, $CuCl_2$ 16·94, CuO 68·67, $H_2O$ 14·39.

*Marcylite* of Shepard, as originally described, was an impure atacamite of a black color; a trial afforded Shepard: Copper 54·30. O and Cl 39 20, H 9·50. G. = 4–4·1. From the south part of the Red River, near the Wachita Mts. (See further under Melaconite.)

TALLINGITE *A. H. Church*, J. Ch. Soc., 18, 77, 213, 1865.

In thin crusts, consisting of irregular aggregations of minute globules, appearing botryoidal under the microscope. Subcrystalline. H. = 3. G. = 3·5 approx. Color bright blue, inclining to green. Streak white. Subtranslucent. Hygroscopic.

A hydrated copper chloride, according to Church. Analysis yielded: Cl 11·33, CuO 66·24. which is explained as Cl 11·33, CuO 53·57, Cu 10·11. $H_2O$ 24·99 = 100, for which Groth writes $Cu_6(OH)_8Cl_2 + 4H_2O$. Another sample contained more water.

Occurs at the Botallack mine, Cornwall. Named after R. Talling, of Lostwithiel, by whom the mineral was collected.

MELANOTHALLITE. Melanotallo *A. Scacchi*, Att. Acc. Napoli, May, 1870.

In thin scales at first black and gradually changing from without to green.

Composition perhaps $CuCl_2.CuO.2H_2O$ = $CuCl_2$ 53 8, CuO 31 8, $H_2O$ 14·4 = 100. Analysis: E. Scacchi, Rend. Acc. Napoli, Dec., 1884, and Zs. Kr., 11, 405, 1886.

| | | |
|---|---|---|
| $CuCl_2$ 58·25 | CuO 31·37 | $H_2O$ (100°) 10·38 = 100 |
| 57·37 | 31·39 | 11·24 = 100 |

Dissolves in water, giving an acid reaction. Found with euchlorine and hydrocyanite at Vesuvius.

ERYTHROCALCITE. Eriocalco *A. Scacchi*. A hydrated copper chloride found in wool-like aggregates of a bright blue color; from the eruption of 1869 at Vesuvius.

It deliquesces on exposure. Composition $CuCl_2$ with an undetermined amount of water; an analysis of the aqueous solution gave: Cu 48·08, Cl 51·92. E. Scacchi, Rend. Acc. Napoli, Dec., 1884, Zs. Kr., 11, 405, 1886.

ATELITE. Atelina *A. Scacchi*, Att. Acc. Napoli, 6, 1873, Contr. Min., II, 22, 1874. Observed as more or less complete pseudomorphs after tenorite, and formed by the action on the latter of fumes of hydrochloric acid; as a result the black color is changed to green. An analysis gave: CuO 45·59, $CuCl_2$ 38·19, $H_2O$ and loss 16·22 = 100. This corresponds to $2CuO.CuCl_2.3H_2O$. Found at Mt. Vesuvius, as a result of the eruption of April, 1872. It is not far from atacamite. Named from ἀτελής, *imperfect*.

**194. DAUBRÉEITE.** Daubreite *I. Domeyko*, C. R., 82, 922, 1876; Min. Chili, p. 297, 1879.

Amorphous; structure compact, earthy, in part fibrous.

H. = 2–2·5. G. = 6·4–6·5. Color yellowish to grayish white. Opaque.

**Comp.**—A hydrated oxychloride of bismuth, perhaps $2Bi_2O_3.BiCl_3.3H_2O$ (Rg.).

**Anal.**—Domeyko, l. c.

| | | | |
|---|---|---|---|
| $Bi_2O_3$ 89·60 | Cl 7·50 | $H_2O$ 3·84(?) | $Fe_2O_3$ 0·72 = 101·66 |

**Pyr.**—In the closed tube gives off acid water, and becomes grayish in color; but on continued heating below fusion turns yellow again. B.B. colors the flame slightly blue; in very thin splinters fuses on the end instantly, the fused part becoming black and compact. Soluble in hydrochloric acid in the cold without residue; the solution has a more or less yellow color.

**Obs.**—Occurs at the Constancia mine, Cerro de Tazna, Bolivia. Named after M. Daubrée, of Paris.

**195. NOCERITE.** Nocerina *A. Scacchi*, Acc. Linc. Trans., 5, 270, 1881. Nocerin.

Hexagonal. In very slender white acicular crystals. Optically negative, uniaxial, Btd[1].

**Comp.**—Perhaps $2(Ca,Mg)F_2.(Ca,Mg)O$, but doubtful.

**Anal.**—E. Fischer and Lederer, Zs. Kr., **10**, 270, 1885.

| F | Al | Mg | Ca | Na | K | O |
|---|---|---|---|---|---|---|
| 37·60 | 4·38 | 17·52 | 26·92 | 2·47 | 0·51 | 11·40 = 100·80 |

**Obs.**—Occurs in volcanic bombs in the tufa of Nocera, near Naples, Italy; it is associated with fluorite, some brown crystals referred to amphibole, and minute crystals in hexagonal prisms, perhaps a variety of microsommite. The exterior of the bombs is covered with mica.

**Ref.**—[1] Bull. Soc. Min., **5**, 142, 1882.

FLUOSIDERITE *A. Scacchi;* E. Fisher, Zs. Kr., **10**, 270, 1885.

In minute crystals forming a granular crust of a bright red color underneath the mica covering of the bombs of Nocera which have yielded the nocerite (see above). Composition unknown; some measurements, but not leading to definite results, have been made by vom Rath, Ber. nied. Ges., Dec. 4, 1882.

PSEUDONOCERINA *A. Scacchi*, Mem. Accad. Napoli, **2**, 1885; Vulcani fluoriferi, p. 69.

In minute, transparent acicular crystals, resembling nocerite and also containing fluorine, but of unknown composition. Fusible B.B. Dissolves in boiling hydrochloric acid with difficulty; with sulphuric acid fluorine is liberated. Found in bombs inclosed in the tufa of Pacognano, near Vico Equense on the south side of the Bay of Naples.

**196. FLUOCERITE.** Neutralt flussspatssyradt Cerium *Berz.*, Afh., **6**, 56, 1818. Neutrales flusssaures Cerer, Flusscerium ceriumfluat, *Germ.* Neutral Fluate of Cerium. Cerium fluatée *Fr.* Flucérine *Beud.*, Tr., **2**, 519, 1832. Fluocerit *Haid.*, Handb., 500, 1845.

Massive.

H. = 4. G. = 5·70 W.; 5·93 Österby, Nd. Luster resinous. Color reddish yellow. Subtranslucent to opaque.

**Comp.**—$R_2OF_4$ or $R_2O_3.4RF_3$, where R = cerium metals chiefly, with some of the yttrium group.

**Anal.**—M. Weibull and Tedin, G. För Förh., **8**, 496, 1886; *b* recalculated on basis of atomic weights: Ce = 141, Di,La = 143, Y, etc. = 97·5.

| | $Ce_2O_3$ | $(La,Di)_2O_3$ | $(Y,Er,Yt)_2O_3$ | F | | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| G. = 5·70 | $\frac{4}{4}$ 46·03 | 36·00 | 3·96 | 19·49 | | 1·78 | Cl,$Al_2O_3$ *tr.*, [$CaCO_3$ 1·50 = 108·76[a] |
| | Ce | La,Di | Y,Er,Yt | F | O | $H_2O$ | |
| | 39·53 | 30·82 | 3·19 | 19·49 | 4·43 | 1·78 | $CaCO_3$ 1·50 = 100·74 |

[a] Deduct O (= F) 8·21 = 100·55

**Pyr., etc.**—In the closed tube yields water, and at a high temperature corrodes the glass; the water contains fluorine, and tinges Brazil-wood paper yellow; the assay changes from yellow to white by heat. B.B. on charcoal infusible, but darkens in color. With soda it is not dissolved, but divides and swells up; the soda is absorbed by the charcoal, and leaves a gray mass on the surface.

**Obs.**—Occurs at Österby in Dalarne, Sweden, in pegmatyte veins with gadolinite, orthite, etc. Cf. remarks under tysonite, p. 166.

## III. Hydrous Chlorides, etc.

### A. Hydrous Chlorides.

| | | | |
|---|---|---|---|
| 197. | **Bischofite** | $MgCl_2 + 6H_2O$ | Monoclinic (artif.) |

| | | | |
|---|---|---|---|
| 198. | **Kremersite** | $KCl.NH_4Cl.FeCl_3 + H_2O$ | Isometric |
| | | | $\breve{a} : \bar{b} : \grave{c}$ |
| 199. | **Erythrosiderite** | $2KCl.FeCl_3 + H_2O$ | Orthorhombic 0·6911 : 1 : 0·7178 |
| 200. | **Douglasite** | $2KCl.FeCl_2 + 2H_2O$ | Monoclinic (artif.) |

| | | | | | |
|---|---|---|---|---|---|
| 201. | **Carnallite** | $KCl.MgCl_2 + 6H_2O$ | Orthorhombic | $\breve{a} : \bar{b} : \dot{c}$<br>0·5936 : 1 : 0·6906 | |
| 202. | **Tachhydrite** | $CaCl_2.2MgCl_2 + 12H_2O$ | Rhombohedral | $\dot{c}$<br>1·90 | |

## B. Hydrous Fluorides.

| | | | | | |
|---|---|---|---|---|---|
| 203. | **Fluellite** | $AlF_3 + H_2O$ | Orthorhombic | $\breve{a} : \bar{b} : \dot{c}$<br>0·7700 : 1 : 0·8776 | |
| 204. | **Prosopite** | $CaF_2.2Al(F,OH)_3$ | Monoclinic | $\grave{a} : \dot{\bar{b}} : \dot{c}$<br>1·3188 : 1 : 0·5950 | $\beta$<br>85° 40′ |
| 205. | **Pachnolite** | $NaF.CaF_2.AlF_3 + H_2O$ | Monoclinic | $\grave{a} : \dot{\bar{b}} : \dot{c}$<br>1·1626 : 1 : 1·5320 | $\beta$<br>89° 40′ |
| 206. | **Thomsenolite** | | " | 0·9975 : 1 : 1·0329 | 86° 48′ |
| 207. | **Gearksutite** | $CaF_2.Al(F,OH)_3 + H_2O$ | | | |
| 208. | **Ralstonite** | $(Mg,Na_2)F_2.3Al(F,OH)_3 + 2H_2O$ | Isometric | | |
| 209. | **Yttrocerite** | | | | |

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## A. Hydrous Chlorides.

**197. BISCHOFITE** *Ochsenius* [Die Bildung der Salzlager, Halle, 1877], JB. Ch., pp. 1284, 1285, 1877.

Crystalline-granular and foliated, sometimes fibrous.

H. = 1–2. G. = 1·65. Colorless to white. Luster vitreous to dull.

**Comp.**—$MgCl_2 + 6H_2O$ = Chlorine 35·0, magnesium 11·8, water 53·2 = 100.

**Anal.**—Koenig:

$\frac{2}{2}$ Cl 35·04 Mg 11·86 $H_2O$ [53·10] = 100

Soluble in 0·6 parts of cold water.

**Obs.**—Occurs in layers 2–3 cm. thick in halite, with kieserite and carnallite; the fibers transverse to the layers, at Leopoldshall, Prussia. The assumption of water is said to commence as soon as the layer is exposed to the air. The artificial salt is monoclinic, cf. Rg., Kr. Ch., 264, 1881.

Named after Dr. Gustav Bischof, the German chemist and geologist (1792–1870).

**198. KREMERSITE.** Eisenchlorid mit den Chloralkalien *Kremers*, Pogg., **84**, 79, 1851. Kremersit *Kenng.*, Min., 9, 1853.

Isometric. In octahedrons.

Color ruby-red. Easily soluble.

**Comp.**—$KCl.NH_4Cl.FeCl_3 + H_2O$ = Potassium chloride 24·2, ammonium chloride 17·3, ferric chloride 52·6, water 5·9 = 100; or Chlorine 57·5, potassium 12·7, ammonium 5·8, iron 18·1, water 5·9 = 100.

**Anal.**—Kremers, l. c.:

Cl 55·15 Fe 16·89 K 12·07 $NH_4$ 6·17 Na 0·16 H [9·56] = 100

**Obs.**—From fumaroles at Vesuvius, associated with ferric chloride as a product of sublimation.

Named after the chemist Dr. P. Kremers.

**199. ERYTHROSIDERITE.** Eritrosidero *A. Scacchi,* Contr. Min., II, p. 42, 1874. Rend. Acc. Napoli, Oct., 1872.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·6911 : 1 : 0·7178 Scacchi.

100 ∧ 110 = *34° 39′, 001 ∧ 101 = 46° 5′, 001 ∧ 011 = 35° 40¼′.

**Forms:** *a* (100, *i*-ī); *d* (102, ½-ī), *e* (101, 1-ī). Angles: *mm‴* = 69° 18′, *dd′* = 54° 53′, *ee′* = 92° 10′, *ad* = 62° 33′, *ae* = 43° 55′.

Crystals somewhat tabular ‖ *a*. Color red, very deliquescent.

**Comp.**—$2KCl.FeCl_3.H_2O$ = Chlorine 53·8, iron 17·0, potassium 23·7, water 5·5 = 100.

**Anal.**—Scacchi, l. c.:

Cl 53·30 Fe 16·81 K 24·21 $H_2O$ 5·68 = 100

**Obs.**—Found at the cone of Vesuvius embedded in the lava of April, 1872, and undoubtedly formed at that time.

Named from ἐρυθρός, *red*, and σίδηρος, *iron*.

**200. DOUGLASITE.** *Ochsenius, Precht*, Ber. Ch. Ges., **13**, 2328, 1881. Eisenchlorürchlorkalium *Germ*.

A salt associated with carnallite at Stassfurt and stated to have the composition $2KCl.FeCl_2.2H_2O$ = Chlorine 48·2, potassium 26·6, iron 19·1, water 6·1 = 100.

The artificial salt is monoclinic with G. = 2·162. Cf. Sbs., Ber. Ak. Wien, **4** (1), 475, 1850, and Rg., Kr. Ch., 273, 1881.

**201. CARNALLITE.** Carnallit *H. Rose*, Pogg., **98**, 161, 1856. Kalium-Magnesiumchlorid *Germ*.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·59356 : 1 : 0·69062 Hessenberg[1].

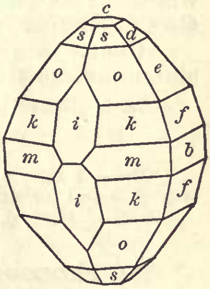
100 ∧ 110 = 30° 41½′, 001 ∧ 101 = 49° 19⅔′, 001 ∧ 011 = 34° 37⅚′.

**Forms**[2]: *b* (010, *i*-ĭ), *c* (001, *O*), *m* (110, *I*), *i* (201, 2-ī), *d* (043, ⁴⁄₃-ī), *e* (021, 2-ĭ), *f* (041, 4-ĭ), *s* (223, ⅔), *o* (111, 1), *k* (221, 2)

*mm‴* = *61° 23′ *ff′* = 140° 12′ *ss′* = 70° 20′ *ss‴* = 39° 59′
*ii′* = 133° 29′ *cs* = 42° 3′ *oo′* = 87° 30′ *oo‴* = 48° 28′
*dd′* = 85° 17′ *co* = *53° 32′ *kk′* = 107° 32′ *kk‴* = 57° 13′
*ee′* = 108° 11½′ *ck* = 69° 43′

Crystals rare, resembling hexagonal pyramids. Commonly massive, granular. No distinct cleavage. Fracture conchoidal. Brittle. H. = 1. G. = 1·60. Luster shining, greasy. Color milk-white, often reddish and with a metallic schiller due to minute enclosed scales of hematite. Transparent to translucent. Strongly phosphorescent. Taste bitter. Deliquescent. Optically +. Double refraction strong. Ax. pl. ‖ *b*. Bx ⊥ (100).

$2E_r$ = 115° 1′, $2E_{bl}$ = 117° 0′ Dx.[3]



Hessenberg.

**Comp.**—$KMgCl_3.6H_2O$ or $KCl.MgCl_2 + 6H_2O$ = Chlorine 38·3, potassium 14·1, magnesium 8·7, water 39·0 = 100 or Potassium chloride 26·8, magnesium chloride 34·2, water 39·0 = 100.

Analyses (5th Ed., p. 118, also Hammerbacher, Inaug. Diss., p. 21, Erlanger, 1874) show the presence of some sodium and calcium chlorides, calcium sulphate, etc. It also sometimes incloses besides iron oxide more or less organic matter. Hammerbacher found thallium in the Stassfurt mineral.

**Pyr., etc.**—B.B. fuses easily. Soluble in water, 100 parts of water at 18·75° C. taking up 64 5 parts; deliquescent.

**Obs.**—Occurs at Stassfurt, where it forms beds in the upper part of the salt formation, alternating with thinner beds of common salt and kieserite, and also mixed with the common salt. Its beds consist of subordinate beds of different colors, reddish, bluish, brown, deep red, sometimes colorless. The red varieties inclose scales of iron oxide and resemble some varieties of oligoclase (sunstone) from Tvedestrand (Groth). Sylvite occurs in the carnallite and may have been formed from it (Tschermak); as may also have been true at Kalusz, Galicia. Also found with salt at Maman in Persia.

Named after von Carnall of the Prussian mines.

**Artif.**—Occurs artificially formed in the salt-pans at Halle.

**Ref.**—[1] On natural crystals, a secondary formation at Stassfurt, Min. Not., **7**, 12, 1866. Rg. (Kr. Ch., 204, 1855) made the artificial crystals hexagonal with *co* = 53° 42′; they were later shown to be orthorhombic, Dx., Ann. Mines, **6**, 593, 1864, and N. R., **46**, 1867. Marignac obtained on artificial crystals: *mm‴* = 61°, *co* = 53° 35′, Ann. Mines, **12**, 3, 1857. The axes of Hbg. are calculated from his measured angle *mm‴* = 61° 23′ and an angle (Rg.) for artif. crystals.

viz.: $oo^{\text{iv}} = 72°\ 40'$, that is $co = 53°\ 40'$. [2] Hbg., l. c., all but *i* observed by Dx. (l.c.) on artificial crystals. [3] On masses from Stassfurt, l. c.

**202. TACHHYDRITE.** Tachhydrit *Rammelsberg*, Pogg., **98**, 261, 1856. Tachyhydrite, Tachydrite.

Rhombohedral. Axis $\dot{c} = 1{\cdot}90$; $rr' = 104°$ Groth[1].

Massive; in roundish masses with easy rhombohedral cleavage, and twin-lamellæ forming planes of parting.

Color wax- to honey-yellow. Transparent to translucent. Very deliquescent on exposure. Optically uniaxial, negative, Dx.[2]

**Comp.**—$CaMg_2Cl_6.12H_2O$ or $CaCl_2.2MgCl_2 + 12H_2O$ = Chlorine 41·1, calcium 7·7, magnesium 9·3, water 41·9 = 100, or Calcium chloride 21·4, magnesium chloride 36·7, water 41·9 = 100.

**Anal.**—Hammerbacher, Inaug. Diss., p. 24, Erlangen, 1874. Also Rg., l. c.; 5th Ed., p. 119.

$\frac{2}{3}$ Cl 40·85 Ca 7·16 Mg 9·97 $H_2O$ 42·50 = 100·48

**Pyr., etc.**—Fuses easily. Very soluble; 100 parts of water at 18·75° C. dissolving 160·3 of the salt.

**Obs.**—From the salt mines of Stassfurt, in thin seams with carnallite and kieserite, in anhydrite.

Named in allusion to its ready deliquescence, from ταχύς, *quick*, and ὕδωρ, *water*.

**Ref.**—[1] Tab. Ueb., 74, 1874. [2] N. R., 20, 1867.

**203. FLUELLITE.** Fluellite *Lévy*, Ann. Phil., **8**, 242, 1824. Fluate of Alumine, Fluorid of Aluminium.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}7700 : 1 : 1{\cdot}8776$ Miller[1].

$100 \wedge 110 = 37°\ 35\frac{3}{4}'$, $001 \wedge 101 = 67°\ 42'$, $001 \wedge 011 = 61°\ 57\frac{2}{3}'$.

In rhombic pyramids (*r*, 111) with basal plane.

Angles: $rr' = {}^*97°\ 48'$, $rr'' = {}^*144°$, $rr''' = 70°\ 56'$, $cr = 72°$.

Cleavage: *r* indistinct. H. = 3. G. = 2·17. Luster vitreous. Colorless to white. Transparent. Ax. pl. ‖ 100. Bx ⊥ *c*. Ax. angle large, = 100° approx. Groth. Refractive index 1·47.

**Comp.**—A hydrous fluoride of aluminium, $AlF_3 + H_2O$ = Fluorine 56·0, aluminium 26·4, water 17·6 = 100, Groth-Brandl.

**Anal.**—Brandl, Zs. Kr., **7**, 484, 1883.

F 56·25 Al 27·62 Na 0·58 $H_2O$ [15·55] = 100

**Obs.**—A rare mineral found at Stenna-gwyn, Cornwall, in minute crystals on quartz, with wavellite and torbernite.

**Ref.**—[1] Min., p. 607, 1852.

**204. PROSOPITE.** Prosopit *Scheerer*, Pogg., **90**, 315, 1853, **92**, 612, 1854, **101**, 361, 1857.

Monoclinic (or triclinic): Axes: $\grave{a} : \overset{1}{b} : \dot{c} = 1{\cdot}3188 : 1 : 0{\cdot}5950$; $\beta = 85°\ 40' = 001 \wedge 100$ Dx.[1]

$100 \wedge 110 = 52°\ 45'$, $001 \wedge 101 = 23°\ 30\frac{2}{3}'$, $001 \wedge 011 = 30°\ 40\frac{5}{6}'$.

**Forms**[2]: *b* (010, *i-ì*), *m* (110, *I*), *o* (011, 1-*ì*), *t* ($\bar{1}$11, 1), *z* (211, −2-2), *y* (231, −3-$\frac{3}{2}$).

$mm''' = 105°\ 30'$ $tt' = 58°\ 13'$ $bz = {}^*66°\ 59'$ $mz = {}^*45°\ 28'$
$bm = {}^*37°\ 15'$ $zz' = 46°\ 2'$ $by = 38°\ 7'$ $mt = 54°\ 59'$
$oo' = 61°\ 22'$ $yy' = 103°\ 46'$

In embedded crystals; also granular massive. Crystals sometimes tabular ‖ *b*.

Cleavage: *z* distinct. Fracture uneven. Brittle. H. = 4·5. G. = 2·88–2·89. Luster vitreous, weak. Colorless, white, grayish. Transparent to translucent. Optically +. Double refraction strong. Ax. pl. ‖ *b*. Bx nearly ‖ edge *z*/*z*′. Dispersion $\rho > v$. Ax. angles, Dx.:

$2H_{a\,r} = 65°\ 9'$ ∴ $2E_r = 104°\ 14'$ also $2H_{o.r} = 120°\ 56'$ ∴ $2V_r = 63°\ 30'$ $\beta_r = 1{\cdot}500$

$2H_{a.y} = 64° 21' \therefore 2E_y = 102° 50'$ also $2H_{o.y} = 121° 42' \therefore 2V_y = 62° 45'$ $\beta_y = 1{\cdot}502$

$2H_{a.bl} = 60° 35' \therefore 2E_{bl} = 96° 24'$ " $2H_{o.bl} = 124° 38' \therefore 2V_{bl} = 59° 20'$ $\beta_{bl} = 1{\cdot}506$

**Comp.**—A hydrous fluoride of aluminium and calcium, $CaAl_2(F,OH)_8$ or $CaF_2.2Al(F,OH)_3$ Groth-Brandl.

**Anal.**—1, Brandl, Zs. Kr., **7**, 490, 1883. 2, Hillebrand, Bull. **20**, U. S. G. Surv., 64, 1885. An earlier incomplete analysis was made by Scheerer.

| | | F | Al | Ca | Mg | Na | $H_2O$ | O |
|---|---|---|---|---|---|---|---|---|
| 1. Altenberg | | 35·01 | 23·37 | 16·19 | 0·11 | 0·33 | 12·41 | [12·58] = 100 |
| 2. Colorado | G. = 2·880 | $\frac{5}{5}$ 33·18 | 22·02 | 17 28 | 0·17 | 0·48 | 13·46 | [13·41] = 100 |

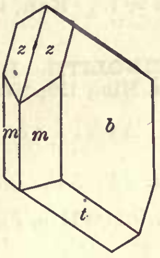
**Pyr., etc.**—In the glass tube affords water and silicon fluoride. Decomposed by sulphuric acid. The water goes off above 260° C.

**Obs.**—Occurs at the tin mines of Altenberg, in crystals, part of which are a kind of kaolin, and others, according to observations by G. J. Brush (Am. J. Sc., **25**, 411, 1858), cleavable violet fluorite, and others still. fluorite partly kaolinized. Also found at the Schlackenwald tin mines. In cellular pachnolite, derived from the alteration of cryolite, with fluorite and astrophyllite at St. Peter's Dome near Pike's Peak, Colorado.

Named from *προσωπεῖον, a mask,* in allusion to the deceptive character of the mineral.

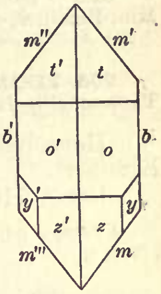
**Ref.**—[1] Made triclinic by Dx. (N. R., 190, 1867), but as shown by Groth (Zs. Kr., **7**, 489, 1883) the variations in angle lie within the probable errors of observation, and hence it seems better to regard it as monoclinic, at least provisionally. These axes are calculated from the fundamental angles of Dx., the mean of 010 ∧ 110, 0$\bar{1}$0 ∧ 1$\bar{1}$0, also of 010 ∧ 211, 0$\bar{1}$0 ∧ 2$\bar{1}$1, being taken. [2] Scheerer, Pogg., **101**, 361, 1857.

1.



Colorado.

2.



Altenberg.

## 205. PACHNOLITE.

Pachnolit *Knop*, Lieb. Ann., **127**, 61, 1863. Pyroconite *Wöhler*, Lieb. Ann., **180**, 231, 1875.

Monoclinic. Axes: $\grave{a} : \bar{b} : \grave{c} = 1{\cdot}1626 : 1 : 1{\cdot}5320$; $\beta = 89° 40' = 001 \wedge 100$ Groth[1].

100 ∧ 110 = 49° 18′, 001 ∧ 101 = 52° 35⅔′, 001 ∧ 011 = 56° 52′.

**Forms**[1]:
*a* (100, *i*-$\bar{i}$) as tw. pl.
*c* (001, *O*)
*m* (110, *I*)
*p* (111, – 1)
*s* (554, – $\frac{5}{4}$)[2]
*t* (553, – $\frac{5}{3}$)[2]
*q* (221, – 2)[2]
*v* (331, – 3)[2]
*x* (551, – 5)[2]
*σ* ($\bar{1}$11, 1)
*e* (311, – 3-$\bar{3}$)[3]

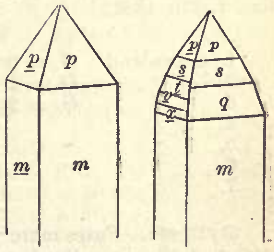
*mm'''* = *98° 36′ — *mp* = 26° 17′ — *mx* = 5° 39′ — *vv'* = 96° 45½′
*cp* = 63° 30′ — *ms* = 21° 34′ — *pp'* = 85° 27′ — *ee'* = 41° 8′
*cm* = 89° 47′ — *mq* = 13° 53′ — *ss'* = 89° 30′ — *cc* = *0° 40′
*ce* = 76° 26′ — *mv* = 9° 22′ — *qq'* = 47° 20′ — $p\underline{p}$ = *71° 46′
*ap* = 54° 7′

Twins: tw. pl. *a*, the crystals having thus an orthorhombic appearance. Crystals prismatic, commonly acutely terminated; also terminated by *c*. Faces *m* striated ‖ edge *m*/*c*.

Cleavage: *c* indistinct. Fracture uneven. Brittle. H. = 3. G. = 2·93–3·0. Luster vitreous. Colorless to white. Transparent to subtransparent. Optically +. Ax. pl. ⊥ *b*. Bx ∧ $\grave{c}$ = + 68° 5′. Ax. angle large, 2E = 120° approx. Dispersion $\rho < v$ weak; horizontal strong, Dx.

**Comp.**—A hydrous fluoride of aluminium, calcium, and sodium, $NaCaAlF_6.H_2O$ or $NaF.CaF_2.AlF_3.H_2O$ = Fluorine 51·5, aluminium 12·2, calcium 17·9, sodium 10·3, water 8·1 = 100.

**Anal.**—1–4, Hillebrand, Bull. **20**, U. S. G. Surv., 54, 1885.


1. 2.

Greenland, Knr.

5, Knop, l. c. 6, Hagemann, Am. J. Sc., **41**, 119, 1866. 7, Wöhler, l. c. 8, Koenig, Proc. Ac. Philad., 42, 1876.

| | | | F | Al | Ca | Na | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. | Colorado, *compact* | G. = 2·980 | [50·27] | 11·94 | 19·32 | 10·43 | 7·91 Mg 0·13 = 100 |
| 2. | " *cryst.* | | [51·19] | 12·93 | 15·22 | 10·28 | 8·72 Mg 1·53, K 0·13 = 100 |
| 3. | " " | | 51·32 | 12·14 | 18·06 | 10·23 | 8·10 = 99·86 |
| 4. | " " | G. = 2·965 | [51·39] | 12·27 | 18·04 | 10·25 | 8·05 = 100 |
| 5. | Greenland | G. = 2·923 | 50·79 | 13·14 | 17·25 | 12·16 | 9·60 = 102·94 |
| 6. | " | | 51·15 | 10·37 | 17·44 | 12·04 | 8·63 = 99·63 |
| 7. | " | G. = 2·929 | [49·78] | 13·43 | 17·84 | 10·75 | 8·20 = 100 |
| 8. | " | G. = 3·008 | 51·54 | 12·50 | 18·14 | 10·23 | 8·19 = 100·60 |

**Obs.**—Occurs with cryolite, thomsenolite, etc., at Ivigtut, Greenland, and at St. Peter's Dome, Colorado.

Pachnolite is from πάχνη, *frost*, λίθος, stone. Pyroconite from πῦρ, *fire*, and κονία, *powder*, because it falls to pieces when ignited B.B.

**Ref.**—[1] Zs. Kr., **7**, 462, 1883. Cf. also Knr., Nat. Ber. aus Ungarn, **1**, 166, 1883, and Kk., Min. Russl., **8**, 425, **9**, 1. [2] Knr., l. c. [3] Hillebrand, l. c.

**206. THOMSENOLITE.** Dimetric Pachnolite *G. Hagemann*, Am. J. Sc., **42**, 93, 1866. Thomsenolite *Dana*, Min., 129, 1868.

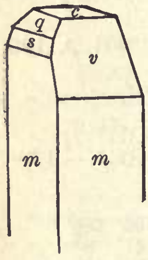
Monoclinic. Axes: $\grave{a} : \bar{b} : \acute{c}$ = 0·9975 : 1 : 1·0329; $\beta$ = 86° 48′ = 001 ∧ 100 Krenner[1].

100 ∧ 110 = 44° 53′, 001 ∧ $\bar{1}$01 = 47° 39⅓′, 001 ∧ 011 = 45° 53′.

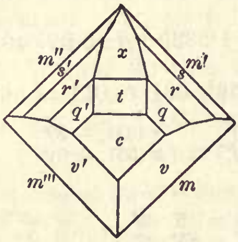
**Forms:** *c* (001, *O*); *m* (110, *I*); *t* ($\bar{1}$01, 1-ī), *x* ($\bar{3}$02, $\frac{3}{2}$-ī); *v* (331, – 3), *q* ($\bar{1}$11, 1), *r* ($\bar{2}$21, 2), *s* ($\bar{3}$31, 3).

| | | | |
|---|---|---|---|
| *mm‴* = *89° 46′ | *cv* = 75° 0′ | *cr* = 73° 9′ | *qq′* = *72° 48′ |
| *ct* = 47° 39′ | *cm* = *87° 44′ | *cs* = 79° 19′ | *rr′* = 85° 3′ |
| *cx* = 59° 30′ | *cq* = 57° 10′ | *vv′* = 86° 2′ | *ss′* = 87° 53½′ |

1.



2.



Greenland, Knr.

Crystals often cubic in aspect (*c*, *m*); also prismatic, with prismatic and also pyramidal faces striated ∥ edge *c*/*m*; often grouped in parallel position. Twins not observed. Also massive, opal, or chalcedony-like.

Cleavage: *c* perfect; *m* less so. Fracture uneven. Brittle. H. = 2. G. = 2·93–3·0. Luster vitreous, on *c* somewhat pearly. Colorless to white, or with a reddish tinge. Transparent to translucent. Optically –. Ax. pl. ⊥ *b*. Bx ∧ $\acute{c}$ = – 52° 22′. Dispersion $\rho < v$. Ax. angles:

$2E_r$ = 69° 10′ $2E_y$ = 69° 36′ also $2H_r$ = 48° 28′ $2H_{bl}$ = 49° 14′ Knr.

**Comp.**—Same as pachnolite, $NaCaAlF_6.H_2O$.

**Anal.**—1, Hagemann, l. c. 2, Wöhler, Nachr. Ges. Göttingen, Nov. 17, 1875. 3, Koenig, Proc. Ac. Philad., p. 42, 1876. 4, Nordenskiöld, G. För. Förh., **2**, 84, 1874. 5–7, Brandl, Zs. Kr., **7**, 470, 1883.

| | | | F | Al | Ca | Na | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. | Greenland | G. = 2·75 | 50·08 | 14·27 | 14·51 | 7·15 | 9·70 $SiO_2$ 2·0 = 97·71 |
| 2. | " | G. = 2·929 | [49·78] | 13·43 | 17·84 | 10·75 | 8·20 = 100 |
| 3. | " | G. = 2·937 | 50·37 | 13·74 | 16·79 | 10·10 | 9·00 = 100 |
| 4. | " | | [52·25] | 14·22 | 15·38 | 8·87 | 8·92 Mg 0·36, K *tr.* = 100 |
| 5. | " | | 50·65 | 13·04 | 17·22 | 10·02 | 8·48 Mg 0·39 = 99·80 |
| 6. | " | | 50·62 | 13·00 | 17·21 | 10·49 | 8·33 Mg 0·20 = 99·85 |
| 7. | " | | 50·61 | 13·26 | 17·22 | 10·43 | 8·42 = 99·94 |

**Pyr., etc.**—Fuses more easily than cryolite to a clear glass. The massive mineral decrepitates remarkably in the flame of a candle. In powder easily decomposed by sulphuric acid.

**Obs.**—Found with pachnolite on the cryolite of Greenland, as a result of alteration of the latter. First noticed by Dr. Julius Thomsen of Copenhagen, the originator of the cryolite industry, after whom it is named. It differs strikingly from pachnolite in its pearly basal cleavage and its nearly square prisms; and from cryolite in the horizontal striæ of the same and the facility of cleavage. The compact variety referred here by Dr. Hagemann has much of the aspect of chalcedony; it incrusts cryolite or occupies seams or cavities in it, and is covered by the chalky gearksutite; the incrustations are sometimes half an inch or more thick.

Also occurs sparingly with pachnolite and other fluorides at St. Peter's Dome, near Pike's Peak, Colorado.

**Ref.**—[1] Nat. Ber. aus Ungarn, **1**, 162, 1882.

HAGEMANNITE *Shepard*, Am. J. Sc., **42**, 246, 1866. Closely resembles in aspect and condition the compact thomsenolite, but passes sometimes into a yellow, opaque, jaspery variety. It incrusts the cryolite, and also constitutes seams ⅓ to ½ inch thick. It sometimes traverses a drusy ferruginous pachnolite. It is ocher-yellow to wax-yellow in color, rarely faint greenish, dull, or with only a faintly glimmering luster, and looks like an iron flint, or yellow chloropal. H. = 3–3·5. G. = 2·59–2·60. Adheres but feebly to the tongue.

Hagemann obtained in an analysis: F 40·30, Al 12·06, Fe 5 96, Mg 2·30, Ca 11·18, Na 8·45, Si 7·79, $H_2O$ 10·44. G. = 2·83. Decrepitates surprisingly in the flame of a candle.

No probable formula can be deduced. Excluding the Si,Mg,Fe, the composition is that of thomsenolite; it is consequently probably an impure thomsenolite. Cf. Groth, Zs. Kr., **7**, 480, 1883.

## 207. GEARKSUTITE *Hagemann; Dana*, Min., p. 130, 1868. Evigtokite *Flight*, J. Ch. Soc., 43, 140, 1883.

Earthy, kaolin-like in aspect, but consisting of very minute colorless needles, with oblique extinction.

H. = 2. Luster dull. Color white.

**Comp.**—Perhaps $CaF_2.Al(F,OH)_3.H_2O$ = Fluorine 42·9, aluminium 15·1, calcium 22·4, water 15·1, oxygen 4·5 = 100, if F : OH = 2 : 1, Hillebrand.

**Anal.**—1, Hillebrand, Bull. **20**, U. S. G. Surv., 59, 1885. 2, G. Lindström, G. För. Förh., **7**, 687, 1885.

| | F | Al | Ca | Na | K | $H_2O$ | O | |
|---|---|---|---|---|---|---|---|---|
| 1. Colorado | $\frac{2}{2}$ 42·07 | 15·20 | 22·30 | 0·10 | 0·04 | 15·46 | [4·83] | = 100 |
| 2. Ivigtut | 41·81[a] | 15·37 | 21·02 | 1·06 | 0·23 | 15 03 | 4·82 | Fe 0·30, Mg 0·16, Cl 0·20=100 |

[a] Direct determination 40·55.

Hagemann's analysis (5th Ed., p. 130) is shown by Hillebrand to be incorrect in the determination of fluorine and water; the same author shows that Flight's *evigtokite* is identical with gearksutite. Flight gives: Al 16·23, Ca 22·39, Na 0·43 or $AlF_3$ 49 87, $CaF_2$ 43·66, NaF 0·76, $H_2O$ [5·71] = 100.

**Pyr.**—B.B. fuses easily to a white enamel. Gently heated in the tube gives off neutral water, but more strongly heated attacks the glass. Soluble in acids.

**Obs.**—Occurs sparingly with the Greenland cryolite, and is one of the results of its alteration. The underlying material is compact thomsenolite. Also more abundant with the fluorides, cryolite, pachnolite, etc., of St. Peter's Dome near Pike's Peak, Colorado.

Named from γή, *earth*, and *arksutite*, alluding to its earthy aspect.

## 208. RALSTONITE. *G. J. Brush*, Am. J. Sc., 2, 30, 1871.

Isometric. In octahedrons, also with cubic planes.

Cleavage none. Fracture uneven. Brittle. H. = 4·5. G. = 2·56–2·62. Luster vitreous. Colorless to white, milky, often yellow on the surface. Transparent to translucent. Often shows weak double-refraction, Btd.[1]

**Comp.**—A hydrous fluoride of sodium and aluminium, $(Na_2,Mg)F_2.3Al(F,OH)_3.2H_2O$, Penfield and Harper. If Na : Mg = 1 : 1 and F : OH = 2 : 1, this requires: Fluorine 43·4, aluminium 23·0, magnesium 4·5, sodium 4·4, water 17·9, oxygen 6·8 = 100.

**Anal.**—1, Nordenskiöld, on 0·22 gr., G. För. Förh., **2**, 81, 1874. 2, Brandl, on 0·5 gr., Zs. Kr., **7**, 474, 1883. 3, Penfield, Am. J. Sc., **32**, 380, 1886. 4 Penfield and Harper, ibid.

| | | F | Al | Mg | Na | Ca | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. | G. = 2·60 | [50·05][a] | 22·94 | 5·52 | 4·66 | 1·99 | 14·84 | K *tr.*, $P_2O_5$ *tr.* = 100 |
| 2. | | 57·12 | 22·14 | 3·56 | 5·50 | 1·53 | 10·00 | = 99·85 |
| 3. | | *undet.* | 22·33 | 4·29 | 4·12 | 1·67 | 18·41 | K 0·11 |
| 4. | G. = 2·58 | $\frac{2}{2}$ 39·91 | 24·25 | 4·39 | 4·27 | 0·03 | 18·73 | K 0·12 = 91·70 |

[a] This, as calculated, includes F 38·13, O 10·69.

Penfield and Harper confirm Nordenskiöld in finding the fluorine insufficient to unite with the bases; they complete analysis 4 by calculating the amount of hydroxyl required, viz. 16·27 (= 8·61 $H_2O$), here F : OH = 2 : 1.

**Pyr., etc.**—In the closed tube whitens, yields water at first, then a copious white sublimate which etches the tube. The water reacts acid. B.B. on charcoal a faint white sublimate. In the forceps whitens, colors the flame yellow, but does not fuse. With cobalt solution gives a deep blue. In salt of phosphorus dissolves completely to a colorless bead in both flames. Soluble with effervescence in a bead of sodium carbonate. Decomposed by sulphuric acid with evolution of hydrofluoric acid.

**Obs.**—Occurs with cryolite and thomsenolite at Ivigtut, Arksuk Fiord, Greenland.

**Ref.**—[1] Bull. Soc. Min., 4, 34, 1881.

**209. YTTROCERITE.** Yttrocerit *Gahn & Berzelius*, Afh., 4, 151, 1814. Yttrocererit *Leonh.*, Handb., 573, 1826. Yttria fluatée *Fr.* Fluate of Cerium and Yttria. Ytterflussspath, Flussyttrocalcit, *Germ.* Yttrocalcit *Glock.*, Syn., 283, 1847.

Massive: crystalline-granular and earthy.

Cleavage: in two directions inclined to each other 71° 30′. Fracture uneven. H. = 4–5. G. = 3·447 Berz.; 3·363 Rg. Luster glistening; vitreous to pearly. Color violet-blue, inclining to gray and white, often white; sometimes reddish brown.

**Comp.**—A fluoride of calcium with the metals of the cerium and yttrium groups. According to Rammelsberg the formula is $2(2RF_3.9CaF_2) + 3H_2O$, with R = Ce(La,Di) : Y(Er) = 1 : 2; further the cerium metals consist one-half of lanthanum and didymium, and the yttrium contains 30 p. c. of erbium.

**Anal.**—1, 2, Rg., Ber. Ch. Ges., 3, 857, 1870. Also earlier, Gahn and Berzelius (l. c. and Schw. J., 16, 241, 1816), 5th Ed., p. 125.

| | | CaO | $Ce_2O_3$ | $Y_2O_3$ | $H_2O$ |
|---|---|---|---|---|---|
| 1. | G. = 3·363 | 47·27 | 9·35 | 14·87 | 2·52 |
| 2. | | 49·32 | 16·14 | | |

**Pyr., etc.**—In the closed tube gives water. B B. on charcoal alone infusible; with gypsum the yttrocerite of Finbo fuses to a bead, not transparent, and that of Broddbo is infusible. With the three fluxes the Finbo mineral behaves like fluorite; the glass is, however, yellow in the oxidizing flame as long as hot, and becomes opaque sooner than the glass given by fluorite. In a pulverized state it dissolves completely in heated hydrochloric acid, forming a yellow solution.

**Obs.**—Occurs sparingly at Finbo and Broddbo, near Falun in Sweden, embedded in quartz, and associated with albite and topaz. Also at Amity, Orange Co., N. Y.; in Mass., probably Worcester Co.; at Mt. Mica, in Paris, Maine.

1016

# V. OXIDES.

**I. Oxides of Silicon.**

**II. Oxides of the Semi-Metals: Tellurium, Arsenic, Antimony, Bismuth; also Molybdenum, Tungsten.**

**III. Oxides of the Metals.**

Hydrogen and Titanium are included here.

## I. Oxides of Silicon.

| | | | | |
|---|---|---|---|---|
| **210.** | **Quartz** | $SiO_2$ | Rhombohedral, trapezohedral | $\grave{c} = 1{\cdot}09997$ |
| **211.** | **Tridymite** | $SiO_2$ | Hexagonal<br>or Pseudo-hexagonal | $\grave{c} = 1{\cdot}6530$ |
| | Asmanite | | | |
| **212.** | **Opal** | $SiO_2.nH_2O$ | Amorphous | |

**210. QUARTZ.** Κρύσταλλος *Theophr.*, etc. Crystallus (with allusion to its hexagonal form and pyramidal terminations) *Plin.*, **37**, 9, 10; Silex *Plin.*, **36**, 371. Crystallus, Quartzum, candidissimum [auriferous], *Germ.* Quertze, Kiselstein, *Agric.*, 276, etc., 444, 459, 465, 1546, 1529. Quartz, Kisel, *Wall.*, 102, 1747. Quarz, Kiesel, *Germ.* Qvarts *Swed.* Quarzo *Ital.* Cuarzo *Span.*

Rhombohedral; with trapezohedral tetartohedrism. Axis: $\grave{c} = 1{\cdot}09997$; $0001 \wedge 10\bar{1}1 = 51° 47' 10''$ Kupffer[1].

**Forms**, pt.[2]:

*c* $(0001, O)$ rare

*m* $(10\bar{1}0, I)$,
*a* $(11\bar{2}0, i\text{-}2\ \text{r})$
*a,* $(2\bar{1}\bar{1}0, i\text{-}2\ \text{l})$
*k* $(51\bar{6}0, i\text{-}\frac{6}{5}\ \text{r})$
$k_2$ $(31\bar{4}0, i\text{-}\frac{4}{3}\ \text{r})$
$k_4$ $(21\bar{3}0, i\text{-}\frac{3}{2}\ \text{r})$
$k_6$ $(32\bar{5}0, i\text{-}\frac{5}{3}\ \text{r})$
*k,* $(6\bar{1}\bar{5}0, i\text{-}\frac{6}{5}\ \text{l})$, etc.

*d* $(10\bar{1}2, \frac{1}{2})$
*r* $(10\bar{1}1, R)$
**m** $(60\bar{6}5, \frac{6}{5})$
*λ* $(50\bar{5}4, \frac{5}{4})$
**t** $(40\bar{4}3, \frac{4}{3})$
*j* $(30\bar{3}2, \frac{3}{2})$
*i* $(50\bar{5}3, \frac{5}{3})$

*l* $(20\bar{2}1, 2)$
*M* $(30\bar{3}1, 3)$
*Γ* $(40\bar{4}1, 4)$
*e* $(50\bar{5}1, 5)$
*ζ* $(60\bar{6}1, 6)$
*T* $(10{\cdot}0{\cdot}\overline{10}{\cdot}1, 10)$

*ω* $(01\bar{1}3, -\frac{1}{3})$
*π* $(01\bar{1}2, -\frac{1}{2})$
*z* $(01\bar{1}1, -1)$
*l,* $(02\bar{2}1, -2)$
*M,* $(03\bar{3}1, -3)$
*e,* $(05\bar{5}1, -5)$
*h* $(07\bar{7}2, -\frac{7}{2})$
*Φ* $(07\bar{7}1, -7)$
*Ψ* $(0{\cdot}11{\cdot}\overline{11}{\cdot}1, -11)$, etc.

*ξ* $(11\bar{2}2, 1\text{-}2\ \text{r})$
*s* $(11\bar{2}1, 2\text{-}2\ \text{r})$
*ξ,* $(2\bar{1}\bar{1}2, 1\text{-}2\ \text{l})$
*s,* $(2\bar{1}\bar{1}1, 2\text{-}2\ \text{l})$

Zone *msz*
*n* $(12{\cdot}1{\cdot}\overline{13}{\cdot}1, 13\text{-}\frac{13}{12}\ \text{r})$
*v* $(71\bar{8}1, 8\text{-}\frac{8}{7}\ \text{r})$
*x* $(51\bar{6}1, 6\text{-}\frac{6}{5}\ \text{r})$
*y* $(41\bar{5}1, 5\text{-}\frac{5}{4}\ \text{r})$
*u* $(31\bar{4}1, 4\text{-}\frac{4}{3}\ \text{r})$
*L* $(12\bar{3}2, -\frac{3}{2}\text{-}\frac{3}{2}\ \text{l})$
*τ* $(13\bar{4}3, -\frac{4}{3}\text{-}\frac{4}{3}\ \text{l})$
$τ_1$ $(14\bar{5}4, -\frac{5}{4}\text{-}\frac{5}{4}\ \text{l})$
$τ_2$ $(15\bar{6}5, -\frac{6}{5}\text{-}\frac{6}{5}\ \text{l})$
$τ_3$ $(16\bar{7}6, -\frac{7}{6}\text{-}\frac{7}{6}\ \text{l})$
$τ_4$ $(17\bar{8}7, -\frac{8}{7}\text{-}\frac{8}{7}\ \text{l})$, etc.
*β* $(\bar{2}9\bar{7}9, -1\text{-}\frac{9}{7}\ \text{r})$

Zone *m'sr*
*ρ* $(15\bar{6}1, -6\text{-}\frac{6}{5}\ \text{l})$

*υ* $(14\bar{5}1, -5\text{-}\frac{5}{4}\ \text{l})$
*μ* $(13\bar{4}1, -4\text{-}\frac{4}{3}\ \text{l})$
*W* $(3{\cdot}7{\cdot}\overline{10}{\cdot}3, -\frac{10}{3}\text{-}\frac{10}{7}\ \text{l})$
*ϵ* $(12\bar{3}1, -3\text{-}\frac{3}{2}\ \text{l})$
*N* $(11{\cdot}12{\cdot}\overline{23}{\cdot}11, -\frac{23}{11}\text{-}\frac{23}{12}\ \text{l})$
*t* $(32\bar{5}3, \frac{5}{3}\text{-}\frac{5}{3}\ \text{r})$
$t_2$ $(21\bar{3}2, \frac{3}{2}\text{-}\frac{3}{2}\ \text{r})$
*γ* $(31\bar{2}3, 1\text{-}\frac{3}{2}\ \text{l})$;

Zone *rπr'*
$B_2$ $(41\bar{5}6, \frac{5}{6}\text{-}\frac{5}{4}\ \text{r})$
$B_3$ $(21\bar{3}4, \frac{3}{4}\text{-}\frac{3}{2}\ \text{r})$
$B_4$ $(12\bar{3}5, -\frac{3}{5}\text{-}\frac{3}{2}\ \text{l})$

*Π* $(21{\cdot}5{\cdot}\overline{26}{\cdot}7, \frac{26}{7}\text{-}\frac{26}{21}\ \text{r})$
*ϕ* $(61\bar{7}3, \frac{7}{3}\text{-}\frac{7}{6}\ \text{r})$
*Δ* $(10{\cdot}5{\cdot}\overline{15}{\cdot}2, \frac{15}{2}\text{-}\frac{3}{2}\ \text{r})$ etc.

For most of these forms the complementary left or right planes, respectively, have been observed: thus, *x,* $(6\bar{1}\bar{5}1, 6\text{-}\frac{6}{5}\ \text{l})$, *t,* $(5\bar{2}\bar{3}3, \frac{5}{3}\text{-}\frac{5}{3}\ \text{l})$, etc., also *ρ,* $(\bar{1}6\bar{5}1, -5\ \frac{5}{6}\ \text{r})$, *τ,* $(\bar{1}4\bar{3}3, -\frac{4}{3}\text{-}\frac{4}{3}\ \text{r})$, *β* $(27\bar{9}9, -1\text{-}\frac{9}{7}\ \text{l})$ f. 14, etc. The distinction between the right and left forms has not usually been made out, and that between + and − forms only imperfectly.

$mk = 8° 57'$
$mk_2 = 13° 54'$
$mk_4 = 19° 6'$

$md = 57° 35'$
$mr = 38° 13'$
$mi = 25° 17'$
$ml = 21° 29'$
$mM = 14° 42'$
$m\gamma = 11° 8'$
$me = 8° 57'$
$m\zeta = 7° 28\frac{1}{2}'$

$mT = 4° 30'$

$m\omega = 67° 3'$
$m\Phi = 6° 25'$
$m\Psi = 4° 6'$

$\omega\omega' = 39° 28'$
$dd' = 55° 19\frac{1}{2}'$
$rr' = 85° 46'$
$rz = {}^*46° 15' 52''$

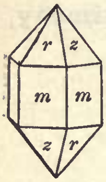
$a\xi = 42° 16\frac{1}{2}'$
$as = 24° 27'$

$mv = 8° 52'$
$mx = 12° 1'$
$my = 14° 35'$
$mu = 18° 29'$
$ms = 37° 58'$
$mL = 49° 29'$
$m\tau = 54° 33'$
$m\tau_1 = 57° 21'$
$m\tau_2 = 59° 7'$
$m\tau_3 = 60° 20'$
$m\tau_4 = 61° 13'$
$mz = 66° 52'$

$m\beta = 76° 39'$
$m\xi = 90° 0'$

$m'\rho = 12° 1'$
$m\upsilon = 14° 35'$
$m'\mu = 18° 29'$
$m'\epsilon = 25° 5'$
$m's = 37° 58'$
$m't = 45° 5'$
$m'r = 66° 52'$
$m'\gamma = 81° 54'$
$rs = 28° 54'$

1.



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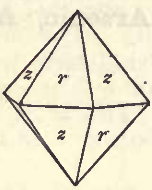

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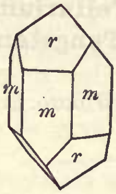

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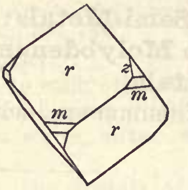

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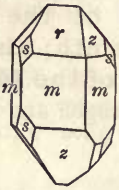

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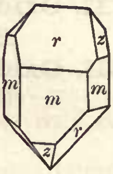

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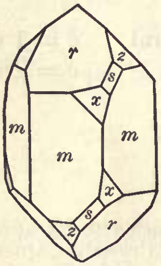

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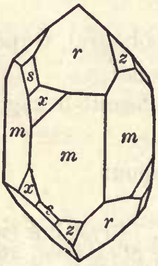

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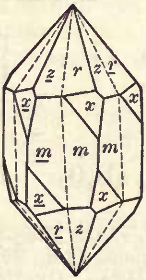

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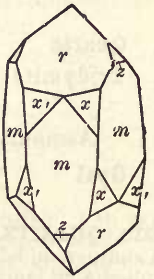

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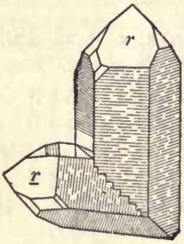

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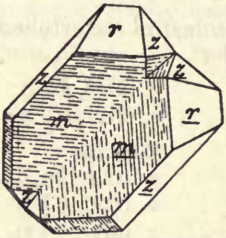

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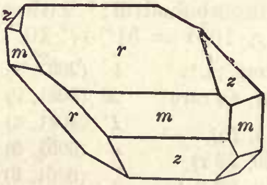
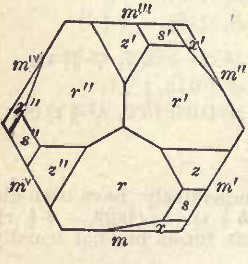


Figs. 1–6, simple forms. 7, Typical right-handed crystal. 8, Left-handed crystal. 9–12, Twins. 13, Distorted crystal. 9, 10, Sbk. 11, Switzerland, Dx. 12, Madagascar, Pfd.

Crystals commonly prismatic, with the *m* faces horizontally striated (f. 11); terminated either by both rhombohedrons (f. 1, 5, 6), or by one only (f. 3). Often in double six-sided pyramids or quartzoids through the equal development of *r* and *z* (f. 2); rarely *r* predominates (f. 4), the form then having a cubic aspect ($rr' = 85° 46'$). Crystals frequently distorted (f. 6, 13), when the correct orientation may be obscure except as shown by the striations on *m*. The faces *s* and $s_,$ also often striated ∥ edge $r/m'$ (*s*), or ∥ edge $r/m^{v}$ ($s_,$), cf. figs. 7, 8, 14; also striations common in other zones, f. 17, 18. Crystals often elongated to acicular forms, and tapering through the oscillatory combination of successive rhombohedrons with the prism. Occasionally twisted or bent. Frequently in radiated masses with a surface of pyramids, or in druses.

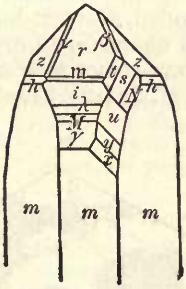
14.



The + rhombohedron (*r*) is usually the predominating form, where *r* and *z* are not equally developed, and its faces often show a higher luster than those of *z*; it can always be recognized by the shape of the etching figures (cf. figs. 26, 27), and also in most cases by pyroelectrical phenomena when these are distinct (see below). As shown by Rose, simple crystals are either right- or left-handed. On a *right-handed* crystal (f. 7), *s*, if present, lies to the right of the *m* face, which is below the plus rhombohedron *r*, and with this belong the plus right trapezohedrons, as *x*, also *u*, *y*, and *t* (f. 15, 16), and minus left trapezohedrons (f. 17), as *ρ*, *τ*, also *a* (left). On a *left-handed* crystal (f. 8), *s* (properly *s*,) lies to the left of the *m* below *r*, and with it (f. 18, 19, 20, the last two twins) the plus left and minus right trapezohedrons, also *a* (right). The right- and left-handed forms (except apparently ξ and ξ,) occur together only in twins. In the absence of trapezohedral planes the striations on *s* (cf. above and f. 16), if distinct, serve to distinguish the planes *r* and *z*, and hence show the right- and left-handed character of the crystals.

Twins[3]: (1) tw. axis ċ (tw. pl. *m*), axes hence parallel, the individuals both right- or both left-handed but unsymmetrical, *r* then parallel to and coinciding with $\underline{z}$, the resulting form, as in fig. 9, mostly penetration-twins, the parts often irregularly united (cf. f. 19, 20), as shown by dull areas (*z*) on the plus rhombohedral face (*r*); otherwise these twins are recognized by pyro-electrical phenomena.

15.



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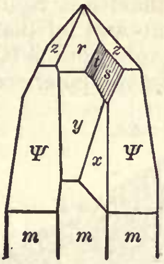

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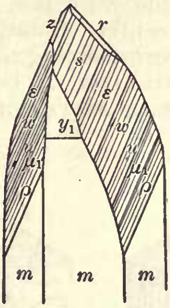

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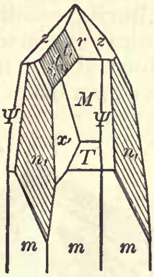

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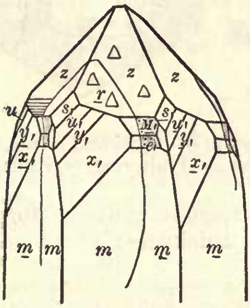

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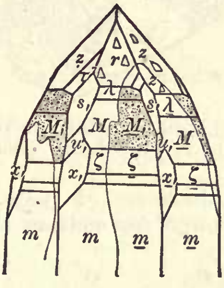

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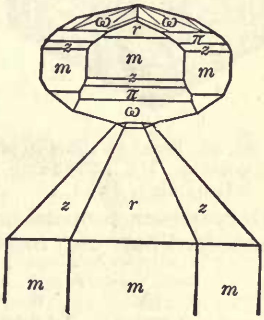


Figs. 15–21, Rath: 15, Dissentis; 16–21, Alexander Co., N. C.

(2) Tw. pl. *a*, sometimes called the *Brazil law*, the individuals respectively right- and left-handed and the twin symmetrical with reference to an *a* face (f. 10), usually as irregular penetration-twins; in these twins *r* and $\underline{r}$, also *z* and $\underline{z}$, coincide. This kind of twinning sometimes gives rise to successive zones of alternate character (as in amethyst); the composition is seen by the simultaneous appearance of planes characterizing both forms (right and left), and in irregular areas on the surface having different physical character; also in the optical behavior of cross-sections (⊥ ċ), as well as by pyro-electrical phenomena. (3) Tw. pl. ξ $(11\bar{2}2)$, contact-twins (f. 11, 12), the axes crossing at an angle of 84° 33′, and a plane *m* coincident in both individuals; the like rhombohedral faces are usually symmetrical, i.e., *r* to $\underline{r}$, etc., but sometimes unsymmetrical, that is, *r* corresponds to *z*, etc. Groupings which simulate twins are common; pseudo-twins, with *s* as the approximate twinning-

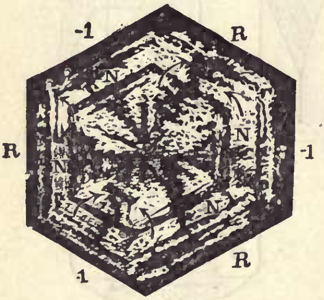
plane, are also produced by the arrangement of crystals in parallel position on the $-\frac{1}{2}R$ faces of calcite.

Massive forms common and in great variety, passing from the coarse or fine granular and crystalline kinds to those which are flint-like or cryptocrystalline. Sometimes mammillary, stalactitic, and in concretionary forms; as sand.

Cleavage: *r*, *z*, difficult and not often observed, also *m*, and sometimes *c*, more difficult; sometimes developed by sudden cooling after being heated; also (Mld.[4]) by the pressure of a sharp point on thin sections, e.g. cut $\parallel \dot{c}$ and $\perp m$. Also a lamellar structure $\parallel r$ and $\parallel z$ as gliding-planes, sometimes developed by secondary means (Judd[4]). Fracture conchoidal to subconchoidal in crystallized forms, uneven to splintery in some massive kinds. Brittle to tough. H = 7. G. = 2·653, 2·654 in crystals, Beud.; 2·660 cryst., Herkimer, Pfd.; cryptocrystalline forms somewhat lower (to 2·60) if pure, but impure massive forms (e.g. jasper) higher. Luster vitreous, sometimes greasy; splendent to nearly dull. Colorless when pure; often various shades of yellow, red, brown, green, blue, black. Streak white, of pure varieties; if impure, often the same as the color, but much paler. Transparent to opaque.

Optically +. Double refraction weak. Polarization circular; axial figure hence having a colored center. Rotation sometimes right-handed, also left-handed, the optical character corresponding to right- and left-handed character of crystals, as defined above; in twins (law 2) both right and left forms sometimes united, sections then often showing Airy's spirals in the polariscope; cf. figs. 23, 24, also 25.

23.



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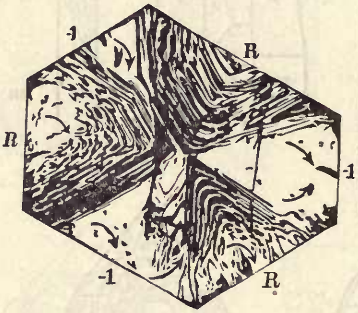


25.

Figs. 23, 24, Basal sections in polarized light, showing interpenetration of right- and left-handed portions, Dx. 25, Same, showing also secondary lamellæ (at *a*, *b*), alternately right- and left-handed, Judd.

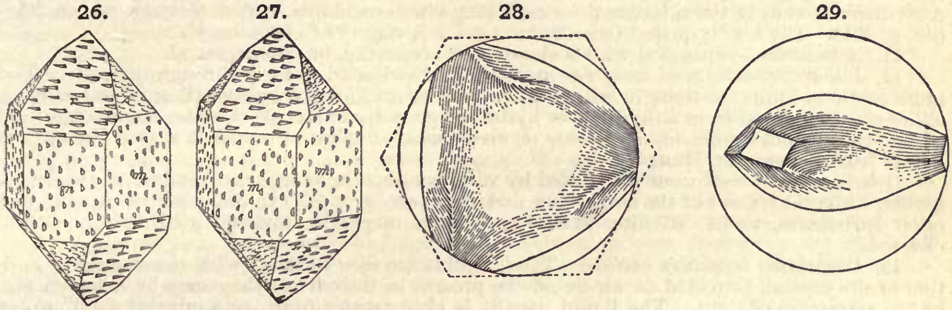
Rotatory power proportional to thickness of plate. Refractive indices[5] for the Fraunhofer lines; also rotatory power[6] for sections of 1mm. thickness:

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| $\omega$ = | 1·53913 | 1·54090 | 1·54181 | 1·54418 | 1·54711 | 1·54965 | 1·55425 |
| $\epsilon$ = | 1·54805 | 1·54990 | 1·55085 | 1·55328 | 1·55631 | 1·55894 | 1·56365 |
| $a$ | 12°·67 | 15°·75 | 17°·32 | 21°·71 | 27°·54 | 32°·77 | 42°·60 |

For $D_2$ $a$ = 21°·684, for $D_1$ $a$ = 21°·736.

Pyro-electric[7]; also electric by pressure or piezo-electric. By change of temperature a simple crystal is divided into + and − electrical zones parallel to the alternate prismatic edges; in right-handed crystals the right edges below *r*, and in left-handed the corresponding left edges (f. 7, 8), become *negative* on cooling, the alternate edges positive. In twins (1) two adjacent edges may have the same character; in twins (2, Brazil law) all the prismatic edges may have the same sign. Cross-sections $\perp \dot{c}$ are divided into sectors, and the irregular penetration is well exhibited by this method. A non-conductor for electricity, acting, in the form of fine threads, as an insulator in a remarkable degree even in a moist atmosphere. Comparable as a conductor, in the direction of the vertical axis, to glass at high temperatures, but not conducting normal to this direction[8].

Etching figures[11], developed by the action of hydrofluoric acid or alkaline carbonates, exhibit the right- and left-hand character of the crystals (Leydolt, Penfield, Molengraaff) as shown in figs. 26, 27. A sphere from a simple right-handed crystal subjected by Penfield to the action of acid was attacked rapidly in the direction of the vertical axis, but not at all at the + extremities of the axes. Cf. figs. 28, 29.



Figs. 26–29, Crystals etched by hydrofluoric acid, Penfield: 26, right-handed, 27, left-handed, crystal. 28, 29, sphere cut from simple right-handed crystal after being etched by acid for 7 weeks: 28, basal view; 29, front view; circle shows original form of sphere, dotted hexagon the position of axes.

**Comp.**—Silica, or silicon dioxide, $SiO_2$ = Oxygen 53·3, silicon 46·7 = 100.

In massive varieties often mixed with a little opal-silica. Impure varieties contain iron oxide, calcium carbonate, clay, sand, and various minerals as inclusions.

**Var.**—1. PHENOCRYSTALLINE: Crystallized, vitreous in luster.

2. CRYPTOCRYSTALLINE: Flint-like, massive.

The first division includes all ordinary vitreous quartz, whether having crystalline faces or not. The varieties under the second are in general acted upon somewhat more by attrition, and by chemical agents, as hydrofluoric acid, than those of the first. In all kinds made up of layers, as agate, successive layers are unequally eroded.

### A. PHENOCRYSTALLINE OR VITREOUS VARIETIES.

1. *Ordinary Crystallized; Rock Crystal.*—Colorless quartz, or nearly so, whether in distinct crystals or not. Ordinary as above described. Here belong the Bristol diamonds, Lake George diamonds, Brazilian pebbles, etc. Some variations from the common type are: (*a*) cavernous crystals, having deep cavities parallel to the faces—occasioned by the interference of impurities during their formation; (*b*) cap-quartz (Kappen-quarz *Germ.*), made up of separable layers or caps, due to the deposit of a little clayey material at intervals in the progress of the crystal; (*c*) drusy quartz, a crust of small or minute quartz crystals; (*d*) radiated quartz, often separable into radiated parts having pyramidal terminations; (*e*) fibrous (Faserkiesel *Germ.*), rarely delicately so, as a kind from Griqualand West, South Africa, altered from crocidolite (see *cat's-eye* below, also crocidolite p. 400).

2. *Asteriated; Star-quartz* (Stern-quarz *Germ.*).—Containing within the crystal whitish or colored radiations along the diametral planes. Occasionally exhibits asterism somewhat like that of the asteriated sapphire.

3. *Amethystine; Amethyst, Aμέθυστον, Theophr.*, etc.—Clear purple, or bluish violet. The color has been supposed to be due to manganese.

4. *Rose.*—Rose-red or pink, but becoming paler on exposure. Common massive, and then usually much cracked. Luster sometimes a little greasy. Fuchs states that the color is due to titanium; he found 1 to 1½ p. c. in specimens from Rabenstein, near Bodenmais. It may come in part from manganese.

5. *Yellow; False Topaz* or *Citrine.*—Yellow and pellucid, or nearly so; resembling somewhat yellow topaz, but very different in crystallization and in absence of cleavage.

6. *Smoky; Cairngorm Stone.* Mormorion *Plin.*, **37**, 63; Morion. (Rauch-quarz *Germ.*)—Smoky-yellow to smoky-brown, and often transparent; but varying to brownish black, and then nearly opaque in thick crystals. The color is probably due to some organic carbon-nitrogen compound (Forster). Called *cairngorms* from the locality at Cairngorm, S. W. of Banff, in Scotland. The name *morion* is given to some dark colored, nearly black, varieties.

7. *Milky.*—Milk-white and nearly opaque. Luster often greasy, and then called *greasy* quartz.

8. *Siderite*, or *Sapphire-quartz.*—Of indigo or Berlin-blue color; a variety occurring in an impure limestone at Golling in Salzburg.

9. *Sagenitic.*—Containing within acicular crystals of rutile (*a*), often in reticulated net-like forms; the mineral called from such specimens *sagenite* (fr. *σαγήνη, a net*) by de Saussure (see RUTILE).

Other included minerals in acicular forms are: (*b*) black tourmaline; (*c*) göthite; (*d*) stibnite; (*e*) asbestus; (*f*) actinolite; (*g*) hornblende; (*h*) epidote.

*Cat's-Eye* (Katzenauge *Germ.*, Œil de Chat *Fr.*)—Exhibiting opalescence, but without prismatic colors, especially when cut *en cabochon*, an effect sometimes due to fibers of asbestus. Also finely present in the siliceous pseudomorphs, after crocidolite, called *tiger-eye* (see crocidolite, p. 401). The highly-prized Oriental cat's-eye is a variety of chrysoberyl.

11. *Aventurine.*—Spangled with scales of mica, hematite, or other mineral.

12. *Impure from the presence of distinct minerals* distributed densely through the mass. The more common kinds are those in which the impurities are: (*a*) *ferruginous* (Eisenkiesel *Germ.*), either red or yellow, from anhydrous or hydrous iron sesquioxide; (*b*) *chloritic*, from some kind of chlorite; (*c*) *actinolitic;* (*d*) *micaceous;* (*e*) *arenaceous*, or sand. Sinopel is a red ferruginous quartz from Schemnitz, Hungary.

Quartz crystals also occur penetrated by various minerals, as topaz, corundum, chrysoberyl, garnet, different species of the amphibole and pyroxene groups, cyanite, zeolites, calcite, and other carbonates, rutile, stibnite, hematite, göthite, magnetite, fluorite, gold, silver, anthracite, etc.

13. *Containing liquids in cavities.* These liquids are seen to move with the change of position of the crystal, provided an air-bubble be present in the cavity; they may be detected also by the refraction of light. The liquid usually is either water (pure, or a mineral solution), or some petroleum-like or other compound. Quartz, especially smoky quartz, also often contains inclusions of both liquid and gaseous carbon dioxide. The water-cavities also occasionally contain minute cubes of sodium chloride. Cf. Hartley, Hawes[12]. Wright has shown the presence of the gases $CO_2$, N, $H_2S$, $SO_2$, $H_3N$ and F in the smoky quartz of Branchville, Conn.

### B. CRYPTOCRYSTALLINE VARIETIES.

1. *Chalcedony.* Murrhina *Plin.*, **37**, 7. *Ιασπις* pt. *Theophr.* Iaspis pt. *Plin.*, **37**, 37. Murrhina, *Germ.* Chalcedonius, *Agric.*, 466, 1546. Chalcedon, Achates vix pellucida, nebulosa, colore griseo mixta, *Wall.*, 83, 1747. Chalcedon *Germ.* Calcédoine *Fr.*—Having the luster nearly of wax, and either transparent or translucent. G. = 2·6–2·64. Color white, grayish, pale brown to dark brown, black; tendon-color common; sometimes delicate blue. Also of other shades, and then having other names. Often mammillary, botryoidal, stalactitic, and occurring lining or filling cavities in rocks. It often contains some disseminated opal-silica. The name *Enhydros* is given to nodules of chalcedony containing water, sometimes in large amount.

Embraced under the general name chalcedony is the crystalline form of silica which forms concretionary masses with radial-fibrous and concentric structure, and which, as shown by Rosenbusch (Mikr. Phys. Min., 345, 1882), is optically *negative*, unlike true quartz. It has $n_r$ = 1·537; G. = 2·59–2·64. Often in spherulites, showing the spherulitic interference-figure. Becker proposes to distinguish it under the name *chalcedonite* (U. S. G. Surv., Mon., **13**, 390, 1888). Cf. *lussatite* of Mallard, p. 197, which has a like structure, but is optically + and has the specific gravity and refractive index of opal.

2. *Carnelian.* *Σάρδιον* *Theophr.* Sarda *Plin.*, **37**, 23, id. = *Germ.* Carneol, *Agric.*, 468, 1546. Carneol, Agates fere pellucida, colore rubescente, *Wall.*, 82, 1747. Sard. Cornaline Fr.—A clear red chalcedony, pale to deep in shade; also brownish red to brown, the latter kind (Sardoine *Fr.*) reddish brown by transmitted light.

3. *Chrysoprase* (not Chrysoprasus *antiq.*). An apple-green chalcedony, the color due to the presence of nickel oxide. Klaproth found in that of Silesia 1·0 p. c. NiO; and Rammelsberg, in the same, 0·41 p. c. NiO.

4. *Prase.*—Translucent and dull leek-green; so named from *πράσον, a leek.* Always regarded as a stone of little value. The name is also given to crystalline quartz of the same color. "Vilioris est turbæ Prasius" says Pliny.

5. *Plasma.* Iaspis pt. *Plin.*, **37**, 37.—Rather bright green to leek-green, and also sometimes nearly emerald-green, and subtranslucent or feebly translucent; sometimes dotted with white.

*Heliotrope*, or *Blood-stone*, is the same stone essentially, with small spots of red jasper, looking like drops of blood.

The *Iaspis*, or jasper of the ancients, was a semitransparent or translucent stone, and included in Pliny's time all bright-colored chalcedony excepting the carnelian (sard). He gives special prominence to sky-blue and green, and mentions also a shade of purple (the color of the best, he says), a rose-color, the color of the morning sky in autumn, sea-green, terebenthine color (yellow like turpentine, as interpreted by King), smoke-color (his capnias), etc.; but in general there is a tinge of blue, whatever the shade. The green kinds may have been chrysoprase or plasma; or perhaps a variety of jade, a stone known in Europe since the Stone age.

The green, with a line running through it (Monogrammos), may have been plasma, or jade, with a narrow seam of white quartz.

Pliny's *Prasius*, spotted with red, was our heliotrope; his *Heliotrope* (**37**. 60) was a leek-green stone (prase or plasma) veined with blood-red (jasper); and the jasper was so abundant a part as to give a general red reflection to the whole when it was put in water in the face of the sun, whence the name from ἥλιος, *sun*, and *τρέπειν*, *to turn*.

6. *Agate*. 'Αχάτης [fr. Sicily] *Theophr*. Achates pt. *Plin*., **37**, 54.—Onyx pt. *Plin*., ib., 24.—A variegated chalcedony. The colors are either (*a*) banded; or (*b*) in clouds; or (*c*) due to visible impurities.

(*a*) *Banded*. The bands are delicate parallel lines, of white, tendon-like, wax-like, pale and dark brown, and black colors, and sometimes bluish and other shades. They follow courses, sometimes straight, more often waving or zigzag, and occasionally concentric circular, as in the eye-agate (*Leucophthalmus* Plin., **37**, 62, and *Triophthalmus* ib., 71). The fine translucent agates graduate into coarse and opaque kinds. The bands are the edges of layers of deposition, the agate having been formed by a deposit of silica from solutions intermittently supplied, in irregular cavities in rocks, and deriving their concentric waving courses from the irregularities of the walls of the cavity. As the cavity cannot contain enough of the solution to fill it with silica, an open hole has been supposed to be retained on one side to permit the continued supply; but it is more probable that it passes through the outer layers by osmosis, the denser solution outside thus supplying silica as fast as it is deposited within. The colors are due to traces of organic matter, or of oxides of iron, manganese, or titanium, and largely to differences in rate of deposition. The layers differ in porosity, and therefore in the rate at which they are etched by hydrofluoric acid; and consequently the etching process brings out the different layers, and makes engravings that will print exact pictures of the agate. Owing also to the unequal porosity, agates may be varied in color by artificial means, and this is done now to a large extent with the agates cut for ornament.

(*b*) *Irregularly* clouded. The colors various, as in banded agate.

A whitish clouded variety is probably the *Leucachates* Plin. (fr. λευκός, *white*); a wax-colored, his *Cerachates* (fr. *cera*, *wax*), a name that may have been applied also to ordinary wax-colored chalcedony, as the stone was one in little repute; (*c*) a reddish, his *Sardachates*, or carnelian-agate. The last probably included also banded kinds. *Hemachates* (fr. *αἷμα*, *blood*) was probably a true light-colored agate, blotched with red jasper, "blushing with spots of blood," as says Solinus (King, p. 207), of which there are very beautiful kinds, and not simple red jasper. *Iaspachates* must have been an agate in which bluish and greenish shades (Iaspis) predominated. These names are given by Pliny without accompanying descriptions. *Ruin-agate* or *Fortification-agate* is a variety with light to dark brown shades, showing, when polished, curious markings well described by the name.

(*c*) *Colors due to visible impurities*. (*a*) *Moss-agate*, or *Mocha-stone*, filled with brown moss-like or dendritic forms, as of manganese oxide, distributed through the mass. (*b*) *Dendritic Agate*, containing brown or black dendritic markings. These two are the *Dendrachates* Plin. (fr. *δένδρον*, *a tree*).

There is also *Agatized wood:* wood petrified with clouded agate.

7. *Onyx*. *'Ονυχιον* *Theophr*. Onyx pt. [rest agate, or stalagmite, p. 268] *Plin*., **37**, 24. Onice *Ital*.—Like agate in consisting of layers of different colors, but the layers are in even planes, and the banding therefore straight, and hence its use for cameos, the head being cut in one color, and another serving for the background. The colors of the best are perfectly well defined, and either white and black, or white, brown, and black alternate; also white and red. Onicolo *Ital*. (dimin.) is a name given to a kind of onyx in which a thin layer of white over black gives a bluish tinge.

8. *Sardonyx* Plin., **37**, 23.—Like onyx in structure, but includes layers of carnelian (sard) along with others of white or whitish, and brown, and sometimes black colors.

9. *Agate-Jasper*—An agate consisting of jasper with veinings and cloudings of chalcedony.

10. *Siliceous sinter*.—Irregularly cellular quartz, formed by deposition from waters containing silica or soluble silicates in solution. See also under opal, p. 195.

11. *Flint*. Silex pt. *Plin*., Feuerstein *Germ*.—Somewhat allied to chalcedony, but more opaque, and of dull colors, usually gray, smoky-brown, and brownish black. The exterior is often whitish, from mixture with lime or chalk, in which it is embedded. Luster barely glistening, subvitreous. Breaks with a deeply conchoidal fracture, and a sharp cutting edge. The flint of the chalk formation consists largely of the remains of diatoms, sponges, and other marine productions. The silica of flint, according to Fuchs, is partly soluble silica. There is usually a small amount of alumina and iron sesquioxide, with some water. The coloring matter of the common kinds is mostly carbonaceous matter. Flint implements play an important part among the relics of early man.

12. *Hornstone*. Silex pt., *Plin*. (Hornstein *Germ*.)—Resembles flint, but more brittle, the fracture more splintery. *Chert* is a term often applied to hornstone, and to any impure flinty rock, including the jaspers.

13. *Basanite; Lydian Stone*, or *Touchstone*. Lapis Lydius *Plin*., **33**, 43? Basanites id., **36**, 11, Lydite.—A velvet-black siliceous stone or flinty jasper, used on account of its hardness and black color for trying the purity of the precious metals. The color left on the stone after rubbing the metal across it indicates to the experienced eye the amount of alloy. It is not splintery like hornstone. It passes into a compact, fissile, siliceous, or flinty rock, of grayish and

other colors, called siliceous slate, and also *Phthanyte;* and then resembles ordinary jasper of grayish and other shades, especially the banded jaspers.

14. *Jasper.*—Impure opaque colored quartz. (*a*) *Red* (Hæmatitis *Plin.*, **37**, c. 60, not his Hæmatites), iron sesquioxide being the coloring matter. (*b*) *Brownish*, or *ocher yellow*, colored by hydrous iron sesquioxide, and becoming red when so heated as to drive off the water. (*c*) Dark green and brownish green. (*d*) Grayish blue. (*e*) Blackish or brownish black. (*f*) *Striped* or *riband jasper* (Bandjaspis *Germ.*), having the colors in broad stripes. (*g*) *Egyptian jasper*, in nodules which are zoned in brown and yellowish colors. (*h*) Jasponyx. (*i*) Jasperized wood.

*Porcelain jasper* is nothing but baked clay, and differs from true jasper in being B.B. fusible on the edges. *Red porphyry*, or its base, resembles jasper, but is also fusible on the edges, being usually an impure feldspar.

C. Besides the above there are also:

1. *Granular Quartz, Quartz-rock*, or *Quartzyte.*—A rock consisting of quartz grains very firmly compacted; the grains often hardly distinct. 2. *Quartzose Sandstone.* 3. *Quartz-conglomerate.* A rock made of pebbles of quartz with sand. The pebbles sometimes are jasper and chalcedony, and make a beautiful stone when polished. 4. *Itacolumyte*, or *Flexible Sandstone.* A friable sand-rock, consisting mainly of quartz-sand, but containing a little mica, and possessing a degree of flexibility when in thin laminæ. 5. *Buhrstone*, or Burrstone. A cellular, flinty rock, having the nature in part of coarse chalcedony.

6. *Pseudomorphous Quartz.*—Quartz appears also under the forms of many of the mineral species, which it has taken through either the alteration or replacement of crystals of those species. The most common quartz pseudomorphs are those of calcite, barite, fluorite, and siderite. (*a*) *Tabular quartz* consists of intersecting plates of quartz, and is probably a result of the quartz being deposited among intersecting plates of other minerals, as barite. (*b*) *Haytorite* of C. Tripe (Phil. Mag., **1**, 40, 1827) is a pseudomorph after datolite. (*c*) *Babel-quartz* is quartz which has, on the under surface, impressions of cubes of fluorite, arising from its having been deposited over the crystals; from Beer-Alston, Devonshire. (*d*) *Silicified shells* are proper pseudomorphs in quartz; they occur through many rock strata, including limestones. (*e*) *Silicified wood* is quartz pseudomorph after wood. The texture of the original wood is usually well retained, it having been formed by the deposit of silica from its solution in the cells of the wood, and finally taking the place of the walls of the cells as the wood itself disappeared.

*Beekite* (Beckite *Dufr.*) is a chalcedonic chert formed by the replacement of limestone fragments in the New Red conglomerate of South Devon, England; it often takes the form of calcareous shells or other fossils. Named after Dr. Beek, Dean of Bristol. See Hughes for occurrence, literature, etc., Min. Mag., **8**, 265, 1889.

**Pyr., etc.**—B.B. unaltered; with borax dissolves slowly to a clear glass; with soda dissolves with effervescence; unacted upon by salt of phosphorus. Insoluble in hydrochloric acid, and only slightly acted upon by solutions of fixed caustic alkalies, the cryptocrystalline varieties to the greater extent. Soluble only in hydrofluoric acid. When fused and cooled it becomes amorphous silica, having G. = 2·2.

**Obs.**—Quartz occurs as one of the essential constituents of granite, syenite, gneiss, mica schist, and many related rocks; as the principal constituent of quartz-rock and many sandstones; as an unessential ingredient in some trachyte (liparyte), porphyry, etc.; as the veinstone in various rocks, and for a large part of mineral veins; as a foreign mineral in the cavities of basalt, and related rocks, some limestones, etc., making geodes of crystals, or of chalcedony, agate, carnelian, etc.; as embedded nodules or masses in various limestones, constituting the flint of the chalk formation, the hornstone of other limestones—these nodules sometimes becoming continuous layers; as masses of jasper occasionally in limestone. It is the principal material of the pebbles of gravel-beds, and of the sands of the sea-shore, and sand-beds everywhere.

In graphic granite (*pegmatyte*) the quartz is arranged in parallel position in feldspar. The quartz grains in a fragmental sandstone are often found to have undergone a secondary growth by the deposition of crystallized silica with like orientation to the original nucleus. Cf. Sorby, Q. J. G. Soc., **36**, 1880, Pres. Address, p. 62; Irving, Am. J. Sc., **25**, 401, 1883.

Quartz crystals occasionally occur of enormous size. A group in the museum of the university at Naples weighs nearly half a ton. A crystal belonging to Sig. Rafelli, of Milan, measures 3¼ ft. in length and 5½ in circumference, and its weight is estimated at 870 lbs.; another in Paris is 3 ft. in diameter and weighs 8 cwt. About a century since a drusy cavity was opened at Zinken, which afforded 1,000 cwt. of rock crystal, and at that early period brought $300,000. One crystal weighed 800 lbs. A single cavity in a vein of quartz near the Tiefen Glacier, in Switzerland, discovered in 1867, afforded smoky quartz crystals weighing in the aggregate about 20,000 pounds; a considerable number of the single crystals having a weight of 200 to 250 pounds, or even more. A group from Moose Mountain, New Hampshire, at Dartmouth College, weighs 147½ lbs., and contains 48 crystals; four of them are from 5 to 5½ inches in diameter, ten from 4 to 4¼ inches. A crystal from Waterbury, Vt., 2 ft. long and 18 inches through, weighs 175 lbs.

Switzerland, Dauphiné, Piedmont, the Carrara quarries, and numerous other foreign localities, afford fine specimens of rock crystal; also Japan, whence the beautiful crystal spheres, in rare cases up to 6 inches in diameter. *Smoky quartz* crystals of great beauty, and often highly complex in form, occur at many points in the central Alps, also at Cairngorm, Scotland. The most beautiful amethysts are brought from India, Ceylon, and Persia, also from Brazil; inferior specimens occur in Transylvania, in large crystalline groups; in the vicinity of Cork, and on Achill Is., Co. Mayo, Ireland. The *false topaz* is met with in Brazil. *Rose quartz* occurs in a vein of manganese, traversing the granite of Rabenstein, near Zwiesel in Bavaria *Prase* is found in the iron mines of Breitenbrunn, near Schwarzenberg in Saxony; and in Brittany, near Nantes and Rennes. The amygdaloids of Iceland and the Färöer Islands afford magnificent specimens of *chalcedony;* also Hüttenberg and Leoben in Carinthia, etc. A smalt-blue variety, in cubical crystals (pseudomorphs of fluorite), occurs at Tresz'yan in Transylvania. The finest *carnelians* and *agates* are found in Arabia, India, Brazil, Surinam, also formerly at Oberstein and Saxony. Scotland affords smaller but handsome specimens (Scotch pebbles). *Chrysoprase*, at Kosemütz in Silesia. *Aventurine quartz*, at Cape de Gata in Spain. *Cat's-eye*, in Ceylon, the coast of Malabar, and also in the Harz and Bavaria. *Plasma*, in India and China, whence it is usually brought in the form of beads. *Heliotrope*, in Bucharia, Tartary, Siberia, and the island of Rum in the Hebrides. *Float stone*, in the chalk formation of Menil Montant, near Paris, and in some of the Cornish mines. The banks of the Nile afford the Egyptian jasper; the striped jasper is met with in Siberia, Saxony, and Devonshire. A *yellow jasper* is found at Vourla, bay of Smyrna, associated with opal, chrysoprase, and hornstone. The plains of Argos are strewn with pebbles of *red jasper*.

In New York, quartz crystals are abundant in Herkimer Co., at Middleville, Little Falls, Salisbury, and Newport, loose in cavities in the Calciferous sand-rock, or embedded in loose earth, and sometimes, according to Beck, in powdered anthracite. Fine quartzoids, at the beds of hematite in Fowler, Herman, and Edwards, St. Lawrence Co., also at Antwerp, Jefferson Co. In Gouverneur, crystals, with tourmaline, etc., in limestone, which have rounded angles as if they had been partially fused. On the banks of Laidlaw lake, Rossie, large implanted crystals. At Palatine, Montgomery Co., crystals, having one end terminated with the usual pyramid, while the other is rounded and smooth. At Ellenville lead mine, Ulster Co., in fine groups. At Diamond island and Diamond Point, Lake George, quartz crystals, as in Herkimer Co. In Mass., crystals with unusual modifications, sparingly at the Somerville syenite quarry. Pelham and Chesterfield, Mass., Paris and Perry, Me., Benton, N. H., Sharon, Vt., and Meadow Mount, Md., are other localities of quartz crystals. At Chesterfield, Mass., small unpolished rhombohedrons, in granite. At Paris, Me., handsome crystals of brown or smoky quartz. In large crystals, often perfect and weighing several pounds, at Minnesota mine, Lake Superior, occasionally enveloped in metallic copper, as if cast around the crystals. Drusy quartz, of brown, apple-green and other tints, at Newfane, Vt. Beautiful colorless crystals occur at Hot Springs, Arkansas. Alexander Co., N. C., has afforded great numbers of highly complex crystals, with rare modifications. Cf. Rath, l. c., Hidden, Am. J. Sc., 1881, 1883. Fine crystals of smoky quartz come from the granite of the Pike's Peak region, Colorado. Geodes of quartz crystals, also enclosing calcite, sphalerite, etc., are common in the Keokuk limestone of the west. For other localities, see the catalogue of localities in the latter part of this volume.

*Rose quartz*, at Albany, and Paris, Me., Acworth, N. H., Williamsburg, Mass., Southbury, Conn., and Port Henry, Essex Co., N. Y.; *smoky quartz*, at Goshen, Mass., Richmond Co., N.Y., etc.; *amethyst*, in trap, at Keweenaw Point, Pic bay, and Gargontwa, on Lake Superior; with fossilized wood at Specimen Mt., Yellowstone Park; at Bristol, Rhode Island, and sparingly throughout the trap region of Massachusetts and Connecticut; in Surry, New Hampshire; in Pennsylvania, in East Bradford, Aston, Chester, and Providence (one fine crystal over 7 lbs. in weight), in Chester Co.; very handsome at the Prince vein, Lake Superior, but now hardly obtainable, as the mine is not worked; also very large fine crystals, near Greensboro, N. C. Crystallized green quartz, in talc, at Providence, Delaware Co., Penn.; at Ellenville, N. Y., with chlorite. Chalcedony and agates of moderate beauty, in the same trap region; more abundantly about Lake Superior, the Mississippi, and the streams to the west; at Natural Bridge, Jefferson Co., N. Y.; about the Willamette, Columbia, and other rivers in Oregon; abundant and beautiful on N. W. shore of Lake Superior. Belmont's lead mine, St. Lawrence Co., N. Y., has afforded good chalcedony and chrysoprase, associated with calcite. Red jasper is found on Sugar Loaf Mt., Maine; in pebbles on the banks of the Hudson at Troy; yellow, with chalcedony, at Chester, Mass.; red and yellow, near Murphy's, Calaveras Co., Cal. Heliotrope occupies veins in slate at Blooming Grove, Orange Co., N. Y.

Smoky quartz in large crystals, some over 100 lbs., have been found on Paradise R., Nova Scotia.

Agatized and jasperized wood of great beauty and variety of color is obtained from the petrified forest called Chalcedony Park, near Carrizo, Apache Co., Arizona; also from the Yellowstone Park; near Florissant and elsewhere in Colorado; Amethyst Mt., Utah; Napa Co., California. Moss agates from Humboldt Co., Nevada, and many other points. On the occurrence of the ornamental varieties of quartz, see Kunz, Gems and Precious Stones of N. America, 1890.

The word quartz is of German provincial origin. Agate is from the name of the river Achates, in Sicily, whence specimens were brought, as stated by Theophrastus.

**Alt.**—Pseudomorphs of pyrite, cassiterite, magnetite, hematite, voltzite, after quartz, have been described. Quartz pseudomorphs after fluorite, barite, and other species are not uncommon.

**Artif.**—Repeatedly produced, both in well-formed crystals and in chalcedonic varieties; thus (Sénarmont) from gelatinous silica in a closed tube with excess of water at a high temperature; also (Daubrée) by the prolonged action of water vapor upon glass under pressure; again (Hautefeuille) by fusing a mixture of alkaline phosphates and fluorides with silica and alumina, orthoclase was obtained at the same time. By the fusion of silica and lithium chloride at a low red heat quartz crystals were obtained (Hautefeuille and Margottet); at a bright red, crystals of tridymite. Cf. Fouqué-Lévy, Synth. Min., 81, 1882; Bourgeois, Reprod. Min., 79, 1884.

**Ref.**—[1] Preisschrift, p. 61, 1825; cf. Kk. Min. Russl., 8, 129, 1878; Dbr. obtained *rz* = 46° 16′ 4″ 8, Pogg., **103**, 107, 1858.

On the crystallization of quartz see: Rose, Abh. Ak. Berlin, 217–274, 1844, a monograph of the first importance; he gives also the earlier bibliography (Weiss, Haid., Wackernagel, etc.), Dx , Mem. Ac. Sc., **15**, 404, 1858, a second equally important memoir, an abstract in Ann. Ch. Phys., **45**, 129, 1855; also later Min., **1**, 7, 1862. Sella, Ac. Sc. Torino, **17**, 1858 (Min. Sarda). E. Weiss, Abh. Ges. Halle, **51**, 51, 1860. Also papers by Websky, Pogg., **99**, 296, 1856; Zs. G. Ges., **17**, 348, 1865; Jb. Min., 1871, 1874. Hbg. Min. Not., **1**, 11, **2**, 3, etc. Rath, Zs. G. Ges., **22**, 619, 1870; Zs. Kr., **5**, 1, 490, 1881, **10**, 156, 475, 1885, Cassel Festschrift, 1886, et al. Scharff, Abh. Senck. Nat. Ges., 1874. Artini, Val Malenco, Mem. Acc. Linc., **5**, April, 1888.

[2] Cf. Rose, E. Weiss, Dx., and later Gdt., Index, **3**, 1, 1888. [3] On *twins*, laws (1) and (2), also fourlings, see Groth, Zs. Kr. **1**, 297, 1877. Twins with inclined axes (ξ tw. pl.) Rath, Pogg., **155**, 57, 1875, he also gives earlier literature. A variety of supposed twins with inclined axes have been described by Jenzsch, Pogg., **130**, 597, 1867, **134**, 540, 1868. Cf. also [4] *Cleavage:* Mld., Bull. Soc. Min., **13**, 61, 1890; Secondary lamellar structure, Judd, Min. Mag., **3**, 1, 1888.

On *refractive indices*[5]: For A by Van der Willigen (ref. p. 271), others Rudberg, Pogg., **14**, 45, 1828; also, ultra-violet, Sarasin, C. R., **85**, 1230, 1878. [6] *Rotatory power:* Soret and Sarasin, C. R., **81**, 610, 1875, **83**, 818, 1876, **84**, 1362, 1877. Also earlier, Biot, Mem. Acad., **20**, 221, 1849; on effect of temperature to increase the rotation, Lang, Ber. Ak. Wien, **71** (2), 1875; Joubert, C. R., **87**, 497, 1879. [7] On *pyro-electricity, etc.:* Hankel, Abh. Sächs. Ges., **12**, 1881, et al.; Wied. Ann., **10**, 618, 1880; Kundt, Ber. Ak. Berlin, 16, 1883; Wied. Ann., **20**, 592, 1883; Kolenko, Zs. Kr., **9**, 1, 1884; Jacques and P. Curie, C. R., **91**, 294, 384, 1880; Friedel and J. Curie, Bull. Soc. Min., **5**, 282, 1882; Röntgen, Ber. Oberhess. Ges., **22**, 1882.

On *elasticity:* Voigt, Jb. Min., Beil.-Bd., **5**, 90, 1887. [8] Elasticity of fine threads, Boys, Phil. Mag., **30**, 99, 1890. *Dilatation* Fizeau, later Le Chatelier, Bull. Soc. Min., **13**, 112, 1890; [9] Boys, Nature, May 16, 1889. [10] Tegetmeier & Warburg, Wied., **32**, 442, 1887. On *magnetism:* Koenig, Wied. Ann., **31**, 273, 1873. [11] On *etching-figures:* Leydolt, Ber. Ak. Wien, **15**, 59, 1855. Baumh., Wied. Ann., **1**, 157, 1877; Pfd., Conn. Acad., **8**, 158, 1889; Molengraaff, Zs. Kr., **14**, 173, 1888, **17**, 137, 1889. [12] *Inclusions:* Hartley, J. Ch. Soc., **29**, 137, 1876; Hawes, Am. J. Sc., **21**, 203, 1881; A. W Wright, ib., **21**, 209, 1881.

COTTERITE *Harkness*, Min. Mag., **2**, 82, 1878. A variety of quartz, having a "peculiar metallic pearly luster," and forming a coating on ordinary quartz crystals, from Rockforest, Ireland.

### 211. TRIDYMITE. *G. vom Rath*, Pogg., **135**, 437, 1868.

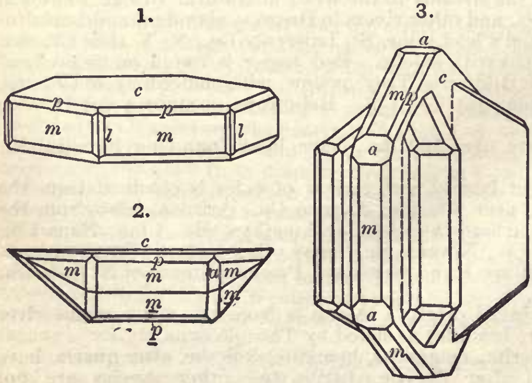
Hexagonal or pseudo-hexagonal. Axis $\dot{c} = 1{\cdot}65304$; $0001 \wedge 10\bar{1}1 = 62° 21'$ Rath[1].

**Forms**[1]: *c* (0001, *O*), *m* ($10\bar{1}0$, *I*), *a* ($11\bar{2}0$, *i*-2), *l* ($45\bar{9}0$, *i*-$\frac{9}{4}$), *i* ($32\bar{5}0$, *i*-$\frac{5}{3}$), *o* ($10\bar{1}3$, $\frac{1}{3}$)[2], *p* ($10\bar{1}1$, 1). Also *q* ($10\bar{1}6$, $\frac{1}{6}$), and *r* ($30\bar{3}4$, $\frac{3}{4}$) as tw. planes.

Angles: *ml* = 10° 53½′, *mi* = 13° 54′, *mp* = *27° 39′, *pp′* = 52° 35′, *co* = 32° 28′, *cq* = 17° 39′, *cr* = 55° 4′, *cp* = 62° 21′.

Crystals usually minute, thin tabular ∥ *c*. Twins very common: (1) tw. pl. *q* ($10\bar{1}6$) f. 2; often in trillings (f. 3), both contact- and penetration-twins. The twinning angle $c\underline{c}$ = 35° 18′, while in trillings it is 70° 36′, approximating closely to the regular octahedron; hence pseudo-isometric forms occur among the compound crystals. (2) *r* ($30\bar{3}4$), often combined with twins (1), $c\underline{c}$ = 69° 52′, also near the octahedral angle. Also united with polysynthetic twinning in fan-shaped groups and spherical rosettes.

Cleavage: prismatic, not distinct; parting ∥ *c*, sometimes observed. Fracture conchoidal.



**Figs. 1–3, Pachuca, Mexico, Rath.**

Brittle. H. = 7. G. = 2·28–2·33. Luster vitreous, on *c* pearly. Colorless to white. Transparent. Optically +. Double refraction weak. Mean refractive index = 1·476 for D, Mld. Often exhibits anomalous refraction phenomena.

A basal section often exhibits a series of differently orientated doubly refracting and biaxial bands, whose existence has been explained[3] by the assumption of a complex twinning of monoclinic or triclinic individuals with a prismatic plane (60°) as twinning-plane. These may be secondary, however, since at a moderately elevated temperature the sections become isotropic and uniaxial[4].

**Comp.**—Pure silica, $SiO_2$, like quartz.

**Pyr.**, **etc.**—Like quartz, but soluble in boiling sodium carbonate.

**Obs.**—Occurs chiefly in acidic volcanic rocks, trachyte, andesyte, liparyte, less often in doleryte; usually in cavities, often associated with sanidine, also hornblende, augite, hematite; sometimes in opal. First observed in crevices and druses in an augite-andesyte from the Cerro San Cristobal, near Pachuca, Mexico; later proved to be rather generally distributed. Thus in trachyte of the Drachenfels and Perlenhardt of the Siebengebirge; of Euganean Hills in N. Italy; Puy Capucin (Mont-Dore) in Central France, and Alleret, Haute Loire; in porphyryte of Waldböckelheim; in augite-andesyte of Gerenczes in Transylvania.

In the ejected masses from Vesuvius consisting chiefly of sanidine. In the andesyte of Krakatau (Zs. Kr., **10**, 174, 1885); at Lyttleton Harbor, near Christchurch, New Zealand, in compound crystals approximating to isometric forms (cf. above, and Rath, Ber. nied. Ges., July 7, 1886). With quartz, feldspar, fayalite in lithophyses of Obsidian cliff, Yellowstone Park. In the andesyte of Mt. Rainier, Washington. In the opal of Zimapan and elsewhere, as in the cacholong of Iceland and Hüttenberg, Carinthia.

Named from τρίδυμος, *three-fold*, in allusion to the common occurrence in trillings.

**Alt.**—The tridymite of the Euganean Hills (pseudo-tridymite, Mld.) has the common form of the species, but, as shown by Mallard, its specific gravity is very near that of quartz, with which it also agrees in optical characters; it is then to be regarded as a paramorph. Bull. Soc. Min., **13**, 162, 1890.

**Artif.**—First formed by Rose by dissolving a silicate in a salt of phosphorus bead, the skeleton of silica, consisting of tridymite; later also by Hautefeuille. Again by Friedel and Sarasin by heating gelatinous silica at a red heat with an alkaline solution in a closed tube. Cf. p. 192; also Fouqué-Lévy, Synth. Min., 85, 1882; Bourgeois, Reprod. Min., 81, 1884. As a recent formation at Plombières (Daubrée). Observed in the vitrified walls of the muffles of a zinc furnace with gahnite and willemite.

**Ref.**—[1] Pogg., **152**, 1, 1874. [2] Mallard on pseudo-tridymite (see above), Bull. Soc. Min., **13**, 162, 1890. [3] Schuster, Min. Mitth., **1**, 71, 1878; Lsx., Zs. Kr., **2**, 253, 1878. [4] Merian, Jb. Min., **1**, 193, 1884.

ASMANITE *Maskelyne*, Phil. Trans., **161**, p. 361, 1871. *Rath*, Pogg., Erg. Bd., **6**, 382, 1873. *Winkler*, Nov. Act. Leopold, Car. Akad., **40**, 339, 1878.

A form of silica found in the meteoric iron of Breitenbach, in very minute grains, generally much rounded and stained with iron on the surface. It is mixed with bronzite (after the removal of the iron, troilite, and chromite), and constitutes about one-third of the mixed siliceous minerals. Also (in irregular particles) in the Rittersgrün iron, making up about one-fourth of the non-metallic portion, with troilite and bronzite, which together form about one-half of the whole.

Described as orthorhombic, with $\breve{a} : \bar{b} : \dot{c} = 1·7437 : 1 : 3·3120$. Observed forms: 100, 001, 110, 013, 012, 023, 011, 043, 116, 112, 223. Angles (calc., Mask.): $110 \wedge 1\bar{1}0 = 59° 40'$, $001 \wedge 011 = 62° 14'$, $001 \wedge 112 = 62° 21'$ (*mm'* = 60°, *cp* = 62° 21' tridymite).

Cleavage: *c* good, with vitreous luster; *m* difficult. Very brittle H. = 5·5. G. = 2·245, Breitenbach. Luster generally resinous, resembling opal. Colorless. Transparent. Optically biaxial, negative. Ax. pl. $\parallel \breve{a}$. $Bx \perp \bar{b}$. $2E = 107°–107\frac{1}{2}°$. Dispersion $\rho > v$. Composition, nearly pure silica. Analyses: 1, 2, Maskelyne, 1 on 0 3114 gr., 2 on 0·2653 gr. 3, Winkler, l. c., p. 358.

| | $SiO_2$ | $Fe_2O_3$ | CaO | MgO | |
|---|---|---|---|---|---|
| 1. Breitenbach | 97·43 | 1·12 | 0·58 | 1·51 | = 100·64 |
| 2. " | 99·21 | 0·79 etc. | | | = 100 |
| 3. Rittersgrün | 97·84 | 1·65 | *tr.* | — | ign. 1 01 = 100·50 |

It has been pretty conclusively proved that asmanite is identical with tridymite, as suggested by Lasaulx (Zs. Kr., **2**, 274, 1878), Weisbach (cf. Winkler, l. c.), and Tschermak, Ber. Ak. Wien, **88** (1), 348, 1883. Groth regards tridymite as orthorhombic and isomorphous with brookite ($TiO_2$).

CRISTOBALITE *G. vom Rath*, Jb. Min., **1**, 198, 1887. Christobalite

In regular octahedrons up to 2 mm., in part spinel twins. Angle *oo'* = 70° 21' Mld. The forms sometimes skeleton-like with depressed faces. No cleavage. H. = 6–7. G. = 2·27 Rath; 2·34 Mld. Luster dull. Color white. Translucent. Shows abnormal double refraction, hence pseudo-isometric Mld. Mean refractive index = 1·432. $\omega - \epsilon = 0·00053$ Mld. Heated to 175° C. the double refraction disappears suddenly, reappearing on cooling.

Composition, pure silica, $SiO_2$. Analysis, Rath, on 0·08 gram, containing some gangue ($Fe_2O_3$, etc.): $SiO_2$ 91·0, $Fe_2O_3,Al_2O_3$ 6·2 = 97·2.

B.B. infusible. Occurs with tridymite in cavities in the andesyte of the Cerro S. Cristobal near Pachuca, Mexico.

The similarity between the pseudo-isometric twinned forms of tridymite and the octahedrons of cristobalite was pointed out by Rath; and the relation between the two forms of silica is minutely discussed by Mallard, Bull. Soc. Min., **13**, 172, 1890.

GRANULINE. Granulina *A. Scacchi*, Rend. Acc. Napoli, **21**, 176, October 1882. A form of silica, probably identical with tridymite, occurring as a white pulverulent incrustation on Vesuvian lava. Very hygroscopic, regaining in the air the water (17·4 p. c.) lost on ignition. G. = 1·73, after ignition 2·20. Readily soluble in sodium carbonate. White pearly hexagonal plates of tridymite occur with it which consist also of silica and water, losing 12·5 p. c. by ignition.

MELANOPHLOGITE *A. v. Lasaulx*, Jb. Min., 250, 627, 1876; 513, 1879. Melanoflogite *G. Spezia*, Mem. Acc. Linc., **15**, 300, 1883.

In minute cubes and spherical aggregates. The cubes have an isotropic crust, while the interior has aggregate polarization like chalcedony. H. = 6·5–7. G. = 2·04. Luster vitreous. Color light brown or colorless. Transparent. The double refraction is sometimes after the analogy of pseudo-isometric species. Mallard (Bull. Soc. Min., **13**, 180, 1890) shows that the crystals are made up of the fibrous melanophlogite turning black upon ignition, with G. = 2·04, with enclosed particles of quartz with G. = 2·65, both probably present by alteration from some earlier mineral.

Analyses.—1, Lasaulx, l. c. 2, Spezia, l. c. 3, Pisani, Bull. Soc. Min., **11**, 298, 1888.

| | | $SiO_2$ | $SO_3$ | $H_2O$ | C | $Fe_2O_3$ |
|---|---|---|---|---|---|---|
| 1. | | 86·29 | 7·20 | 2·86 | — | 0·70 SrO 2·80 = 99·85 |
| 2. | | 89·46 | 5·60 | 2·42 | 1·33 | 0·25 = 99·06 |
| 3. | G. = 2·02 | 91·12 | 5·30 | 1 52 | — | 0 43 ($Al_2O_3$) = 98·37 |

The carbon is present in minute yellow grains whose composition is undetermined; separated by use of hydrofluoric acid and heated on platinum foil they turn black and disappear. The mineral turns black superficially when heated B.B. (hence name from *μέλας*, *black*, and *φλέγεσϑαι*, *to be burned*) in consequence of the presence of this enclosed carbon.

Occurs with calcite and celestite implanted upon an incrustation of opaline silica over the sulphur crystals of Girgenti, Sicily.

This anomalous substance can hardly be regarded as other than of pseudomorphous origin.

SULFURICIN *Guyard*, Bull. Soc. Chim., **22**, 61, 1874. *Brezina*, Min. Mitth., 243, 1876.

A white porous silica, having a sour taste and impregnated with sulphur. From Greece. An analysis gave Guyard: $SiO_2$ 80·38, $SO_3$ 6·80, S 4·10, $H_2O$ 6·10, $Al_2O_3$ 0·43, $Fe_2O_3$ 0 57 (in orig. 8·57), MgO 0·37, CaO 1·25 = 100. Cf. melanophlogite.

VESTAN *Jenzsch*, Pogg., **105**, 320, 1878. A supposed triclinic form of silica from the melaphyre of Saxony and the Thüringer Wald. Cf. 5th Ed., p. 198.

JENZSCHITE *Dana*, Min., 5th Ed., p. 201. A name proposed for certain kinds of opal silica, described by Jenzsch (Pogg., **126**, 497, 1865), having the specific gravity of quartz but soluble in a hot solution of caustic potash. The kinds here referred to are a white cacholong from Hüttenberg in Carinthia, G. = 2·591; from Hutberg, near Weissig, in amygdaloid, G. = 2·633–2·647; from the porphyry of Regensberg, G. = 2·620; from Brazil, G. = 2·596. They are generally associated with chalcedony, and Jenzsch regards them as a result of its alteration.

PASSYITE *E. Marchand*. Ann. Ch. Phys., **1**, 392, 1874. An impure variety of silica occurring in white earthy masses at Contremoulins, Caux, France.

### 212. OPAL. Opalus, Pæderos, *Plin.*, **37**, 21, 22. Quartz resinite *H.*, Tr., **2**, 1801.

Amorphous. Massive; sometimes small reniform, stalactitic, or large tuberose. Also earthy.

H. = 5·5–6·5. G. = 1·9–2·3; when pure 2·1–2·2. Luster vitreous, frequently subvitreous; often inclining to resinous, and sometimes to pearly. Color white, yellow, red, brown, green, gray, blue, generally pale; dark colors arise from foreign admixtures; sometimes a rich play of colors, or different colors by refracted and reflected light. Streak white. Transparent to nearly opaque. Refractive indices, Dx.

$n_r$ = 1·4374, 1·4555 hyalite  1·450 fire-opal  1·442, 1·446 precious opal
$n_r$ = 1·406 white hydrophane  1·446 same, with absorbed water

Often shows double refraction similar to that observed in colloidal substances due to tension. The mammillary form, hyalite, often yields the uniaxial interference cross of a negative substance in parallel polarized light; this is referred to tension by Schultze, Ber. nied. Ges., 69, 1861. The cause of the play of color in the precious opal was investigated by Brewster (Ed. Phil. J., 38, 385, 1845), who ascribed it to the presence of microscopic cavities. Behrends, however, has given a monograph on the subject, Ber. Ak. Wien, **64** (1), 1871, and has shown that this explanation is incorrect; he refers the colors to thin curved lamellæ of opal whose refractive power may differ by 0·1 from that of the mass. These are conceived to have been originally formed in parallel position, but have been changed, bent, and finally cracked and broken in the solidification of the ground-mass.

**Comp.**—Silica, like quartz, with a varying amount of water, $SiO_2.nH_2O$. The water is sometimes regarded as non-essential.

The opal condition is one of lower degrees of hardness and specific gravity, and, as generally believed, of incapability of crystallization. The water present varies from 2 to 13 p. c. or more, but mostly from 3 to 9 p. c. A hyalite gave 3 p. c. $H_2O$; milk-opal 4·3 p. c.; fire-opal 6–8 p. c.; precious opal from Hungary gave 10 p. c.; geyserite 9–13 p. c. Small quantities of ferric oxide, alumina, lime, magnesia, and alkalies are usually present as impurities. Quartz is often mixed with the opal. For analyses, see 5th Ed., p. 198, also Rg., Min. Ch., pp. 164–168, 1875.

**Var.**—1. *Precious Opal.*—Exhibits a play of delicate colors, or, as Pliny says, presents various refulgent tints in succession, reflecting now one hue and now another. Seldom larger than a hazel-nut; a mass in the Vienna museum has the size of a man's fist and weighs 17 oz., but has numerous fissures, and is not wholly free from the matrix. *Harlequin opal* is a kind presenting a variegated play of colors in a reddish ground, resembling the fire-opal.

2. *Fire-opal.* Feueropal, fr. Mexico, *Humboldt*, *Karsten*, Klapr. Beitr., 4, 156, 1807.—Hyacinth-red to honey-yellow colors, with fire-like reflections, somewhat irised on turning.

3. *Girasol.*—Bluish white, translucent, with reddish reflections in a bright light.

4. *Common Opal.*—In part translucent; (*a*) *milk-opal*, milk-white to greenish, yellowish, bluish; (*b*) *Resin-opal* (Wachsopal, Pechopal, *Germ.*), wax-, honey- to ocher-yellow, with a resinous luster; (*c*) dull olive-green and mountain-green; (*d*) brick-red. Includes *Semiopal*, Halbopal *Wern.*; also

(*e*) *Hydrophane*, which is translucent, whitish, or light-colored, adheres to the tongue, and becomes more translucent or transparent in water (to which the name, from *ὕδωρ, water*, and *φαίνεσθαι, to make clear* alludes), a common quality of opal. *Pyrophane* is a name (from *πῦρ, fire*) given to a kind which by the absorption of melted wax is made translucent when hot, but becomes opaque again on cooling. The name has also been used for fire-opal.

(*f*) *Forcherite* Aichhorn [Wien. Ztg. Abendbl., Jul. 11, 1860]; an orange-yellow opal, colored by orpiment; G. = 2·17 Maly (J. pr. Ch., **86**, 501, 1862). It is from Knittenfeld, in Upper Styria.

*Blackmorite* A. C. Peale (Hayden's, 6 Ann. Rep., U. S. G. S., 169, 1873) is a yellow variety of opal from Mt. Blackmore, Montana. Analysis gave: $SiO_2$ 85·20, $H_2O$ at 110° 7·40, ign. 2·40, $Fe_2O_3$ 2·68, CaO 1·48 MgO 0·37, $Na_2O$ *tr.* = 99·53; G. = 2·172.

5. *Cacholong.* Kascholong *Germ.* Perl-mutter-opal *Karst.*, Tab., 1808.—Opaque, bluish white, porcelain-white, pale yellowish or reddish; often adheres to the tongue, and contains a little alumina. The word is of Tatar origin.

6. *Opal-agate.*—Agate-like in structure, but consisting of *opal* of different shades of color.

7. *Menilite.* Pechstein de Menil Montant *Delarbre & Quinquet*, J. de Phys., **31**, 219, 1787; Menilite *de Saussure*, Delameth. T. T., **2**, 169, 1797. Leberopal *Karst.*, Tab., 24, 1800.—In concretionary forms, tuberose, reniform, etc., opaque, dull grayish, grayish brown, occurring embedded in a shaly argillaceous deposit.

8. *Jasp-opal.* Karst. Tab., 26, 1808; Opal-jasper, Eisenopal, *Hausm.*, Handb., 428, 1813.—Opal containing some yellow iron oxide and other impurities, and having the color of yellow jasper, with the luster of common opal.

9. *Wood-opal.* Holz-opal *Germ.*—Wood petrified by opal; sometimes called lithoxyle when showing a woody structure.

10. *Hyalite.* Mullerisches Glas [= Muller's Glass, after the discoverer]; Hyalit *Wern.*, Hoffm. Min., **2**, *a*, 134, 1812, *Karst.*, Tab., 22, 1800; Gummistein *Blumenb.*, Nat., 553; Glasopal *Hausm.*, Handb., 424, 1813. Jalite *Ital.*—Clear as glass and colorless, constituting globular concretions, and also crusts with a globular, reniform, botryoidal, or stalactitic surface; also passing into translucent, and whitish. Less readily dissolved in caustic alkalies than other varieties.

11. *Fiorite, Siliceous Sinter.* Kieselsinter *Germ.*; *Santi*, Viaggio al Montomiata, Pisa, 1795, Crell's Ann., **2**, 589, 1796; *Thomson*, J. de Phys., **39**, 407, 1791. Breve Notizia di un Viaggiatore sulle Incrost. Sil. termali d'Italia, etc., 1795, Crell's Ann., **1**, 108, 1796, Bibl. Brittan, 185, 1796 (? name fiorite here given); *Pfaff.*, Crell's Ann., **2**, 589, 1796; Resinite termogino (*Ital.*).

Includes translucent to opaque, grayish, whitish, or brownish incrustations, porous to firm in texture; sometimes fibrous-like or filamentous, and, when so, pearly in luster (then called *Pearl-sinter*); formed from the decomposition of the siliceous minerals of volcanic rocks about fumaroles, and deposited from the siliceous waters of hot springs, in part by the action of vegetation. It graduates at times into hyalite.

(*a*) The original *fiorite* (or pearl-sinter), as described by Thomson, occurs in tufa in the vicinity of Santa Fiora, Italy, and also on Ischia, and at the Solfatara near Naples, in globular, botryoidal, and stalactitic concretions, pearly in luster. Thomson also mentions (1791) a similar incrustation as formed from the hot waters of the Sasso lagoons. It was referred by Werner to hyalite in 1816.

(*b*) The *Michaelite* (J. W. Webster, Am. J. Sc., **3**, 391, 1821) is similar, from the island of St. Michaels, one of the Azores, where it occurs in snow-white incrustations, capillary or filiform in structure, pearly in luster, with G. = 1·866.

(*c*) *Geyserite.* Kieseltuff (fr. Geysers) *Klapr.*, Beitr., **2**, 109, 1797; Geysirite *Delameth.*, Min., 1812; Damour, Bull. G. Fr., 157, 1848. Constitutes concretionary deposits about the geysers of the Yellowstone Park, Iceland, and New Zealand, presenting white or grayish, porous, stalactitic, filamentous, cauliflower-like forms, often of great beauty; also compact-massive, and scaly-massive; H. = 5; rarely transparent, usually opaque; sometimes falling to powder on drying in the air. *Pealite* F. M. Endlich (Hayden's 6 Ann. Rep., U. S. G. S., p. 153, 1873) is a variety of geyserite from the Yellowstone region containing but a small amount of water; one sample gave 1·5 p. c. with G. = 2·49. Named after A. C. Peale, chemist to the U. S. G. S. *Viandite* E. Goldsmith (ibid., 12 Ann. Rep., Pt. II, 407, 1883) is a form of silica, deposited by some of the hot springs of the Yellowstone Park, in thin sheets or sponge-like forms resembling a vegetable growth. It becomes soft and leather-like when dry. Contains when first collected a large, but probably not definite, quantity of water; this is estimated as forming 80 p. c. of the whole.

Analyses of ordinary geyserite from the Yellowstone region by A. C. Peale gave 9–13·4 p. c. $H_2O$; others from the Steamboat Springs, Nevada, by R. W. Woodward, gave 5·5 p. c. (U. S. G. S., 40th Par., **2**, 826, 1877). For description of thermal springs, etc., see A. C. Peale, Hayden's 12 Ann. Rep., U. S. G. S., Pt. II, pp. 65, 448, analyses (and by Leffmann) on p. 411, also (Iceland, New Zealand, quoted) p. 413. Leffmann's analyses are also given in Ch. News, **43**, 124, 1881. On the essential part played by vegetable growth in the deposition of siliceous sinter, see Weed, Am. J. Sc., **37**. 351, 1889, with analyses by Whitfield; also U. S. G. Surv., 9 Ann. Rep., pp. 619–676.

12. *Float-stone.* Quartz nectique, *H.*, Tr., **2**, 1801; Schwimmstein *Germ.*—In light concretionary or tuberose masses, white or grayish, sometimes cavernous, rough in fracture. So light, owing to its spongy texture, as to float on water. The concretions sometimes have a flint-like nucleus.

13. *Tripolite.* Tripel, Terra Tripolitana (fr. Tripoli, in part), *Wall.*, 32, 1747. Infusorial earth; Bergmehl, Kieselmehl, Kieselguhr, *Germ.* Farina fossilis. Randanite *Salvetat*, Ann. Ch. Phys., **24**, 348, 1848.—Formed from the siliceous shells of Diatoms (hence called *diatomite*) and other microscopic species, as first made known by Ehrenberg, and occurring in deposits, often many miles in area, either uncompacted or moderately hard. (*a*) *Infusorial Earth*, or *Earthy Tripolite*, a very fine-grained earth looking often like an earthy chalk, or a clay, but harsh to the feel, and scratching glass when rubbed on it.

(*b*) *Randannite* (*Randanite* wr. orthog.), a kaolin-like variety from Ceyssat (Ceyssatite *Gonnard*, Lyon, Feb. 15, 1875, who explains that the hamlet Randanne has been confounded with the larger town Randan) and Randanne, in Dept. Puy-de-Dôme, and from Algiers, with 9 to 10 p. c. $H_2O$. A deposit at Santa Fiora in Tuscany was made known by G. Fabbroni in 1794 (Giorn. Fis.-med di D. Brungnatelli, p. 154; Crell's Ann., **2**, 199, 1794; Bergmehl v. Santa Fiora *Klaproth*, Beitr., **6**, 348). It consists of a grayish white, loose, mealy earth; Fabbroni states that he made bricks of it which would float like those which Pliny described as made in Spain from a sort of pumice-like earth (**35**, 49), and supposes the material the same. Ehrenberg has shown it to be an infusorial earth.

(*c*) *Tripoli slate* (Polishing slate, Polirschiefer, Tripelschiefer, Saugkiesel, Klebschiefer, *Germ.*), a slaty or thin laminated variety, fragile; G. = 1·909–2·08. Often much impure from mixture with clay, magnesia, iron oxide, etc. (*d*) *Alumocalcite* (fr. Eibenstock, *Breith.*, Char., 97, 326, 1832) is a milk-white material, having a hardness of only 1 to 1½; G. = 2·174; it may be a variety of tripolite, containing a little lime and alumina.

**Pyr., etc.**—Yields water. B.B. infusible, but becomes opaque. Some yellow varieties, containing iron oxide, turn red. Soluble in hydrofluoric acid somewhat more readily than quartz; also soluble in caustic alkalies, but more readily in some varieties than in others.

**Obs.**—Occurs filling cavities and fissures or seams in igneous rocks, as trachyte (Opalmutter *Germ.*) porphyry, also in some metallic veins. Also embedded, like flint, in limestone, and sometimes, like other quartz concretions, in argillaceous beds; also formed from the siliceous waters of some hot springs; also resulting from the mere accumulation, or accumulation and partial solution and solidification, of the siliceous shells of infusoria, of sponge spicules, etc.,—which consist essentiallyof opal-silica. The last mentioned is the probable source of the opal of limestones and argillaceous beds (as it is of flint in the same rocks), and of part of that in igneous rocks. It exists in most chalcedony and flint. Common opal and hyalite are products of the decomposition of a Roman cement at the hot springs of Plombières in France.

*Precious opal* occurs in porphyry at Czerwenitza, near Kashau in Hungary; at Frankfort; at Gracias a Dios in Honduras; Esperanza, Queretaro in Mexico, with fire-opal, milk-opal, and other kinds; a beautiful blue opal, with delicate play of colors, on Bulla Creek, Queensland (Phil. Soc. Glasgow, **13**, 427, 1882); Abercrombie R., New South Wales. *Fire-opal* occurs at Zimapan in Mexico; the Färöer; near San Antonio, Honduras. *Common opal* is abundant at Telkebánya in Hungary; near Pernstein, Luckau, and Smrezet in Moravia; in Bohemia; at Kosemütz in Silesia; Hubertsburg in Saxony; Stenzelberg and Quegstein in Siebengebirge; Steinheim near Hanau; in Iceland; the Giant's Causeway, and the Hebrides; also within ½ m. and to the S.W. of the watering-place at Vourla, the harbor of Smyrna, with yellow jasper and hornstone, embedded in a low ridge of yellowish compact limestone; of a wax-yellow and grayish green color, occasionally white, at the Giant's Causeway. *Hyalite* occurs in amygdaloid at Schemnitz, Hungary; in clinkstone at Waltsch, Bohemia. *Wood-opal* forms large trees in the pumice conglomerates of Saiba, near Neusohl; Kremnitz, Hungary; near Hobart Town, Tasmania; and in many other regions of igneous rocks.

In U. S., *hyalite* occurs sparingly in N. York, at the Phillips ore bed, Putnam Co., in thin coatings on granite; in connection with the trap rock of New Jersey and Connecticut; rarely in N. C., Cabarrus Co., with the auriferous quartz; in Georgia, in Burke and Scriven Cos., lining cavities in a siliceous shell-rock; in Washington Co., good fire-opal; at the Suanna spring, Florida, small quantities of siliceous sinter. A remarkable specimen of hydrophane from Colorado absorbed half its own volume of water and became perfectly transparent (Kunz, Am. J. Sc., **34**, 479, 1887, Church, Min. Mag., **8**, 181, 1889). A water-worn specimen of fire-opal has been found on the John Davis river, in Crook Co., Oregon.

Common opal is found at Cornwall, Lebanon Co., Penn.; at Aquas Calientes, Idaho Springs, Col.; a white variety at Mokelumne Hill, Calaveras Co., Cal., and on the Mt. Diablo range. Geyserite occurs in great abundance and variety in the Yellowstone region (cf. above); also siliceous sinter at Steamboat Springs, Nevada. Other localities are given by Kunz, Gems and Precious Stones of N. A., 1890.

**Artif.**—Formed by the gradual drying of a siliceous jelly. See Fouqué-Lévy, Synth. Min., 92, 1882; Btd., Bull. Soc. Min., **3**, 57, 1880.

LUSSATITE *Mallard*, Bull. Soc. Min., **13**, 63, 1890. A form of silica, similar in structure to chalcedony but having a low specific gravity, G. = 2·04, near that of opal; refractive index (for D) 1·446 like opal, but crystalline and optically *positive*. It consists of pure silica, probably anhydrous, and is associated with true amorphous opal-silica. Observed in the well-known blue "chalcedony" of Tresztyan, Hungary; also forming an envelope with fibrous structure over clear quartz crystals in the bitumen of Lussat, near Pont-du-Chateau, Puy-de-Dôme; also from Cornwall; the Färöer. Cf. also observations on chalcedony, p. 188.

Colloid silica, probably directly derived from the remains of siliceous sponges, occurs in beds in the Lower Chalk of Berkshire and Wilton, England, similar to the malmstones of the Greensand. Jukes-Browne, Q. J. G. Soc., **45**, 403, 1889; Hinde, Phil. Trans., pt. 2, 403, 1885.

TABASHEER. Tabaschir *Germ.* Amorphous, opal-like silica deposited within the joints of the bamboo. Color milk-white. G. = 0·54 and when calcined less than 0·67. Refractive index, $n_r = 1{\cdot}119$ Dx. It absorbs water and becomes translucent like hydrophane; in certain oils it becomes as transparent as glass with a remarkable increase in refractive power. See Hintze, Zs. Kr., **13**, 392, 1887; Blasius, ib., **14**, 258, 1888; also Judd, Nature, **35**, 488, 1887.

## II. Oxides of the Semi-Metals; also Molybdenum, Tungsten.

### 1. Arsenolite Group. $R_2O_3$. Isometric.

| | |
|---|---|
| **213. Arsenolite** | $As_2O_3$ |
| **214. Senarmontite** | $Sb_2O_3$ |

### 2. Valentinite Group. $R_2O_3$.

| | | | | |
|---|---|---|---|---|
| | | | $\grave{a} : \bar{b} : \dot{c}$ | $\beta$ |
| **215. Claudetite** | $As_2O_3$ | Monoclinic | 0·4040 : 1 : 0·3445 | 84° 3′ |
| | | | $\breve{a} : \bar{b} : \dot{c}$ | |
| **216. Valentinite** | $Sb_2O_3$ | Orthorhombic | 0·3910 : 1 : 0·3364 | |

The above species are near one another in form although belonging to different systems.

| | | | |
|---|---|---|---|
| | | | $\breve{a} : \bar{b} : \dot{c}$ |
| **217. Bismite (artif. cryst.)** | $Bi_2O_3$ | Orthorhombic | 0·8166 : 1 : 1·0649 |

### 3. Tellurite Group. $RO_2$. Orthorhombic.

| | | $\breve{a} : \bar{b} : \acute{c}$ |
|---|---|---|
| 218. **Tellurite** | $TeO_2$ | 0·4566 : 1 : 0·4693 |
| **Selenolite** | $SeO_2$? | |

### 4. Molybdite Group. $RO_3$.

| | | | $\breve{a} : \bar{b} : \acute{c}$ |
|---|---|---|---|
| 219. **Molybdite** | $MoO_3$ | Orthorhombic | 0·3874 : 1 : 0·4747 |
| 220. **Tungstite** | $WO_3$ | " | 0·7002 : 1 : 0·3991 |

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| | |
|---|---|
| 221. **Cervantite** | $Sb_2O_3.Sb_2O_5$ |
| 222. **Stibiconite** | $H_2Sb_2O_5$? |

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### 1. Arsenolite Group. $R_2O_3$. Isometric.

**213. ARSENOLITE.** Arsenicum nativum farinaceum, A. n. crystallinum, *Wall.*, 224, 1747. A. calciforme *Cronst.*, 207, 1758. A. cubicum, etc., *Linn.*, 1768. White arsenic *Hill*, 1771. Natürlicher Arsenikkalk. Arsenikblüthe *Karst.*, Tab., 79, 1800. Arsenic oxidé *H.* Arsenit *Haid.*, Handb., 487, 1845. Arsenolite *Dana*, Min., 139, 1854. White arsenic, Arsenious acid, Arsenious oxide. Arsenige Säure *Germ.* Arsenikblomma *Swed.* Acide arsenieux, Arsenic blanc natif *Fr.* Arsenico bianco *Ital.* Arsenico blanco, Acido arsenioso *Span.*

Isometric. In octahedrons. Usually in minute capillary crystals, in stellar aggregates, or as crusts. Also botryoidal, stalactitic; earthy.

H. = 1·5. G. = 3·70–3·72. Luster vitreous or silky. Color white, occasionally with a yellowish or reddish tinge. Streak white, pale yellowish. Transparent to opaque. Taste astringent, sweetish. Refractive indices: $n_r$ = 1·748 Li, $n_y$ = 1·755 Na at 17° C., Dx.[1] Sometimes shows anomalous double refraction[1].

**Comp.**—Arsenic trioxide, $As_2O_3$ = Oxygen 24·2, arsenic 75·8 = 100.

**Pyr., etc.**—Sublimes in the closed tube, condensing above in minute octahedrons. B.B. on charcoal volatilizes in white fumes, giving a white coating and an alliaceous odor. Slightly soluble in hot water.

**Obs.**—Accompanies ores of silver, lead, arsenical iron, cobalt, nickel, antimony, etc., as a result of the decomposition of arsenical ores. Occurs at Andreasberg in the Harz; at Wheal Sparnon in Cornwall; Joachimsthal in Bohemia; Kapnik in Hungary; the old mines of Bieber in Hanau; the Ophir mine, Nevada; the Armagosa mine, Great Basin, California.

**Alt.**—Native arsenic is often covered by a blackish crust or powder, which has been considered a suboxide; but according to Suckow, it is a mixture of metallic arsenic and arsenic trioxide.

**Ref.**—[1] See references under senarmontite.

**214. SENARMONTITE.** Antimoine oxydé octaédrique *H. de Senarmont*, Ann. Ch. Phys., **31**, 504, 1851. Senarmontite *Dana*, Am. J. Sc., **12**, 209, 1851.

Isometric; in octahedrons. Also granular massive; in crusts.

Cleavage: octahedral, in traces. H. = 2–2·5. G. = 5·22–5·30. Luster resinous, inclining to subadamantine. Transparent to translucent. Colorless or grayish. Streak white. Refractive indices: $n_r$ = 2·073, $n_y$ = 2·087 Dx.[1] Anomalous double refraction strongly marked, resembling boracite[1].

**Comp.**—Antimony trioxide, $Sb_2O_3$ = Oxygen 16·7, antimony 83·3 = 100.

**Pyr., etc.**—In the closed tube fuses and partially sublimes. B.B. on charcoal fuses easily, and gives a white coating; this treated in R.F. colors the outer flame greenish blue. Soluble in hydrochloric acid.

**Obs.**—A result of the decomposition of stibnite and other ores of antimony. First found in the district of Haraclas in Algeria; occurs also at Perneck near Malaczka in Hungary. Endellion in Cornwall; the antimony mine of S. Ham, Wolfe Co., Quebec, Canada. The octahedrons from Algeria are sometimes nearly ½ inch in diameter.

Named after H. de Senarmont (1808–1862), who first described the species.

**Ref.**—[1] Cf. Dx., N. R., 3, 9, 1867; Mld., Ann. Mines, **10**, 108, 1876; Groth, Pogg., **137**, 1869; Grosse-Bohle, Zs. Kr., **5**, 222, 1880; Prendel, Min. Mitth., **11**, 7, 1889.

**Alt.**—Crystals from South Ham have been noted which were superficially altered to stibnite; 428, also others changed throughout, by paramorphism, to valentinite (Hintze).

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## 2. Valentinite Group. $R_2O_3$.

**215. CLAUDETITE.** Prismatic Arsenious Acid *F. Claudet*, Proc. Ch. Soc., 1868, Ch. News, **22**, 128, 1868; Claudetite *Dana*, Min., 796, 1868. Rhombarsenite *Adam*, Tabl. Min., 41, 1869. Arsenphyllite. Acide arsénieux prismatique *Fr.*

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c}$ = 0·4040 : 1 : 0·3445; β = 86° 3′ = 001 ∧ 100 Schmidt [1].

100 ∧ 110 = 21° 57′, 001 ∧ 101 = 38° 47′, 001 ∧ 011 = 18° 58′.

**Forms**[1]:
a (100, i-ī)
b (010, i-ì)
m (110, I)
r (120, i-2̀)[2]
s (130, i-3̀)[2]
t (1·10·0, i-1̀0)[2]
d (1̲01, − 1-ī)
q (1̄01, 1-ī)
γ (011, 1-ì)
β (021, 2-ì)
o (1̲11, − 1)
g (1̄11, 1)

mm‴ = 43° 54′
rr′ = 102° 15½′
ss′ = 79° 11′
ad = 47° 16′
a′q = 51° 50½′
γγ′ = 37° 56′
bγ = *71° 2′
ββ′ = 69° 0′
mo = 45° 25′
ao = 48° 52′
oo′ = 28° 24′
bo = *75° 48′
oγ = *37° 24′
a′g = 53° 23½′
gg′ = 30° 19′

Crystals in thin plates, resembling selenite; tabular ‖ *b*, with the pyramids *o*, *g* prominent; often penetration-twins, with *a* as twinning-plane.

Cleavage: *b* perfect; fibrous fracture ‖ *m*. Flexible like selenite. H. = 2·5. G. = 3·85 Claudet; 4·151 Groth. Luster on cleavage surface pearly, otherwise vitreous. Colorless to white. Transparent to translucent. Optically +. Ax. pl. ‖ *b*. Bx ∧ $\grave{c}$ = + 5½°. $2H_r$ = 66° 14′ Li, $2H_y$ = 65° 21′ Na. Dispersion $\rho < v$.

**Comp.**—Arsenic trioxide, like arsenolite, $As_2O_3$ = Oxygen 24·2, arsenic 75·8 = 100.

**Pyr.**—As for arsenolite.

**Obs.**—Occurs in seams in an ore of arsenical pyrites, at the San Domingo mines, Portugal. Also observed as the result of the burning of a mine at Szomolnok (or Schmöllnitz) in Hungary, Szabo, Földt. Közl., **18**, 49, 1888, Schmidt, l. c.

**Alt.**—Crystals consisting of octahedral crystals (paramorphs) have been noted, Ulrich.

**Ref.**—[1] Szomolnok, Zs. Kr., **14**, 575, 1888. Cf. also Dx., Bull. Soc. Min., **10**, 303, 1887. Groth (Pogg., **137**, 414, 1869), who made the crystals orthorhombic, observed on crystals from a Freiberg furnace, a number of other planes, which are thus referred by Schmidt to the monoclinic axes, viz.: (1·0·12) = 001, γ (1·12·12) = 011, (210), μ (250), ν (150), *n* (171). α (1·48·12) = 041, β (1·24·12) = 021. [2] Schmidt, l. c.

**216. VALENTINITE.** Chaux d'antimoine native (fr. Chalanches) *Mongez*, J. de Phys., **23**, 66, 1783; (fr. Přibram) *Rössler*, Crell's Ann., **1**, 334, 1787. Antimonium spatosum album *Hacquet*, ib., **1**, 523, 1788. Weiss-Spiesglaserz *Wern.*, *Hoffm.*, Bergm. J., 385, 398, 1789. Weiss-Spiessglanzerz *Klapr.*, Crell's Ann., **1**, 9. 1789; *Beitr.*, **3**, 183, 1802. Antimoine oxydé *H.*, Tr., **4**, 1801. White Antimonial Ore *Kirwan*, **1**, 251, 1796. Antimonblüthe *v. Leonh.*, Handb., 160, 1821. Exitèle *Beud.*, Min., 615, 1832. Exitelite *Chapman*, Min., 39, 1843. Valentinit *Haid.*, Handb., 506, 1845. White antimony, Antimonious acid, Antimony trioxide. Antimonige Säure *Germ.* Antimonblomma *Swed.* Acide antimonieux *Fr.* Antimonio bianco *Ital.* Antimonio blanco pt. *Span.*

Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c}$ = 0·3910 : 1 : 0·3364 Laspeyres [1].

100 ∧ 110 = 21° 20⅓′, 001 ∧ 101 = 40° 42½′, 001 ∧ 011 = 18° 35½′.

**Forms**[2]:
a (100, i-ī)
b (010, i-ĭ)
π (310, i-3̄)
μ (210, i-2̄)
σ (540, i-$\bar{\frac{5}{4}}$)
m (110, I)
ρ (160, i-6̆)
ξ (508, $\frac{5}{8}$-ī)
ϵ (101, 1-ī)
l (011, 1-ĭ)
i (054, $\frac{5}{4}$-ĭ)
k (043, $\frac{4}{3}$-ĭ)
Q (032, $\frac{3}{2}$-ĭ)
g (0·15·8, $\frac{15}{8}$-ĭ)
q (021, 2-ĭ)
f (073, $\frac{7}{3}$-ĭ)
r (041, 4-ĭ)
e (092, $\frac{9}{2}$-ĭ)
s (0·16·3, $\frac{16}{3}$-ĭ)
h (071, 7-ĭ)?
d (0·27·4, $\frac{27}{4}$-ĭ)
t (0·16·1, 16-ĭ)
v (5·10·8, $\frac{5}{4}$-2̆)
y (481, 8-2̆)
u (3·10·3, $\frac{10}{3}$-$\breve{\frac{10}{3}}$)
x (1·20·15, $\frac{4}{3}$-20)

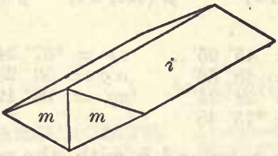
ππ‴ = 14° 51′
μμ‴ = 22° 7½′
mm‴ = 42° 41′
ϵϵ′ = 81° 25′
ll′ = 37° 11′
ii′ = 45° 37′
qq′ = 67° 52′
ff′ = 76° 15½′
rr′ = 106° 46′
ss′ = 121° 44′
uu‴ = 80° 44′
vv′ = 52° 44′
vv‴ = 40° 39′
xx′ = 48° 15′

Commonly prismatic either ∥ ċ (*m*) or ă (*i*, *g*, *q*, *r*, or *s*); also tabular ∥ *b*; often rounded by striations ∥ *m*/*m*′ and ∥ *i*/*i*′. Crystals often aggregated in fan-shaped or stellar groups, in bundles and druses and as aggregations of thin plates. Also massive; structure lamellar, columnar, granular.

Cleavage: *b* perfect; also *m*. H. = 2·5–3. G. = 5·566. Luster adamantine, *b* often pearly; shining. Color snow-white, occasionally peach-blossom red, and ash-gray to brownish. Streak white. Translucent to subtransparent.

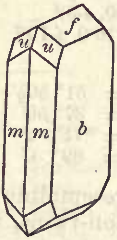
Ax. pl. ∥ *c* for red rays, ⊥ *c* for blue, for yellow nearly uniaxial; dispersion $\rho > v$ strong (Bräunsdorf); also in other crystals (Přibram, Algeria), the axes for red are sensibly united, those for other colors lie ⊥ *c*, and $\rho > v$. Bx always ⊥ *a*; axial angles small. Heated to 75° C. the axes ∥ *c* unite slightly, those ⊥ *c* open slightly, Dx[3].

1.



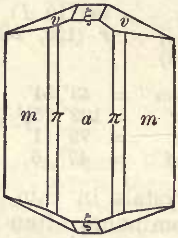
Bräunsdorf, Lasp.

2.



Přibram, Id.

3.



Constantine, Id.

**Comp.**—Antimony trioxide, $Sb_2O_3$ = Oxygen 16·7, antimony 83·3 = 100.

**Pyr., etc.**—Same as for senarmontite.

**Obs.**—Occurs with other antimonial ores, and results from their alteration. Found at Přibram in Bohemia, in veins traversing metamorphic rocks; at Felsöbánya in Hungary, with stibnite and arsenopyrite; Malaczka in Hungary; Bräunsdorf near Freiberg in Saxony; Allemont in Dauphiné; Sempsa, Province of Constantine, Algiers. Also at the antimony mine of South Ham, Wolfe Co., Quebec; with native antimony at the Prince William mine, York Co., N. B.

The *prismatic* form of $Sb_2O_3$ is obtained from solutions at a temperature above 100° C.

Named after Basil Valentine, an alchemist of the 15th century, who discovered the properties of antimony.

**Alt.**—Observed as a paramorph after senarmontite.

**Ref.**—[1] Mean of results for Bräunsdorf crystals, Zs. Kr., **9**, 162, 1884; cf. also Groth, Pogg., **137**, 429, 1869; Tab. Ueb., 84, 1874; and Brezina, Ann. Mus. Wien, **1**, 145, 1886; the last suggests *i* as 011, but without very distinct advantage. [2] See Brz. for critical summary of results of earlier authors, also Lasp., who adds many new planes. [3] N. R., 58, 1867, also Groth, l. c.

*Antimonophyllite* of Breithaupt, of unknown locality, occurring in thin angular six-sided prisms, is probably valentinite.

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**217. BISMITE.** Bismuth trioxide, Bismuth Ocher *pt.* Wismuthoxyd, Wismuthocker, *Germ.* Bismuth oxydé *Fr.* Bismutocra *Ital.* Bismite *Dana*.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·8166 : 1 : 1·0649 Nordenskiöld[1].

**Forms** (artif.): *c* (001, *O*); *m* (110, *I*); *q* (034, $\frac{3}{4}$-ĭ), *r* (011, 1-ĭ), *s* (032, $\frac{3}{2}$-ĭ), *t* (031, 3-ĭ).
Angles: *mm*‴ = *78° 28′, *rr*′ = 93° 36′, edge *m*/*m*′ ∧ *r*/*m* = *129° 31′.

Habit of artif. cryst. prismatic. Natural mineral not crystallized; occurs massive and disseminated, pulverulent, earthy; also passing into foliated.

Fracture conchoidal to earthy. G. = 4·361 Büsson. Luster adamantine to dull, earthy. Color greenish yellow, straw-yellow, grayish white.

**Comp.**—Bismuth trioxide, $Bi_2O_3$ = Oxygen 10·4, bismuth 89·6 = 100. Iron and other impurities often present.

**Pyr., etc.**—In the closed tube most specimens give off water. B.B. on charcoal fuses, and is easily reduced to metallic bismuth, which in O.F. gives a yellow coating of oxide. Soluble in nitric acid.

**Obs.**—Occurs pulverulent at Schneeberg in Saxony, at Joachimsthal in Bohemia; with native gold at Berezov in Siberia; in Cornwall, at St. Roach, and near Lostwithiel.

Dr. Jackson reports an oxide of bismuth not carbonated, as occurring with the tetradymite of Virginia.

See further, BISMUTITE, p. 307, which includes some bismuth ocher.

**Ref.**—[1] Öfv. Ak. Stockh., **17**, 447, 1860, and Pogg., **114**, 622, 1861.

KARELINITE *Hermann*, J. pr. Ch., **75**, 448, 1858. Massive. Structure crystalline. Cleavage in one direction rather distinct. H. = 2. G. = 6·60. Luster strongly metallic within. Color lead-gray. Analysis, Hermann: O [5·21], S 3·53, Bi 91·26 = 100.

From the Savodinski mine in the Altai, with hessite. The mineral is not homogeneous, containing along with the metallic substance a gray, earthy mass of bismutite. By treating the powdered mass with hydrochloric acid, a metallic powder remains, free from any native bismuth, which is the supposed mineral karelinite. Named after Mr. Karelin, the discoverer.

VANADIC OCHER. Vanadic acid *Teschemacher*, Am. J. Sc., **11**, 233, 1851. A yellow pulverulent substance, encrusting masses of native copper, along with quartz, at the Cliff mine, Lake Superior, according to Teschemacher. The color before the blowpipe changed to black; also the powder, boiled in nitric acid, afforded an apple-green solution, from which, on partial evaporation, after standing some weeks, red crystalline globules formed on the surface, which, as they enlarged, fell to the bottom; by means of these crystalline masses the vanadates of silver and lead were made. As no metal was found in the first solution, the yellow mineral was inferred to be probably vanadic oxide.

TANTALIC OCHER. Tantalochra *A. E. Nordenskiöld*, Finl. Min., 27, 1855. A tantalic ocher of brownish color occurring on crystals of tantalite at Pennikoja in Somero, Finland.

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## 3. Tellurite Group. $RO_2$. Orthorhombic.

**218. TELLURITE.** Tellurige Säure *Petz*, Pogg., **57**, 478, 1842. Tellurite *Nicol*, Min., 429, 1849. Tellurocker *Rg.*, Min. Ch., 175, 1875.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·45656 : 1 : 0·46927$ Brezina[1].

$100 \wedge 110 = 24° \, 32\frac{1}{3}'$, $001 \wedge 101 = 45° \, 47\frac{1}{6}'$, $001 \wedge 011 = 25° \, 8\frac{1}{3}'$.

**Forms**[2]: *b* (010, *i*-ĭ), *m* (110, *I*), *r* (120, *i*-2̆), *s* (140, *i*-4̆), *p* (111, 1).

Angles: *mm‴* = 49° 5′, *rr′* = 95° 12′, *ss′* = 57° 18′, *pp′* = 85° 53′, *pp″* = *96° 58·8′, *pp‴* = 36° 14′, *bp* = *71° 52·8′.

In slender prismatic crystals, tabular ‖ *b*, and often striated vertically; also grouped in tufts; in spherical masses with radiated structure.

Cleavage: *b* perfect. Flexible. H. = 2. G. = 5·90. Luster subadamantine. Color white, yellowish white, honey- or straw-yellow. Transparent to translucent. Optically —. Ax. pl. ‖ *a*. Bx ⊥ *b*. $2H_y = 140° \, 8'$ Na ($n = 1·6567$) Knr.

**Comp.**—Tellurium dioxide, $TeO_2$ = Oxygen 20·4, tellurium 79·6 = 100.

**Pyr.**—In the open tube fuses, when strongly heated, to brown drops and sublimes.

**Obs.**—With native tellurium at Fačzebaja and Zalathna, Transylvania. In cavities in and as an incrustation on native tellurium at the Keystone, Smuggler, and John Jay mines, Boulder Co., Colorado.

**Ref.**—[1] Fačzebaja, Ann. Mus. Wien, **1**, 135, 1886; cf. Knr. [Term. Füz., **10**, 81, 106, 1886], Zs. Kr., **13**, 69. [2] Brz., l. c.; vicinal planes *o* (3·16·0), *n* (3·34 0), *π* (1·42·1) also appear.

SELENOLITE. Selenious oxide ($SeO_2$) is noted by Bertrand as probably occurring with some selenium minerals at Cacheuta, Argentine Republic. Bull. Soc. Min., **5**, 92, 1882.

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## 4. Molybdite Group.

**219. MOLYBDITE.** Molybdena or Molybdic Ocher. Molybdic Acid. Molybdänocker, Molybdänoxyd, Molybdänsäure *Germ.* Molybdine *Greg & Lettsom*, Dana, Min., 144, 1854. Brit. Min., 348, 1858. Molybdite *Breith.*, B. H. Ztg., **17**, 125, 1858.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·3874 : 1 : 0·4747$ Nordenskiöld[1].

**Forms**: *a* (100, *i*-ī), *b* (010, *i*-ĭ), *c* (001, *O*); *m* (110, *I*), *μ* (430, *i*-$\frac{4}{3}$), *t* (103, $\frac{1}{3}$-ī), *s* (102, $\frac{1}{2}$-ī), *r* (203, $\frac{2}{3}$-ī).

Angles, *mm‴* = 42° 16′, *bμ* = *73° 48′, *cs* = *31° 30′.

In capillary crystallizations, tufted and radiated; also subfibrous massive; and as an earthy powder or incrustation.

Cleavage: *c* distinct; also *a* and *b*. H. = 1–2. G. = 4·49–4·50 Weisbach. Luster of crystals silky to adamantine, on *c* pearly; earthy. Color straw-yellow, yellowish white. Optically +. Ax. pl. ∥ *a*. Bx ⊥ *c*. Axial angles, Dx.[2]:

$$2H_{o.r} = 117° \ 15' \qquad 2H_{o.y} = 119° \ 23' \qquad 2H_{o.bl} = 127° \text{ approx.}$$

**Comp.**—Molybdenum trioxide, $MoO_3$ = Oxygen 33·3, molybdenum 66·7 = 100.

**Pyr., etc.**—B.B. on charcoal fuses and coats the charcoal with minute yellowish crystals of molybdic oxide near the assay, becoming white near the outer edge of the coating. This coating treated for an instant in R.F. assumes a deep blue color, which changes to dark red on continued heating. With borax gives in O.F. a yellow bead while hot, becoming colorless on cooling; in R.F. a saturated bead becomes brown or black and opaque. With salt of phosphorus gives a yellowish bead in O.F., becoming green when treated in R.F. and allowed to cool.

**Obs.**—Occurs with molybdenite, from which it is probably derived, at the foreign localities of that species; Adun-Chalon Mts. in Eastern Siberia, and at Pitkäranta on L. Ladoga, in silky tufts of capillary crystals.

In N. Hamp., at Westmoreland, earthy; in Penn., at Chester, Delaware Co.; Georgia, Heard Co., in silky fibrous tufts; in the gold region, a few miles north of Nevada City, Cal., in subfibrous masses, and tufted crystallizations of a deep yellow color (*molybdate of iron* of D. D. Owen, Proc. Ac. Philad., 6, 108 but shown by Genth to be this species mixed with limonite).

**Ref.**—[1] Artif. cryst., Öfv. Ak. Stockh., **17**, 300. 1860, Pogg., **112**, 160. [2] N. R., 26, 1867.

ILSEMANNITE *H. Höfer*, Jb. Min., 566, 1871. Crypto-crystalline. Color blue-black to black, on exposure becoming blue. Soluble in water, giving a deep blue solution. The solution contained on analysis chiefly a molybdate of molybdic oxide, and yielded on evaporation deep blue crystals, which were considered to be identical with the known compound $MoO_2.4MoO_3$, which is also supposed to be the composition of the mineral. A product of the decomposition of metallic molybdates, and occurs embedded in barite and associated with wulfenite at Bleiberg in Carinthia. Named after Mining Commissioner J. C. Ilsemann (1727–1822).

**220. TUNGSTITE.** Tungstic Ocher *B. Silliman*, Am. J. Sc., 4, 52, 1822. Wolframocker, Wolframsäure, Scheelsäure *Germ.* Wolframine *Lettsom & Greg*, Dana, Min., 1854, Brit. Min., 349, 1858.

Orthorhombic. Axes: $\breve{a} : \bar{b} : \acute{c}$ = 0·7002 : 1 : 0·3991 Nordenskiöld[1].

**Forms:** *a* (100, *i-ī*), *c* (001, *O*); *m* (110, *I*), *n* (021, *2-ī*). Rather uncertain 031, 041, 051, 081. Angles: *am* = *35°, *cn* = *38° 36′.

Pulverulent and earthy. Color bright yellow, or yellowish green.

**Comp.**—Tungsten trioxide, $WO_3$ = Oxygen 20·7, tungsten 79·3 = 100.

**Pyr., etc.**—B.B. on charcoal becomes black in the inner flame, but infusible. With salt of phosphorus gives in O.F. a colorless or yellowish bead, which treated in R. F. gives a blue glass on cooling. Soluble in alkalies, but not in acids.

**Obs.**—Occurs with wolframite in Cumberland, and Cornwall, England; at Lane's mine, Monroe, Ct., filling small cavities in other ores of tungsten, or coating them, and has resulted from their decomposition; in Cabarrus Co., N. C.; at St. Leonard, near Limoges, rarely in distinct crystals of a sulphur-yellow color on wolframite and quartz.

**Ref.**—[1] Artif. cryst., Öfv. Ak. Stockh., **17**, 449, 1860, and Pogg., **114**, 623, 1861.

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MEYMACITE *Carnot*, C. R., 79, 639, 1874.

A hydrated tungstic oxide, formed from the alteration of scheelite. Sometimes yellow or greenish yellow, with the structure and cleavage of scheelite; sometimes when the alteration has been more complete, the mineral is friable between the fingers and has a yellow or brownish color. Luster resinous.

Analyses: 1 and 2 on friable material, color yellow to brownish, streak sulphur-yellow. G. = 3·80. 3, firm, with lamellar structure and yellowish streak. G. = 4·54.

| $WO_3$ | $Ta_2O_5$ | $Fe_2O_3$ | $Mn_2O_3$ | CaO | $H_2O$ | gangue | |
|---|---|---|---|---|---|---|---|
| 71·85 | 1·00 | 6·00 | 0·75 | 2·50 | 12·93 | 4·50 | = 99·53 |
| 74·25 | 1·05 | 6·10 | 0·65 | 4·65 | 11·75 | 1·85 | = 100·30 |
| 75·12 | 0·70 | 6·25 | 0·32 | 7·00 | 6·85 | 2·55 | = 98·79 |

Deducting the calcium tungstate and hydrated iron oxide, regarded as impurities, Carnot deduces the formula $WO_3.2H_2O$. In the tube gives off water. On charcoal turns black. With salt of phosphorus, gives in the O.F. a yellow bead, nearly colorless on cooling. In R.F. gives a bead colored violet to red (iron and tungsten together). With acids gives the reaction of tungsten when treated in the usual way.

Found with wolframite and scheelite at Meymac, Corrèze, France.

**221. CERVANTITE.** Spiesglanzokker pt. *Karst.*, Mus. Lesk., **1**, 534, 1789, Tab., 54, 78, 1800. Antimony Ocher pt. Antimonocker pt. *Germ.* Gelbantimonerz (from Hungary) *Breith.*, Char., 98, 1823. 224, 1832. Acide antimonieux *Dufr.*, Min., **2**, 654, 1845. Antimonous Acid, Antimonoso-antimonic Oxide. Cervantite *Dana*, Min., 1854.

Orthorhombic. In acicular crystallizations. Also massive; as a crust, or a powder.

H. = 4–5. G. = 4·084. Luster greasy or pearly, also bright or earthy. Color isabella-yellow, sulphur-yellow, or nearly white, sometimes reddish white. Streak yellowish white to white.

**Comp.**—$Sb_2O_4$ or $Sb_2O_3.Sb_2O_5$ = Oxygen 21·1, antimony 78·9 = 100.

**Pyr., etc.**—B.B. infusible and unaltered; on charcoal easily reduced. Soluble in hydrochloric acid.

**Obs.**—Occurs at various mines of stibnite, and results from the alteration of this and other antimonial ores. Found at Cervantes in Galicia, Spain; Chazelles in Auvergne; Felsöbánya, Kremnitz, and elsewhere in Hungary; Pereta in Tuscany; near St. Minvers, at Wheal Lea, at Wheal Kine, and at Endellion, in Cornwall; in Ayrshire, Scotland, at Hare Hill; in Borneo, in rhombic prisms half an inch long, terminating in two planes, and also massive; at the Carmen mine at Zacualpan in Mexico; at South Ham, Wolfe Co., Quebec; in California, Tulare Co., at Pass of San Amedio, with stibnite; with other antimony minerals in Sevier Co., Ark.

**222. STIBICONITE.** Antimony Ocher pt. (Syn. under Cervantite). Stibiconise *Beud.*, Tr., **2**, 616, 1832. Stiblith *Blum & Delffs*, J. pr. Ch., **40**, 318, 1847. Stibiconite *Brush*, Am. J. Sc., **34**, 207, 1862.

Massive, compact. Also as a powder and in crusts.

H. = 4–5·5. G. = 5·1–5·28. Luster pearly to earthy. Color pale yellow to yellowish white, reddish white.

**Comp.**—Probably $H_2Sb_2O_6$ or $Sb_2O_4.H_2O$ = Oxygen 19·9, antimony 74·5, water 5·6 = 100. Usually more or less impure.

**Anal.**—1, Blum & Delffs, l. c. 2, Santos, Chem. News, **36**, 167, 1877. 3, Sharples, Am. J. Sc., **20**, 423, 1880.

| | | O | Sb | As | $H_2O$ |
|---|---|---|---|---|---|
| 1. Goldkronach | G. = 5·28 | 19·54 | 75·83 | *tr.* | 4·63 = 100 |
| 2. Sevier Co., Arkansas | G. = 5·58 | 19·85 | [76·15] | — | 3·08 insol. 0·92 = 100 |
| 3. Sonora | G. = 5·07 | [20·0] | 75·0 | — | 5·0 |

**Pyr.**—In the closed tube gives off water, but does not fuse; on charcoal decrepitates, fuses with difficulty to a gray slag, and gives a white coating.

**Obs.**—From Goldkronach, Bavaria; with cervantite in Borneo, cf. Frenzel, Min. Mitth., 298, 1877. Probably from other localities of antimony ocher. Forms extensive deposits in Sonora, Mexico, usually massive. H. C. Lewis speaks of glassy octahedral crystals with G. = 4·9; he found 3·1 p. c. $H_2O$ (Amer. Nat., 608, 1882). Raimondi mentions a similar mineral derived from the alteration of stibnite from Chayramonte, Cajamarca, Peru.

VOLGERITE. Antimony Ocher pt. Hydrous Antimonic Acid. Volgerite *Dana*, Min., 142, 1854. Cumengite *Kenng.*, Min., 29, 1853.

Massive, or as a powder. Color white. Analysis: Cumenge, Ann. Mines, **20**, 80, 1851.

O 17·0 Sb 62·0 $H_2O$ 15·0 $Fe_2O_3$ 1·0 gangue 3·0 = 98·0

This corresponds perhaps to $Sb_2O_5.4H_2O$.

From the province of Constantine, Algeria. Volger remarks that white antimony ocher ($Sb_2O_5.5H_2O$) is a common result of the alteration of stibnite. Entwickl. Min., 77.

The following are uncertain minerals containing chiefly oxide of antimony.

RIVOTITE *Ducloux*, C. R., **78**, 1471, 1874.

Amorphous, compact, with a stony look. Fracture uneven. Fragile. H. = 3·5–4. G. = 3·55–3·62. Opaque. Color yellowish green to grayish green. Streak grayish green. Analysis.—Ducloux:

$Sb_2O_5$ 42·00 $Ag_2O$ 1·18 CuO 39·50 $CO_2$ 21·00 CaO *tr.* = 103·68

Occurs in small irregular masses disseminated through a yellowish white limestone, on the west side of the Sierra del Cadi, province of Lerida. Named after Prof. Rivot of the École des Mines, Paris

STIBIANITE *E. Goldsmith*, Proc. Ac. Philad., 154, 1878. An alteration product of stibnite, from Victoria, Australia. Massive, porous. H. = 5. G. = 3·67. Color reddish yellow, of powder pale yellow. Luster dull. Analysis by W. H. Dougherty. l. c.: $Sb_2O_5$ 81·21, $H_2O$ 4·46, gangue 13·55. After deduction of the impurities: $Sb_2O_5$ 94·79, $H_2O$ 5·21 = 100, which, if the results could be trusted, would correspond to the formula $Sb_2O_5.H_2O$.

**Stibioferrite** *E. Goldsmith,* Proc. Ac. Philad., p. 366, 1873. Amorphous. Brittle, fracture uneven to conchoidal. H. = 4. G. = 3·598. Luster slightly resinous. Color yellow to brownish yellow. Streak dull yellow. Soluble in hydrochloric acid. Analysis:

$Sb_2O_5$ 42·96 $Fe_2O_3$ 3·85 $H_2O$ 15·26 $SiO_2$ 8·84 loss 1·09 = 100

Occurs as a coating, sometimes ¼ inch thick, on stibnite from Santa Clara Co., Cal.

**Partzite** *A. Arents,* Am. J. Sc., **43**, 362, 1867. Apparently a hydrous oxide of antimony mixed with various metallic oxides, as pronounced by Blake (ib., **44**, 119). It varies in color from yellowish green to blackish green and black; has G. = 3·8; H. = 3–4; and an even conchoidal fracture.

An analysis afforded Arents: $Sb_2O_3$ 47·65, $Cu_2O$ 32·11, $Ag_2O$ 6·12, PbO 2·01, FeO 2·33, $H_2O$ 8·29 = 98·51. It occurs in the Blind Spring Mts., Mono Co., California, with argentiferous galena, and antimonial ores of lead and silver, from whose decomposition it has probably proceeded. Named for Dr. A. F. W. Partz.

A related mineral occurs at the mine of San Lorenzo, province of Huaylas, and mine des Italiens, province of Cajatambo, Peru, *Raimondi,* Min. Pérou, pp. 83, 86, 87, 1878.

**Stetefeldtite** *E. Riotte,* B. H. Ztg., **26**, 253, 1867. Appears to be very similar to partzite. It occurs massive; blackish and brown in color; H. = 3·5–4·5; G. = 4·12–4·24, with a shining streak. Stetefeldt (ib., p. 281) found as a mean of two analyses: $Sb_2O_4$ 43·77, S 4·7, Ag 23·74, Cu 12·78, Fe 1·82, $H_2O$ 7·9; and thence deduces $Sb_2O_5$ 46·47, S 4·59, Ag 23·23, Cu 2·27, FeO 2·41, CuO 13·28, $H_2O$ 7·75 = 100.

It comes from southeastern Nevada, in the Empire district; also in the Philadelphia district. Named for the mining engineer, Ch. Stetefeldt.

An antimonite of copper, resembling stetefeldtite, has been described by Domeyko as occurring at the Potochi copper mine, near Huancavelica, Peru. It is amorphous, compact. Fracture smooth or uneven, in parts coarsely granular. Color black or greenish black. Streak yellowish green. Luster weakly resinous. An analysis on the purest material obtainable (though still mixed with some sub-sulphate of copper) gave: $Sb_2O_4$ 32·93, CuO 32·27, $Fe_2O_3$ 11·14, ZnO 0·50, $SO_3$ 1·00, $H_2O$ (loss at low redness) 18·53, insoluble 1·57 = 96·94. B.B. infusible. Dissolves readily in hydrochloric acid. Domeyko regards the mineral as probably having come from the decomposition of chalcostibite. 3d Appendix Min. Chili, 1871.

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## III. Oxides of the Metals.

**A. Anhydrous.** **B. Hydrous.**

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### A. Anhydrous Oxides.

I. Protoxides, $R_2O$ and RO.
II. Sesquioxides, $R_2O_3$
III. Intermediate, $\overset{II}{R}\overset{III}{R}_2O_4$ or $RO.R_2O_3$, etc.
IV. Dioxides, $RO_2$.

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### I. Protoxides, $R_2O$ and RO.

| | | | | |
|---|---|---|---|---|
| 223. | **Water, Ice** | $H_2O$ | Hexagonal | $\dot{c} = 1·4026$ |
| 224. | **Cuprite** | $Cu_2O$ | Isometric | |

### Periclase Group. RO. Isometric.

| | | |
|---|---|---|
| 225. | **Periclase** | MgO |
| 226. | **Manganosite** | MnO |
| 227. | **Bunsenite** | NiO |

| | | | | | |
|---|---|---|---|---|---|
| 228. | **Zincite** | ZnO | Hexagonal | 1·6219 | |

| | | | | $\breve{a} : \bar{b} : \breve{c}$ | |
|---|---|---|---|---|---|
| 229. | **Massicot** | PbO | Orthorhombic | 0·6706 : 1 : 0·9764 | (artif.) |

| | | | | $\grave{a} : \grave{\bar{b}} : \grave{c}$ | $\beta$ |
|---|---|---|---|---|---|
| 230. | **Tenorite**<br>Melaconite | CuO | Monoclinic | 1·4902 : 1 : 1·3604 | 80° 28′ |

**223. WATER.** Wasser *Germ.* Vatten *Swed.* Eau *Fr.* Acqua *Ital.* Agua *Span.*

Water exists in three states: (1) a solid, Ice, at or below 0° C.; (2) a liquid, Water proper, between 0° and 100°; (3) a gas, Steam and Aqueous Vapor, the former at 100° C. under a pressure of 760 mm., or at higher or lower temperatures with requisite increase or decrease of pressure, the latter in the atmosphere at all temperatures.

**ICE.** Eis *Germ.* Is *Swed.* Glace *Fr.* Ghiâccio *Ital.*

Hexagonal; probably hemimorphic. Axis $\dot{c}$ = 1·4026 approx.; $0001 \wedge 10\bar{1}1 = 58° \ 18\frac{1}{2}'$ Nordenskiöld.

**Forms**[1]: *c* (0001, *O*), *m* ($10\bar{1}0$. *I*); *r* ($10\bar{1}2$, ½), *s* ($10\bar{1}1$, 1), *t* ($40\bar{4}1$, 4).

Angles: *cr* = *39°, *cs* = 58° 18½′, *ct* = 81° 13½′, *rr′* = 36° 41′, *ss′* = 50° 21½′, *tt′* = 59° 14′.

Distinct faces rare. Usually, as snow crystals, in compound six-rayed stellate forms of great variety and delicacy; occasionally as hail[3], with hexagonal crystals projecting from a solid nucleus, or rarely in distinct quartzoids. Also granular and compact massive.

Brittle at low temperatures, but somewhat less so near the melting-point. H. = 1·5. G. = 0·9167 Bunsen[2]. Fracture conchoidal. Luster vitreous. Colorless to white when pure, but in thick layers pale blue. Transparent. Optically uniaxial, positive. Refractive indices, Reusch[4]:

$\omega_r = 1·30598$ $\epsilon_r = 1·30734$ $\omega_{gr} = 1·3120$ $\epsilon_{gr} = 1·3136$ $\omega_v = 1·317$ $\epsilon_v = 1·321$

Also Meyer[5]:

$\omega_r = 1·2970$ Li at $-8°$C. $\omega_y = 1·3090$ Na at $-8°$ $\omega_{gr} = 1·3107$ Tl at $- 3·8°$
$\epsilon_r = 1·3037$ " " $\epsilon_y = 1·3133$ " " $\epsilon_{gr} = 1·3163$ " "

**Comp.**—$H_2O$ = Oxygen 88·9, hydrogen 11·1 = 100.

**Obs.**—Formed as a coating over ponds, lakes, rivers, etc., at low temperatures; also direct from water vapor in the atmosphere as snow, often in crystals of great beauty and variety of form; also as frost, hail, etc. Forming permanent fields of snow at definite altitudes, depending upon the latitude; under favorable conditions changed into solid ice and descending as glaciers far below the snow-line; also, when the latter reach the sea, forming icebergs carried by ocean currents into lower latitudes.

**Ref.**—[1] Öf. Ak. Stockh., **17**, 439, 1860, or Pogg., **114**, 612, 1861; the measurements are only approximate, and but little weight can be given to them; forms apparently orthorhombic or tetragonal were also observed. Cf. also Clarke, Trans. Cambridge Phil. Soc., **1**, 210, 1821; Bravais, on halos, etc., Ann. Ch. Phys., **21**, 361, 1847; Leydolt, Ber. Ak. Wien, **7**, 477, 1851; Listing, Pogg., **122**, 161, 1864. Later Koch, Jb. Min., 449, 1877; Klocke, ib., 272, 1879; **1**, 23, 188[illegible]. Bertin, Ann. Ch. Phys., **13**, 283, 1878. A great variety of snow-crystals are figured by

Scoresby in his History and Description of the Arctic Regions, 1820. [2] Pogg., **141**, 7, 1870 [3] Cf. Pogg., **146**, 475, 1872, Nature, Dec. 12, 1889 (figures from Abich, Tiflis, 1871); Am. J. Sc., **40**, 176, 1890. [4] Pogg., **121**, 573, 1864; earlier, Bravais, l. c. [5] Wied. Ann., **31**, 321, 1887.

**224. CUPRITE.** Aes caldarium rubro-fuscum, *Germ.* Lebererzkupfer, *Agric.*, Foss., 334, Interpr., 462, 1546. Minera cupri calciformis pura et indurata, colore rubro, vulgo Kupferglas, Kupfer Lebererz., *Cronst.*, Min., 173, 1758. Cuprum tessulatum nudum *Linn.*, Syst., 172, tab. viii , 1756; Cuprum cryst. octaëdrum *ib.*, 1768. Octahedral Copper Ore, Red Glassy Copper Ore, *Hill*, Foss., 1771. Mine rouge de cuivre *Sage*, Min., 1772. Mine de cuivre vitreuse rouge *de Lisle*, Crist., 1772, 1783. Rothes Kupferglas *Pallas*, Nord. Beiträge, **5**, 283, 1793. Rothkupfererz. Cuivre oxidulé. Oxydulated copper. Ziguéline *Beud.*, Tr., **2**, 713, 1832. Ruberite *Chapm.*, Pract. Min., 63, 1843. Cuprit *Haid.*, Handb, 548, 1845. Ruby copper.

Ziegelerz = Tile Ore; Kupferlebererz; Hepatinerz. Ziguelina *Ital.*

Haarförmiges Rothkupfererz. Cuivre oxidulé capillaire, *H.* Kupferblüthe *Hausm.* Capillary Red Oxide of Copper. Chalkotrichit *Glock* , Grundr., 369, 1839. Plush Copper Ore.

Isometric; with trapezohedral hemihedrism. Observed forms[1]:

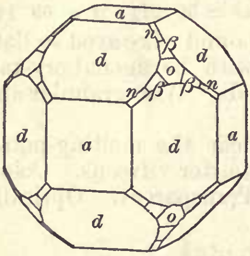
$a$ (100, $i$-$i$) $o$ (111, 1) $e$ (210, $i$-2) $q$ (331, 3) $\delta$ (533, $\frac{5}{3}$-$\frac{5}{3}$)[3] $s$ (321, 3-$\frac{3}{2}$)
$d$ (110, $i$) $\eta$ (510, $i$-5) $p$ (221, 2) $n$ (211, 2-2) $\beta$ (322, $\frac{3}{2}$-$\frac{3}{2}$)[2]

Also $x$ (986, $\frac{3}{2}$-$\frac{9}{8}$) developed as a trapezohedral hemihedral form, f. 3, Miers[4].

Commonly in octahedrons; also in cubes and dodecahedrons, often highly modified. Sometimes cubes lengthened into capillary forms. Also massive, granular; sometimes earthy.

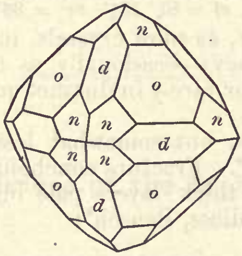
Cleavage: $o$ interrupted; rarely $a$[4]. Fracture conchoidal, uneven. Brittle. H. = 3·5–4. G. = 5·85–6·15; 5·992, Haid. Luster adamantine or submetallic to earthy. Color red, of various shades, particularly cochineal-red, sometimes almost black; occasionally crimson-red by transmitted light. Streak several shades of brownish red, shining. Subtransparent to subtranslucent. Refractive index high, $n_r$ = 2·849 Fizeau[5].

1.



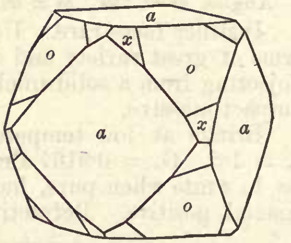
Arizona.

2.



Gov't Perm, Kk.

3.



Cornwall, Miers[4].

**Var.**—1. *Ordinary.* (*a*) Crystallized; commonly in octahedrons, dodecahedrons, cubes, and intermediate forms; the crystals often with a crust of malachite; (*b*) massive.

2. *Capillary; Chalcotrichite.* Plush copper Ore. In capillary or acicular crystallizations, which are cubes elongated in the direction of the octahedral axis (Knop, Jb. Min., 521, 1861).

3. *Earthy; Tile Ore,* Ziegelerz *Germ.* Brick-red or reddish brown and earthy, often mixed with red oxide of iron; sometimes nearly black. The *hepatinerz*, or *liver ore*, of Breithaupt has a liver-brown color. Von Bibra found (J. pr. Ch., **96**, 203, 1865) the tile-ore of Algodon bay, Bolivia, to be a mixture of atacamite, cuprite, hematite, and other earthy material.

**Comp.**—Cuprous oxide, $Cu_2O$ = Oxygen 11·2, copper 88·8 = 100.

**Pyr., etc.**—Unaltered in the closed tube. B.B. in the forceps fuses and colors the flame emerald-green; if previously moistened with hydrochloric acid, the color imparted to the flame is momentarily azure-blue from chloride of copper. On charcoal first blackens, then fuses, and is reduced to metallic copper. With the fluxes gives reactions for copper. Soluble in concentrated hydrochloric acid, and a strong solution when cooled and diluted with cold water yields a heavy, white precipitate of subchloride of copper.

**Obs.**—Occurs at Kamsdorf and Saalfeld in Thuringia; at Les Capanne Vecchie in Tuscany; on Elba, in cubes; in Cornwall, in fine translucent crystals with native copper and quartz, at Wheal Gorland and other Cornish mines; in Devonshire near Tavistock; in isolated crystals, sometimes an inch in diameter, in lithomarge, at Chessy, near Lyons, which are generally coated with, or entirely altered to, malachite; at Ekaterinburg in the Ural; in South Australia; also abundant in Chili, Peru, Bolivia; very fine crystals from Andacollo near Coquimbo.

In the U. S. it has been observed at Schuyler's, Somerville, and Flemington copper mines, N. J., crystallized and massive, associated with chrysocolla and native copper; also near New Brunswick, N. J., in red shale; 2 m. from Ladenton, Rockland Co., N. Y., with green malachite in trap; in soft earthy form in sandstone at Cheshire near New Haven, Conn.; at Cornwall, Lebanon Co., Pa.; in the Lake Superior region; at the copper mines in St. Genevieve Co., Mo. With malachite, limonite, etc., at the Copper Queen mine, Bisbee, Arizona, sometimes in fine crystals; beautiful *chalcotrichite* at Morenci; at Clifton, Graham Co., in crystals, and massive.

Named *cuprite* by Haidinger from the Latin *cuprum*, copper.

**Artif.**—An occasional furnace-product. Cf. Arzruni, Zs. Kr., **18**, 58, 1890. Also a recent formation on buried copper coins, bronze utensils, etc., cf. Fletcher, Min. Mag., **7**, 187, 1887.

**Alt.**—A deoxidation of cuprite sometimes takes place, producing native copper. It also becomes carbonated and green, by means of carbonated waters, changing to malachite or azurite; or through a silicate in solution it is changed to chrysocolla; or by taking oxygen it becomes melaconite. Limonite occurs as a pseudomorph by substitution after cuprite.

**Ref.**—[1] Cf. Mlr., Min., 223, 1852; Schrauf, Atlas, L. An early paper illustrated with 9 plates and 108 figures is given by Phillips in Trans. G. Soc. London, 1, 23, 1811. [2] Schrauf, Liskeard, Cornwall, Min. Mitth., 106, 1871. [3] Miers, Wheal Phœnix, Min. Mag., 8, 207, 1889. [4] Phil. Mag., 18, 127, 1884. [5] Quoted by Dx., N. R., 10, 1867.

HYDROCUPRITE *Genth*, Report Min. Penn., 46, 1875. From Cornwall, Lebanon Co., Penn. Is perhaps a hydrated cuprite. Amorphous, orange-yellow to orange-red; forms very thin coatings, sometimes rag-like, upon magnetite. A similar substance has been noted with cuprite at Schapbach, Baden (Sandb.).

## Periclase Group. RO. Isometric.

**225. PERICLASE.** Periclasia *Scacchi*, Mem. Min., Naples, 1841. Periklas *Germ.* Periclasite.

Isometric. In cubes or octahedrons. Also in grains.

Cleavage: cubic, perfect; octahedral less distinct. H. = nearly 6. G. = 3·674, Vesuvius; 3·90, Nordmark. Colorless to grayish, and dark green. Transparent to translucent.

**Comp.**—Magnesia, MgO = Oxygen 40, magnesium 60 = 100. Iron or manganese may be also present.

**Anal.**—1, 2, Damour, Ann. Mines, **3**, 381, 1843, and Bull. Soc. G. Fr., **6**, 311, 1849; also earlier, Scc., l. c. and 5th Ed., p. 134. 3, A. Sjögren, G. För. Förh., **9**, 526, 1887. 4, G. Lindström, ibid.

| | MgO | FeO | MnO | ZnO | ign. | |
|---|---|---|---|---|---|---|
| 1. Vesuvius G. = 3·674 | 93·86 | 5·97 | — | — | — | = 99·83 |
| 2. " | 93·38 | 6·01 | — | — | — | = 99·39 |
| 3. Nordmark G. = 3·90 | $\frac{3}{3}$ 86·38 | 0·46 | 8·27 | 1·98 | 1·45 | = 98·54 |
| 4. " | 87·38 | 0·19 | 9·00 | 2·52[a] | — | = 99·09 |

[a] Incl. some MnO.

**Pyr., etc.**—B.B. unaltered and infusible; the manganesian variety becomes dark colored. With cobalt solution after long blowing assumes a faint flesh-red color. The pulverized mineral shows an alkaline reaction when moistened, and dissolves in mineral acids without effervescence.

**Obs.**—Occurs disseminated through ejected masses of a white limestone, and in spots of small clustered crystals, on Mt. Somma, sometimes with forsterite and earthy magnesite. At the Kitteln manganese mine, Nordmark, Wermland, Sweden, in small grains in a dolomitic limestone together with hausmannite; the grains are surrounded by a more or less distinct zone of brucite formed by alteration.

Peculiar pseudomorphs of serpentine (and in part of dolomite), showing a structure apparently corresponding to a highly perfect cubic cleavage, have been observed at the Tilly Foster iron mine at Brewster, N. Y. (J. D. D., Am. J. Sc., 8, 375, 1874). The nature of the original mineral is in doubt; Tschermak has suggested that it may have been periclase.

Named from *περί*, *about*, and *κλάσις*, *fracture*, in allusion to the cleavage.

**Artif.**—Formed in crystals of a cubo-octahedral form by making lime to act at a high temperature on magnesium borate (Ebelmen); by the action of hydrochloric acid gas on magnesia (Deville); by the action of magnesium chloride on lime (Daubrée).

**226. MANGANOSITE.** Manganosit *Blomstrand*, G. För. Förh., **2**, 179, 1874.

Isometric. In minute octahedrons, with *d* and rarely *a*.

Cleavage: cubic. H. = 5–6. G. = 5·18. Luster vitreous. Color emerald green when fresh, becoming black on exposure. Isotropic.

**Comp.**—Manganese protoxide, MnO = Oxygen 22·6, manganese 77·4 = 100.

**Anal.**—Blomstrand, 9 För. Föhr., **2**, 182, 1874.

| | MnO | FeO | MgO | CaO | |
|---|---|---|---|---|---|
| $\frac{3}{2}$ | 98·04 | 0·42 | 1·71 | 0·16 | = 100·33 |

**Pyr., etc.**—B.B. blackens, without sensibly fusing. Dissolves with difficulty in strong nitric acid, forming a colorless solution. Reacts for manganese with the fluxes.

**Obs.**—Occurs with pyrochroite and manganite, in a manganiferous dolomite (anal.: $CaCO_3$ 56·47, $MnCO_3$ 30·10, $MgCO_3$ 13·56, $FeCO_3$ 0·18 = 100·31, Blomstrand) at Långban, Wermland, Sweden; also in calcite, brucite, or dolomite, with hausmannite, pyrochroite, garnet, etc., at the Moss mine, Nordmark, Wermland, Sweden.

**227. BUNSENITE.** Nickeloxydul *C. Bergemann*, J. pr. Ch., **75**, 243, 1858. Bunsenite *Dana*, Min., 134, 1868.

Isometric. In minute octahedrons, sometimes having truncated edges.

H. = 5·5. G. = 6·398. Luster vitreous. Color pistachio-green. Streak brownish black. Translucent. Artificial crystals observed in slags have a metallic luster, and brownish black color.

**Comp.**—Nickel protoxide, NiO = Oxygen 21·5, nickel 78·5 = 100.

**Obs.**—Occurs in cavities with other nickel ores, and ores of uranium, at Johanngeorgenstadt. Named after Prof. R. W. Bunsen of Heidelberg (b. 1811), who observed long since artificial crystals of this nickel oxide.

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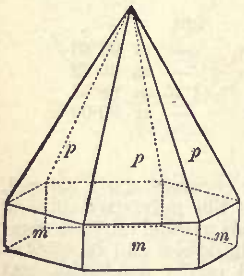
**228. ZINCITE.** Red Oxide of Zinc *A. Bruce*, Bruce's Min. J., **1**, No. 2, 96, 1810. Zinkoxyd, Rothzinkerz, *Germ.* Zinc oxydé *Fr.* Red Zink Ore. Zinkit *Haid.*, Handb., 548, 1845. Spartalite *B. & M.*, 218, 1852. Sterlingite F. Alger, Min., 565, 1844.

Hexagonal; hemimorphic. Axis $\dot{c} = 1·6219$; $0001 \wedge 10\bar{1}1 =$ *61 °54′ Rinne[1].

**Forms**[2]: *c* (0001, *O*), *m* ($10\bar{1}0$, *I*), *p* ($10\bar{1}1$, 1). Also on artif. cryst.[3]: *a* ($11\bar{2}0$, *i*-2), *s* ($10\bar{1}3$, $\frac{1}{3}$), *ρ* ($20\bar{2}5$, $\frac{2}{5}$), *n* ($10\bar{1}2$, $\frac{1}{2}$), *ω* ($30\bar{3}5$, $\frac{3}{5}$), *q* ($20\bar{2}3$, $\frac{2}{3}$), *ξ* ($80\bar{8}9$, $\frac{8}{9}$)[5] as tw. pl., *v* ($80\bar{8}5$, $\frac{8}{5}$), *y* ($20\bar{2}1$, 2); *d* ($11\bar{2}1$, 2-2)[5]; *μ* ($21\bar{3}3$, 1-$\frac{3}{2}$)[4].

Angles: *pp′* = 52° 21′, *cρ* = 36° 50′, *cω* = 48° 20′, *cv* = 71° 33′, *cd* = 72° 52′.

1.



Natural crystals rare, hemimorphic (f. 1); usually foliated massive, or in coarse particles and grains; also with granular structure.

Artif. crystals generally prismatic (*m*) or quartzoids (*p*) with *c*; hemimorphic in habit (as also shown by etching-figures, Rinne, l. c.), like wurtzite, greenockite, iodyrite, with which species it is homœomorphous. Also twinned, with *ξ* as tw. pl., Rath[6]; also with *c* tw. pl. and comp.-face, Rinne.

Cleavage: *c* perfect; prismatic, sometimes distinct. Fracture subconchoidal. Brittle. H. = 4–4·5. G. = 5·43–5·7; 5·684, cryst., Blake. Luster subadamantine. Streak orange-yellow. Color deep red, also orange-yellow. Translucent to subtranslucent. Optically +.

**Comp.**—Zinc oxide, ZnO = Oxygen 19·7, zinc 80·3 = 100. Manganese protoxide is sometimes present.

**Anal.**—Stone, Sch. Mines, Q., **8**, 149, 1887. See also 5th Ed., p. 135.

| | | ZnO | MnO | $Fe_2O_3$ |
|---|---|---|---|---|
| 1. Sterling Hill | G. = 5·531 | 93·28 | 6·50 | 0·44 = 100·22 |
| 2. " " | G. = 5·507 | 94·30 | 5·54 | 0·36 = 100·20 |

**Pyr., etc.**—Heated in the closed tube blackens, but on cooling resumes the original color. B.B. infusible; with the fluxes, on the platinum wire, gives reactions for manganese, and on charcoal in R.F. gives a coating of zinc oxide, yellow while hot, and white on cooling. The coating, moistened with cobalt solution and treated in O.F., assumes a green color. Soluble in acids without effervescence. On exposure to the air it suffers a partial decomposition at the surface, and becomes invested with a white coating of zinc carbonate.

**Obs.**—Occurs with franklinite and willemite, at Sterling Hill near Ogdensburg, and at Mine Hill, Franklin Furnace, Sussex Co., N. J., sometimes in lamellar masses in pink calcite. It was first noticed, described, and analyzed by Dr. Bruce. Has been reported as forming pseudomorphs after sphalerite at Schneeberg.

**Artif.**—Mitscherlich has observed minute six-sided prisms in the iron-furnaces of Königshütte, in Silesia. Similar crystals have been met with in the zinc furnace~~s near~~ Siegen; also in the furnaces and roast-heaps at the New Jersey zinc mines; surface drusy, color white to amber-yellow (Am. J. Sc., **13**, 417, 1852); in hexagonal prisms in the zinc furnaces at Bethlehem, Pa., and Newark, N. J.; by L. Stadtmüller at the iron furnace of Van Deusenville, Mass.; also at other furnaces in Europe and America. Cf. also ref. below and Gorgeu, Bull. Soc. Min., **10**, 36, 1887.

**Ref.**—[1]Artif. cryst. from Lerbach in the Harz, Jb. Min., **2**, 164, 1884; Rose gives $pp' =$ 52° 17′ to 52° 20′, Kr.-Chem. Min., 64, 1852. [2]E. S. D., Franklin Furnace, N. J., Am. J. Sc., **32**, 389, 1886. [3]Cf. Hausm. for a reconciliation of earlier observations, Handb., **2**, 199, 1847. [Stud., Gött. Ver. Bergm. Freunde, **5**, 215]; some of these planes are doubtful; also Greim, Ber. Oberhess. Ges., **24**, 1886. [4]Rath, Pogg., **122**, 406, 1864. [5]Busz, artif. cryst., Zs. Kr., **15**, 621, 1889. [6]Id., Pogg., **144**, 580, 1871; cf. Lévy, Ann. Mines, **4**, 516, 1843. See p. 1052.

CALCOZINCITE *Shepard*, Contrib. Min., Amherst, 1876, Am. J. Sc., **12**, 231, 1876. A substance from Sterling Hill, New Jersey, described as having a fine granular to columnar structure, light orange-yellow color. It is probably a mechanical mixture of zincite and calcite, as an analysis indicates.

**229. MASSICOT.** *Huot*, Min., 346, 1841. Massicottite *A. D'Achiardi* I Metalli, **1**, 221, 1883. Lead ocher, Plumbic ocher, Lead oxide. Bleiglätte, Bleioxyd, *Germ.* Chrysitin *Weisbach*, Synops. Min., 54, 1875. Plomb oxidé jaune *Fr.* Piombo ossidato *Ital.* Litarjirio nativo *Span.*, Domeyko, Min. Chili, 1879.

Massive; structure scaly crystalline or earthy.

H. = 2. G. = 8·0; 7·83–7·98, Mexico, Pugh; 9·2–9·36 when pure. Luster dull. Color between sulphur- and orpiment-yellow, sometimes reddish. Streak lighter than the color. Opaque. Does not soil.

Artif. cryst. early described as isometric, later shown to be orthorhombic; crystals thin tabular ∥ *a*, with *a* (100), *c* (001), *d* (*h*0*l*), *r* (111), *s* (455), *t* (233), and two other undetermined brachypyramids *q*, *v* Nd.[1] See also Mitsch.[2], who describes rhombic pyramids, also Grail.[3], Rg.[4], and Lüdecke[5], who mention tetragonal forms; also Michel[6], who finds them optically negative.

**Comp.**—Lead monoxide, PbO = Oxygen 7·2, lead 92·8 = 100. The natural mineral is more or less impure.

Analyses, see 5th Ed., p. 136.

**Pyr., etc.**—B.B. fuses readily to a yellow glass, and on charcoal is easily reduced to metallic lead.

**Obs.**—It is said to occur at Badenweiler in Baden, in quartz. Gerolt states that it has been ejected from the volcanoes of Popocatapetl and Jztaccituall, in Mexico. It is found in many places in the provinces of Chihuahua and Cohahuila in considerable quantities, having been collected along the streams between Ceralvo and Monterey, being supposed to come from the range of mountains running nearly north of Monterey. The specimens (often 2 or more cubic inches in size) are between orpiment- and sulphur-yellow in color, and glisten like a granular mica of a nearly golden color. The natural surface is slightly crystalline and shining, and when broken it shows a scaly texture.

Occurs also at Austin's mines, Wythe Co., Va.

**Artif.**—Artificial crystals have been obtained among furnace-products and by direct chemical methods, as well as from fusion. The yellow powder (PbO) obtained by heating lead in a current of air is called *massicot;* if, however, the heat is sufficient to fuse the oxide, the product, crystallizing usually in yellowish red scales, is called *litharge.*

**Ref.**—[1] Pogg., **114**, 619, 1861. [2] Ber. Ak. Berlin, 11, 1840. [3] Ber. Ak. Wien, **28**, 282, 1858. [4] Kr. Ch., **1**, 181, 1881. [5] Zs. Kr., **8**, 82, 1883. [6] Bull. Soc. Min., **13**, 56, 1890.

**230. TENORITE.** Kupferschwärze *Wern.*, Bergm. J., 1789. Melaconite *Huot*, Min., 326, 1841. Tenorite *Semmola*, Opere Minori, 45, Napoli, 1841, Bull. G. Fr., **13**, 206, 1841–42. Melaconisa *A. Scacchi*, Distrib. Sist. Min., 40, Napoli, 1842. Melaconite *Dana*, Min., 518, 1850. Black copper; Black Oxide of Copper. Kupferoxyd *Germ.* Cuivre oxydé noir *Fr.* Nero rame *Ital.* Cobre negro *Span.*

Monoclinic (or Triclinic). Axes: $\grave{a} : \bar{b} : \acute{c} = 1·4902 : 1 : 1·3604$; $\beta = 80° 28'$ = 001 ∧ 100 Maskelyne[1].

100 ∧ 110 = 55° 46′, 001 ∧ 101 = 38° $1\frac{2}{3}$′, 001 ∧ 011 = 53° 18′.

**Forms:** *a* (100, *i*-*ī*), *c* (001, *O*); *x* (601, – 6-*ī*), *q* (011, 1-*ĭ*), *u* (111, – 1), *o* ($\bar{1}$11, 1), *z* (611, – 6-$\bar{6}$).

Angles: *qq'* = 106° 36', *uu'* = 85° 6', *oo'* = 94° 38', *au* = 57° 4', *aq* = 84° 19', *a'o* = 65° 50.

The axial ratio of Maskelyne given above (he gives no angles) was deduced by him from melaconite crystals from Cornwall. Artif. crystals were described by Jenzsch as orthorhombic, but his results agree better with those of Maskelyne (Scacchi, Kalkowsky). Tenorite crystals from Vesuvius have been described by Scacchi, and later by Kalkowsky, who makes them triclinic on optical grounds. Supposed isometric crystals of melaconite from Lake Superior were perhaps pseudomorphs.

Twins: tw. pl. *a*. Often in thin shining flexible scales. Earthy; massive; pulverulent.

Cleavage: *c* easy, also *u* (111) Mask. Fracture conchoidal to uneven. H. = 3–4. G. = 5·825 cryst., Mask.; 6·25, massive, Whitney; 5·952, id., Joy. Luster metallic, and color steel- or iron-gray when in thin scales; dull and earthy, with a black or grayish black color, and ordinarily soiling the fingers when massive or pulverulent.

**Var.**—1. *Tenorite.* In minute scales with metallic luster, found at Vesuvius.

2. *Melaconite.* Earthy black massive.

**Comp.**—Cupric oxide, CuO = Oxygen 20·2, copper 79·8 = 100.

**Pyr., etc.**—B.B. in O.F. infusible; other reactions as for cuprite, p. 206. Soluble in hydrochloric and nitric acids.

**Obs.**—Found on lava at Vesuvius in scales from a twentieth to a third of an inch across, often hexagonal and sometimes triangular; and also pulverulent. Common in the earthy form about copper mines, as a result of the decomposition of chalcopyrite and other copper ores. Abundant thus at the Ducktown mines in Tennessee, and also formerly at Copper Harbor, Keweenaw Point, L. Superior. Named after Sr. Tenore, President of the Naples Academy.

**Ref.**—[1] Brit. Assoc., 33, 1865. Jenzsch, Pogg., **107**, 647, 1859. Kalkowsky, Zs. Kr., 3, 279, 1879. On paramelaconite, see p. 1043.

MARCYLITE *Shepard*, Marcy's Expl. Red River, 135, 1854, Shep. Min., 405, 1857. An uncertain mixture from the Red River, near the Wachita Mts., Arkansas. Supposed to consist of oxide of copper, sulphide of copper, with water. It is evidently a result of the alteration of a copper sulphide. See 5th Ed., p. 137.

A similar mixture from Peru is mentioned by Raimondi, Min. Pérou, 137, 1878.

LIME. Calcium oxide. Calce *Scacchi.*

Found at Vesuvius enveloped in the lava of 1631, as a result of the alteration of calcium carbonate.

PALLADINITE *Adam*, Tabl. Min., 82, 1869. Palladium oxide, PdO; credited to Lampadius.

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## II. Sesquioxides, $R_2O_3$.

### Hematite Group.* Rhombohedral.

| | | | | *rr'* | $\dot{c}$ |
|---|---|---|---|---|---|
| 231. | Corundum | $Al_2O_3$ | | 93° 56' | 1·3630 |
| 232. | Hematite | $Fe_2O_3$ | | 94° 0' | 1·3656 |
| 233. | Ilmenite | $(Fe,Ti)_2O_3$ | Tetartohedral | 94° 29' | 1·3846 |

231. **CORUNDUM.** Corindon (= Sapphire, Corundum, and Emery united) *H.*, Gilb. Ann., **20**, 187. 1805, Lucas Tabl., **1**, 257, 1806.

1. SAPPHIRE.—*Ὑάκινθος Gr.;* Hyacinthos *Plin.*, **37**, 44; Asteria, ibid., 49. Jacut *Arab.* *Ἄνθραξ* pt., *Theophr.* Carbunculus, Lychnis, pt., *Plin.*, **37**, 25, 29. Saphir, Sapphirus, *Wall.*, Min., 116; Orientalisk Rubin, *id.*, 117, 1747. Télésie *H.*, Tr., 1801. Corindon hyalin *H.*, 1805.

2. CORUNDUM.—Adamas Siderites *Plin.*, **37**, 15. Karund *Hind.* Corivindum, Corivendum, *Woodw.*, Cat. Foss., 1714, 1725. Adamantine Spar *Black*, 1780, according to Greville and Klaproth (v. seq.). Demantspath *Klapr.*, Mem. Acad., Berlin, 1786–87, Berlin, 1792; Beitr., **1**, 47, 1795; *Wern.*, Bergm. J., **1**, 375, 390, 1789. Spath adamantin *Delameth.*, J. de Phys., **30**, 12, 1787; *Haüy*, ib., 193. Corundum *Greville*, Phil. Trans., 1798. Corindon *H.*, Tr., 1801. Corindon harmophane *H.* Corindon adamantin *Brongn.*, Min., **1**, 429, 1807. Korund *Germ.*

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* Includes also pyrophanite, $MnTiO_3$, p. 1045, and perhaps långbanite, pp. 543, 1039.

3. Emery.—'Ακονη ἐξ 'Αρμενίας [= Armenian Whetstone], *Theophr.* *Σμῦρις Dioscor.*, 5, 165. Naxium, Naxium ex Armenia, *Plin.*, 36, 10. Pyrites vivus (?) *Plin.*, 36, 30. Smyris, Smiris, *Agric.*, Foss., 1546. Smergel, Smiris ferrea, *Wall.*, Min., 267, 1747. Smirgel, Schmirgel, *Germ.* Emeril *H.*, Tr., 1801; Corindon granuleux *H.*, 1805.

Rhombohedral. Axis $\dot{c} = 1·3630$; $0001 \wedge 10\bar{1}1 = 57° 34' 8''$ Miller[1].

**Forms**[2]:

$c$ $(0001, O)$
$m$ $(10\bar{1}0, I)$
$a$ $(11\bar{2}0, i\text{-}2)$
$f$ $(71\bar{8}0, i\text{-}\frac{8}{7})$
$\gamma$ $(10\bar{1}5, \frac{1}{5})$

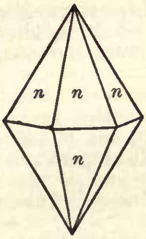
$\delta$ $(10\bar{1}3, \frac{1}{3})$
$d$ $(10\bar{1}2, \frac{1}{2})$
$r$ $(10\bar{1}1, 1)$
$b$ $(70\bar{7}2, \frac{7}{2})$[3]
$q$ $(70\bar{7}1, 7)$[5]
$\eta$ $(01\bar{1}1, -1)$

$s$ $(02\bar{2}1, -2)$
$\beta$ $(07\bar{7}2, -\frac{7}{2})$[3]
$o$ $(22\bar{4}5, \frac{4}{5}\text{-}2)$[6]
$n$ $(22\bar{4}3, \frac{4}{3}\text{-}2)$
$\varsigma$ $(7·7·\bar{1}\bar{4}·9, \frac{14}{9}\text{-}2)$
$w$ $(11\bar{2}1, 2\text{-}2)$

$k$ $(7·7·\bar{1}\bar{4}·6, \frac{7}{3}\text{-}2)$
$v$ $(44\bar{8}3, \frac{8}{3}\text{-}2)$
$u$ $(11·11·\bar{2}\bar{2}·6, \frac{11}{3}\text{-}2)$[5]
$z$ $(22\bar{4}1, 4\text{-}2)$
$\lambda$ $(7·7·\bar{1}\bar{4}·3, \frac{14}{3}\text{-}2)$[3]
$\theta$ $(8·8·\bar{1}\bar{6}·3, \frac{16}{3}\text{-}2)$

$\nu$ $(44\bar{8}1, 8\text{-}2)$
$\omega$ $(14·14·\bar{2}\bar{8}·3, \frac{28}{3}\text{-}2)$[3,4]
$i$ $(42\bar{6}5, \frac{2}{5}^{3})$
$g$ $(32\bar{5}4, \frac{1}{4}^{5})$
$\rho$ $(2·8·\bar{1}\bar{0}·9, -\frac{2}{3}^{\frac{5}{3}})$

1.



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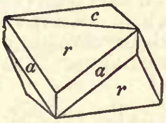

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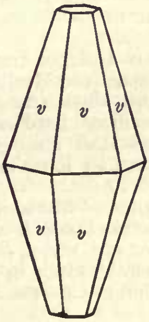

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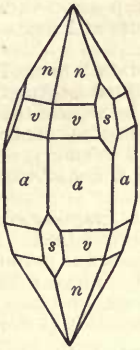

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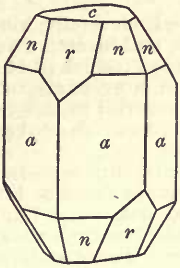

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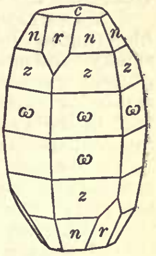


1, Ceylon. 2, Burma, Mallet. 3, Zánskár, Id. 4, 5, Ceylon, Haid. 6, Ilmen Mts., Kk.

$af = 23° 25'$
$mf = 6° 35'$
$c\gamma = 17° 28'$
$c\delta = 27° 41'$
$cd = 38° 12'$
$cs = 72° 22\frac{1}{2}'$
$cb = 79° 43'$
$cn = 61° 11'$
$c\varsigma = 64° 45'$
$cw = 69° 51'$
$ck = 72° 33'$

$cv = 74° 37'$
$cz = 79° 36'$
$c\lambda = 81° 4'$
$c\theta = 82° 10'$
$c\nu = 84° 45\frac{1}{2}'$
$c\omega = 85° 30'$
$ci = 59° 1'$
$cg = 59° 45'$
$c\rho = 58° 2'$
$\gamma\gamma' = 30° 8\frac{1}{2}'$
$\delta\delta' = 47° 27'$

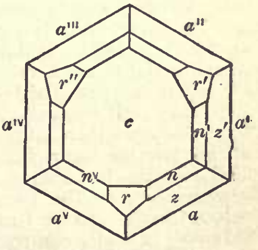
$dd' = 64° 46'$
$rr' = {}^*93° 56'$
$ss' = 111° 15'$
$bb' = 116° 53'$
$r\eta = 49° 56'$
$nn' = 51° 58'$
$\varsigma\varsigma' = 53° 46'$
$ww' = 55° 59\frac{1}{2}'$
$kk' = 56° 58\frac{1}{2}'$
$vv' = 57° 38\frac{1}{2}'$
$zz' = 58° 55'$

$\lambda\lambda' = 59° 12'$
$\theta\theta' = 59° 23'$
$\nu\nu' = 59° 43\frac{1}{2}'$
$\omega\omega' = 59° 48'$
$ii' = 68° 17'$
$ii^{v} = 46° 46'$
$gg' = 61° 59'$
$gg^{v} = 40° 9'$
$\rho\rho^{v} = 79° 47'$
$\rho\rho' = 18° 27'$
$ar = 43° 2'$
$as = 34° 22\frac{1}{2}'$

Twins: tw. pl. *r*; sometimes penetration-twins; often polysynthetic, and thus producing a laminated structure. Crystals often rough and rounded, especially if large. Planes in zone *ca* deeply striated horizontally; *c* striated ‖ edge *c/r*, or divided into sectors by lines radiating from center normal to edges *c/a*. Also massive, with nearly rectangular parting or pseudo-cleavage; granular, coarse or fine.

Parting: *c*, sometimes perfect, but interrupted; also *r* due to twinning, often prominent. Fracture uneven to conchoidal. Brittle, when compact very tough. H. = 9. G. = 3·95–4·10. Luster adamantine to vitreous; on *c* sometimes pearly. Occasionally showing asterism. Color blue, red, yellow, brown, gray, and nearly white; streak uncolored. Pleochroic in deeply colored varieties. Transparent to translucent.

7.



Ilmen Mts., Kk.

Normally uniaxial, negative; sapphire $\omega_r = 1·7676$ to $1·7682$ and $\epsilon_r = 1·7594$

to 1·7598; ruby $\omega = 1·7675$, $\epsilon = 1·7592$, Dx.[7] Often abnormally biaxial[8]. Phosphorescent with a rich red color, and yielding a double crimson line (at $\lambda = 6937$, 6942) in the spectroscope (Crookes).

**Var.**—There are three subdivisions of the species prominently recognized in the arts, and until early in this century regarded as distinct species; but which actually differ only in purity and state of crystallization or structure. Haüy first (in 1805) formally united them under the name here accepted for the species, though the fact that adamantine spar and sapphire were alike in crystallization did not escape the early crystallographer Romé de Lisle, and led him to suggest their identity.

VAR. 1. SAPPHIRE, RUBY.—Includes the purer kinds of fine colors, transparent to translucent, useful as gems. Stones are named according to their colors: *Sapphire* blue; true *Ruby*, or *Oriental Ruby*, red; *O. Topas*, yellow; *O. Emerald*, green; *O. Amethyst*, purple. A variety having a stellate opalescence when viewed in the direction of the vertical axis of the crystal, is the *Asteriated* Sapphire or Star Sapphire (*Asteria* of Pliny). The ruby sapphire was probably included under the *ἄνθραξ* of Theophrastus, and the *Carbunculus* and *Lychnis* of Pliny. The blue sapphire (Ceylon) was called Salamstein by Werner.

*Barklyite* is a more or less opaque magenta-colored ruby from Victoria, cf. Liversidge, Min. N. S. W., 198, 1888. *Chlorsapphir* is a deep green variety occurring in bombs of a "sanidine-gneiss" enclosed in an ancient trachytic tufa at Königswinter on the Rhine, cf. Polig, Ber. nied. Ges., May 7, 1888.

2. CORUNDUM.—Includes the kinds of dark or dull colors and not transparent, colors light blue to gray, brown, and black. The original adamantine spar from India has a dark grayish smoky-brown tint, but greenish or bluish by transmitted light, when translucent, and either in distinct crystals, often large, or cleavable-massive. It is ground and used as a polishing material, and being purer, is superior in this respect to emery. It was thus employed in ancient times, both in India and Europe. The "Armenian stone" is supposed by King to have been corundum rather than emery.

3. EMERY. Schmirgel *Germ.*—Includes granular corundum, of black or grayish black color, and contains magnetite or hematite intimately mixed. Sometimes associated with iron spinel or hercynite. Feels and looks much like a black fine-grained iron ore, which it was long considered to be. There are gradations from the evenly fine grained emery to kinds in which the corundum is in distinct crystals. This last is the case with part of that at Chester, Massachusetts. The specific gravity varies rather widely, G. = 3·75–4·31 Smith.

**Comp.**—Alumina, $Al_2O_3$ = Oxygen 47·1, aluminium 52·9 = 100. The crystallized varieties are essentially pure; analyses of emery show more or less impurity, chiefly magnetite.

For analyses, etc., see J. L. Smith, Am. J. Sc., **10**, 354, 1850, **11**, 53, 1851, **42**, 83, 1866, and 5th Ed., p. 139.

**Pyr., etc.**—B.B. unaltered; slowly dissolved in borax and salt of phosphorus to a clear glass, which is colorless when free from iron; not acted upon by soda. The finely pulverized mineral, after long heating with cobalt solution, gives a beautiful blue color. Not acted upon by acids, but converted into a soluble compound by fusion with potassium bisulphate.

**Obs.**—Usually occurs in crystalline rocks, as granular limestone or dolomite, gneiss, granite, mica slate, chlorite slate. The associated minerals often include some species of the chlorite group, as prochlorite, corundophilite, margarite, also tourmaline, spinel, cyanite, diaspore, and a series of aluminous minerals, in part produced from its alteration. Occasionally found in ejected masses enclosed in younger volcanic rocks, as at Königswinter, Niedermendig, etc. Rarely observed as a contact-mineral. The fine sapphires are usually obtained from the beds of rivers, either in modified hexagonal prisms or in rolled masses, accompanied by grains of magnetite, and several kinds of gems, as spinel, etc. The emery of Asia Minor, Dr. Smith states, occurs in granular limestone.

The best rubies come from the mines in Upper Burma, north of Mandalay, in an area covering 25 to 30 square miles, of which Mogok is the center. Also found in the marble hills of Sagyin, 16 miles north of Mandalay. The rubies occur *in situ* in crystalline limestone, also in the soil of the hillsides and in gem-bearing gravel. All the crystallized varieties of the species occur here; the spinel ruby is a common associate. A ruby weighing 304 carats is said to have been found here in 1890. Rubies and sapphires have also been reported from other localities, and the massive varieties are common especially in the crystalline rocks of southern India. Ruby mines have also been worked at Jagdalak, 32 miles east of Kábul, Afghánistán. Some fine sapphires were obtained in 1882 from the Zánskár range of the Kashmir Himalayas near the village Machél in Pádar, and since then mining has been carried on there with some success (Mallet, Min. India; La Touche, Rec. G. Surv. India, **23**, 59, 1890). Blue sapphires are brought from Ceylon, often as rolled pebbles, but also as well-preserved crystals. Corundum occurs in the Carnatic on the Malabar coast, on the Chantibun hills in Siam, and elsewhere in the East Indies; also near Canton, China. At St. Gothard, it occurs of a red or blue tinge in dolomite, and near Mozzo in Piedmont, in white compact feldspar. Adamantine spar is met with in large coarse, hexagonal pyramids in Gellivara, Sweden.

Emery is found in large boulders at Naxos, Nicaria, and Samos of the Grecian islands; also in Asia Minor, 12 m. E. of Ephesus, near Gumuch-dagh, where it was discovered *in situ* by Dr. J. Lawrence Smith, associated with margarite, chloritoid, pyrite, calcite, etc.; and also at Kulah, Adula, and Manser, the last 24 m. N. of Smyrna; also with the nacrite (?) of Cumberland, England. Other localities are in Bohemia, near Petschau; in the Ural, near Ekaterinburg; and in the Ilmen mountains, not far from Miask; in the gold-washings northeast of Zlatoust as small crystals (called *soimonite* after Senator Soimonov) in barsovite (Kk. Min. Russl., **1**, 30, **2**, 80). Corundum, sapphires, and less often rubies occur in rolled pebbles in the diamond gravels on the Cudgegong river, at Mudgee and other points in New South Wales.

In N. America, in *Maine*, at Greenwood, in cryst. in mica schist, with beryl, zircon, lepidolite, rare. In *Massachusetts*, at Chester, corundum and emery in a large vein, consisting mainly of emery and magnetite, associated with diaspore, ripidolite, margarite, etc.; the corundum occasionally in blue pyramidal crystals. In *Connecticut*, at W. Farms, near Litchfield, in pale blue crystals; at Norwich, with sillimanite, rare. In *New York*, at Warwick, bluish and pink, with spinel, and often in its cavities; Amity, white, blue, reddish crystals, with spinel and rutile in gran. limestone. Emery with magnetite and green spinel (hercynite) in Westchester Co. in Cortlandt township, near Cruger's Station, and elsewhere (Am. J. Sc., **33**, 194, 1887). In *New Jersey*, at Newton, blue crystals in gran. limestone, with grass-green hornblende, mica, tourmaline, rare; at Vernon, near State line, red crystals, often several inches long. In *Pennsylvania*, in Delaware Co., in Aston, near Village Green, in large crystals; at Mineral Hill, in loose cryst.; in Chester Co., at Unionville, abundant in crystals, some masses weighing 4,000 lbs., and crystals occasionally 4 in. long, with tourmaline, margarite, and albite; in large crystals loose in the soil at Shimersville, Lehigh Co. In *Virginia*, in the mica schists of Bull Mt., Patrick Co.

Common at many points along a belt extending from Virginia across western North and South Carolina and Georgia to Dudleyville, Alabama; especially in Madison, Buncombe, Haywood, Jackson, Macon, Clay, and Gaston counties in North Carolina. The localities at which most work has been done are the Culsagee mine, Corundum hill, near Franklin, Macon Co., N.C., and 26 miles S. E. of this, at Laurel Creek, Ga. The corundum occurs in beds in chrysolite (and serpentine) and hornblendic gneiss, associated with a species of the chlorite group, also spinel, etc., and here as elsewhere with many minerals resulting from its alteration. (Cf. Shepard, Am. J. Sc., **4**, 109, 175, 1872; also Genth, l. c.) Fine pink crystals of corundum occur at Hiawassee, Towns Co., Georgia.

In *Colorado*, in small blue crystals in mica schist near Salida, Chaffee Co. Gem sapphires are found near Helena, Montana, in gold-washings and in bars in the Missouri river, especially the Eldorado bar. In *California*, in Los Angeles Co., in the drift of San Francisqueto Pass. In *Canada*, at Burgess, Ontario, red and blue crystals.

**Alt.**—Corundum undergoes extensive alteration, a series of aluminous minerals being the result. The commonest change is to the potash mica damourite, also to spinel, cyanite, fibrolite, zoisite, margarite, and other species. Cf. Genth, Am. Phil. Soc., **13**, 361, 1873; ibid., **20**, 381, 1882; Am. J. Sc., **39**, 47, 1890.

**Artif.**—Formed by decomposing potash alum by charcoal (Gaudin); in crystals by exposing to a high heat 4 pts. of borax and 1 of alumina (Ebelmen); by subjecting in a carbon vessel aluminium to the action of boric acid, the process yielding large rhombohedral plates (Deville & Caron); by addition to the last of chromium fluoride in varying amounts, affording the red sapphire or blue sapphire, or a fine green kind; by action of aluminium chloride on lime (Daubrée). Again by the fusion of alumina and minium in siliceous earthen crucibles, yielding a fusible lead aluminate which was subsequently decomposed by the silica, setting free the alumina in hexagonal crystals of considerable size (Frémy and Feil); under varying conditions rubies, sapphires, etc., being obtained. Also by the decomposition of aluminium chloride by magnesium and water vapor at a high temperature in a sealed tube (Meunier). Cf. Fouqué-Lévy, Synth. Min., 218–224, 1882; Bourgeois, Reprod. Min., 62, 1884.

**Ref.**—[1] Min., p. 242, 1852. [2] Cf. Mlr., l. c., and Svr., Att. Acc. Torino, **7**, 377, 1871. [3] Klein, Ceylon, Jb. Min., 486, 1871. [4] Kk., Ceylon, Min. Russl., **6**, 223, 1874. [5] Busz, Ceylon, Zs. Kr., **15**, 622, 1889. [6] Bruhns, ibid., **17**, 554, 1890. [7] Dx., Propr. Opt., **2**, 18, 1858. [8] Cf. Mld., Ann. Mines, **10**, 150, 1876, who makes the species orthorhombic; also Btd., Bull. Soc. Min., **1**, 95, 1878; Tschermak, Min. Mitth., **1**, 362, 1878, who regards it as monoclinic; Lsx., Zs. Kr., **10**, 346, 1885.

**232. HEMATITE.** ῾Αιματίτης [= Blood-stone] pt. *Theophr.*, 325 B.C.; *Dioscor.*, **5**, 143, A.D. 40. Hæmatites pt. *Plin.*, **36**, 28, 38, A.D. 77. (1) Galenæ genus tertium omnis metalli inanissimum, *Germ.* Eisenglanz, (2) Hæmatites pt. = *Germ.* Blutstein, Glaskopf, *Agric*, Interpr., 465, 468, 1546. (1) Speglande Jernmalm, Minera ferri specularis. (2) Hæmatites ruber, (3) Ochra rubra, *Wall.*, 259–266, 1747. Rotheisenstein. (1) Järnmalm tritura rubra, Speglande Eisenglimmer, (2) Hæmatites ruber, (3) Ochra pt., *Cronst.*, 178–185, 1758. Specular Iron; Red Hematite, Red Ocher. Specularite. Fer speculaire, (2) Hematite rouge, Sanguine, *Fr.* (1) Eisenglanz, (2) Roth Eisenstein, Rother Glaskopf, Rother Eisenrahm, *Wern.*, Bergm. J., 1789. Iron Glance, Red Iron Ore, Red Oxide of Iron, Micaceous Iron Ore. (1) Fer oligiste, (2) Fer oxydé rouge, *H.*, Tr., 1801. Hämatit *Hausm.*, Haid. Handb., 552, 1845, Hausm. Handb., 232, 1847. Jernglans, Röd Jernmalm, Blodsten, Rödmalm, *Swed.* Ematite rossa, Oligisto, Ferro specolare *Ital.* Hematita rojo, Hierro oligisto *Span.*

Rhombohedral. Axis $\dot{c} = 1{\cdot}36557$ ; $0001 \wedge 10\bar{1}1 = 57^\circ\ 37'\ 4''$ Koksharov[1].

Forms[2]:
$c\ (0001,\ O)$
$m\ (10\bar{1}0,\ I)$
$a\ (11\bar{2}0,\ i\text{-}2)$
$h\ (41\bar{5}0,\ i\text{-}\frac{5}{4})$
$\delta\ (21\bar{3}0,\ i\text{-}\frac{3}{2})$
$\lambda\ (1{\cdot}0{\cdot}\bar{1}{\cdot}16,\ \frac{1}{16})$
$\vartheta\ (10\bar{1}9,\ \frac{1}{9})$
$u\ (10\bar{1}4,\ \frac{1}{4})$
$\mathfrak{r}\ (3{\cdot}0{\cdot}\bar{3}{\cdot}10,\ \frac{3}{10})^3$
$\mathfrak{e}\ (20\bar{2}5,\ \frac{2}{5})$
$d\ (10\bar{1}2,\ \frac{1}{2})$
$\mathfrak{g}\ (40\bar{4}7,\ \frac{4}{7})$
$T\ (30\bar{3}5,\ \frac{3}{5})$

$\phi\ (50\bar{5}8,\ \frac{5}{8})$
$r\ (10\bar{1}1,\ R)$
$l\ (50\bar{5}2,\ \frac{5}{2})$
$\mathfrak{m}\ (40\bar{4}1,\ 4)$
$\alpha\ (0{\cdot}1\ \bar{1}{\cdot}23,\ -\frac{1}{23})$
$y\ (01\bar{1}8,\ -\frac{1}{8})$
$\mathfrak{n}\ (0{\cdot}2{\cdot}\bar{2}\ 13,\ -\frac{2}{13})$
$\mu\ (01\bar{1}5,\ -\frac{1}{5})$
$o\ (01\bar{1}4,\ -\frac{1}{4})$
$\gamma\ (02\bar{2}7,\ -\frac{2}{7})$
$e\ (01\bar{1}2,\ -\frac{1}{2})$
$\rho\ (05\bar{5}7,\ -\frac{5}{7})$
$\varLambda\ (04\bar{4}5,\ -\frac{4}{5})$
$\eta\ (01\bar{1}1,\ -1)$

$\mathfrak{y}\ (06\bar{6}5,\ -\frac{6}{5})^4$
$N (05\bar{5}4,\ -\frac{5}{4})$
$\mathfrak{a}\ (03\bar{3}2,\ -\frac{3}{2})$
$s\ (02\bar{2}1,\ -2)$
$p\ (05\bar{5}1,\ -5)$
$q\ (11\bar{2}6,\ \frac{1}{3}\text{-}2)$
$\pi\ (11\bar{2}3,\ \frac{2}{3}\text{-}2)$
$Y (22\bar{4}5,\ \frac{4}{5}\text{-}2)$
$n\ (22\bar{4}3,\ \frac{4}{3}\text{-}2)$
$X (44\bar{8}3,\ \frac{8}{3}\text{-}2)$
$V (33\bar{6}2,\ 3\text{-}2)$
$x\ (5{\cdot}5\ \bar{1}\bar{0}{\cdot}3,\ \frac{10}{3}\text{-}2)$
$z\ (22\bar{4}1,\ 4\text{-}2)$

$\mathfrak{t}\ (29{\cdot}4{\cdot}\bar{3}\bar{3}{\cdot}31,\ \frac{25}{31}^{\frac{33}{25}})$
$w (51\bar{6}1,\ 4^{\frac{3}{2}})$
$\mathfrak{q}\ (8{\cdot}2{\cdot}\bar{1}\bar{0}{\cdot}9,\ \frac{2}{3}^3)^3$
$\mathfrak{s}\ (72\bar{9}8,\ \frac{5}{8}^{\frac{9}{5}})$
$\epsilon\ (3{\cdot}1{\cdot}\bar{4}{\cdot}32,\ \frac{1}{16}^2)$
$f\ (62\bar{8}1,\ 4^2)$
$O (52\bar{7}6,\ \frac{1}{2}^{\frac{7}{3}})$
$v\ (15{\cdot}7{\cdot}\bar{2}\bar{2}{\cdot}2,\ 4^{\frac{11}{4}})$
$t\ (21\bar{3}4,\ \frac{1}{4}^3)$
$i\ (42\bar{6}5,\ \frac{2}{5}^3)$
$k\ (21\bar{3}1,\ 1^3)$
$g\ (32\bar{5}4,\ \frac{1}{4}^5)$
$\sigma (6{\cdot}4{\cdot}\bar{1}\bar{0}{\cdot}5,\ \frac{2}{5}^5)$

$C\ (34\bar{7}5,\ -\frac{1}{5}^7)$
$\Omega\ (6{\cdot}8{\cdot}\bar{1}\bar{4}{\cdot}13,\ -\frac{2}{13}^7)$
$\zeta\ (23\bar{5}5,\ -\frac{1}{5}^5)$
$\Psi\ (4{\cdot}6{\cdot}\bar{1}\bar{0}{\cdot}7,\ -\frac{2}{7}^5)$
$\xi\ (23\bar{5}2,\ -\frac{1}{2}^5)$
$Z\ (12\bar{3}8,\ -\frac{1}{8}^3)$
$\psi\ (12\bar{3}5,\ -\frac{1}{5}^3)$
$P\ (24\bar{6}7,\ -\frac{2}{7}^3)$
$\Phi\ (7{\cdot}14{\cdot}\bar{2}\bar{1}{\cdot}20,\ -\frac{7}{20}^3)$
$\chi\ (12\bar{3}2,\ -\frac{1}{2}^3)$
$\beta\ (24\bar{6}1,\ -2^3)$
$\omega\ (25\bar{7}6,\ -\frac{1}{2}^{\frac{7}{3}})$
$R\ (1{\cdot}10{\cdot}\bar{1}\bar{1}{\cdot}3,\ -3^{\frac{11}{9}})$

Bucking adds: $(9{\cdot}5{\cdot}\bar{1}\bar{4}{\cdot}0,\ i\text{-}\frac{14}{9})$; $\Pi\ (50\bar{5}4,\ \frac{5}{4})$, $\Theta\ (20\bar{2}1,\ 2)$; $(05\bar{5}9,\ -\frac{5}{9})$, $(0{\cdot}8{\cdot}\bar{8}{\cdot}11,\ -\frac{8}{11})$, $\nu\ (09\bar{9}2,\ -\frac{9}{2})$, $W\ (07\bar{7}1,\ -7)$; $\kappa\ (1{\cdot}1{\cdot}\bar{2}{\cdot}10,\ \frac{1}{5}\text{-}2)$. $Q\ (33\bar{6}5,\ \frac{6}{5}\text{-}2)$; $\tau\ (72{\cdot}1{\cdot}\bar{7}\bar{3}{\cdot}73,\ \frac{71}{73}^{\frac{73}{71}})$, $B\ (26{\cdot}6\ \bar{3}2{\cdot}7,\ \frac{20}{7}^{\frac{8}{5}})$, $H (24{\cdot}6{\cdot}\bar{3}\bar{0}{\cdot}5,\ \frac{18}{5}^{\frac{5}{3}})$, $K\ (16{\cdot}8{\cdot}\bar{2}\bar{4}{\cdot}25,\ \frac{8}{25}^3)$, $D\ (15{\cdot}8{\cdot}\bar{2}\bar{3}{\cdot}22,\ \frac{7}{22}^{\frac{23}{7}})$, $F\ (9{\cdot}5{\cdot}\bar{1}\bar{4}{\cdot}13,\ \frac{4}{13}^{\frac{7}{2}})$, $E\ (11{\cdot}7{\cdot}\bar{1}\bar{8}{\cdot}22,\ \frac{2}{11}^{\frac{9}{2}})$, $J\ (14{\cdot}8{\cdot}\bar{2}\bar{2}{\cdot}38,\ \frac{6}{11}^{\frac{11}{3}})$; $\varDelta\ (5{\cdot}9{\cdot}\bar{1}\bar{4}{\cdot}20,\ -\frac{1}{5}^{\frac{7}{2}})$, $G\ (8{\cdot}15{\cdot}\bar{2}\bar{3}{\cdot}19,\ -\frac{7}{19}^{\frac{23}{7}})$, $A\ (10{\cdot}20{\cdot}\bar{3}\bar{0}{\cdot}27,\ -\frac{10}{27}^3)$, $M\ (7{\cdot}14{\cdot}\bar{2}\bar{1}{\cdot}18,\ -\frac{7}{8}^3)$, $\Sigma\ (1{\cdot}15{\cdot}\bar{1}\bar{6}{\cdot}4,\ -\frac{7}{2}^{\frac{8}{7}})$. Scacchi mentions several doubtful pyramids and scalenohedrons.

$rr' = {}^*94^\circ\ 0'$
$r\eta = 49^\circ\ 57'$
$\lambda\lambda' = 9^\circ\ 45'$
$uu' = 37^\circ\ 2'$
$\mathfrak{e}\mathfrak{e}' = 55^\circ\ 2'$
$dd' = 64^\circ\ 51'$
$TT' = 73^\circ\ 3'$
$ll' = 114^\circ\ 10'$
$\mathfrak{m}\mathfrak{m}' = 117^\circ\ 36'$

$c\lambda = 5^\circ\ 38'$
$cu = 21^\circ\ 31'$
$c\mathfrak{e} = 32^\circ\ 14\frac{1}{2}'$
$cd = 38^\circ\ 15'$
$cT = 43^\circ\ 25'$
$cl = 75^\circ\ 46'$
$c\mathfrak{m} = 80^\circ\ 59\frac{1}{2}'$
$cy = 11^\circ\ 9'$

$c\mu = 17^\circ\ 30'$
$c\varLambda = 51^\circ\ 36'$
$c\mathfrak{a} = 67^\circ\ 5'$
$cs = 72^\circ\ 24'$
$cp = 82^\circ\ 46'$

$yy' = 19^\circ\ 17'$
$\mu\mu' = 30^\circ\ 12'$
$ee' = 64^\circ\ 51'$
$\varLambda\varLambda' = 85^\circ\ 29'$
$\mathfrak{a}\mathfrak{a}' = 105^\circ\ 49'$
$ss' = 111^\circ\ 17'$
$pp' = 118^\circ\ 26\frac{1}{2}'$

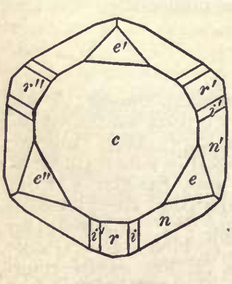
$cq = 24^\circ\ 28\frac{1}{2}'$
$c\pi = 42^\circ\ 19'$
$cY = 47^\circ\ 32'$
$cn = 61^\circ\ 13'$
$cX = 74^\circ\ 39'$

$cV = 76^\circ\ 17'$
$cx = 77^\circ\ 37'$
$cz = 79^\circ\ 37\frac{1}{2}'$

$nn' = 51^\circ\ 59'$
$ww' = 101^\circ\ 12'$
$ww^{\text{v}} = 17^\circ\ 47'$
$\epsilon\epsilon = 14^\circ\ 29'$
$\epsilon\epsilon^{\text{v}} = 4^\circ\ 39'$
$ff' = 91^\circ\ 45'$
$ff^{\text{v}} = 27^\circ\ 41'$
$tt' = 56^\circ\ 24'$
$tt^{\text{v}} = 27^\circ\ 20'$
$ii' = 68^\circ\ 20'$
$ii^{\text{v}} = 32^\circ\ 37'$
$kk' = 79^\circ\ 5'$
$kk^{\text{v}} = 37^\circ\ 7'$
$gg' = 62^\circ\ 1'$

$gg^{\text{v}} = 48^\circ\ 15'$
$CC' = 44^\circ\ 3'$
$CC^{\text{v}} = 60^\circ\ 40'$
$\zeta\zeta' = 44^\circ\ 58'$
$\zeta\zeta^{\text{v}} = 57^\circ\ 38'$
$\xi\xi' = 54^\circ\ 1'$
$\xi\xi^{\text{v}} = 69^\circ\ 49'$
$ZZ' = 17^\circ\ 25'$
$ZZ^{\text{v}} = 35^\circ\ 14'$
$\psi\psi' = 24^\circ\ 13'$
$\psi\psi^{\text{v}} = 49^\circ\ 36'$
$PP' = 29^\circ\ 3'$
$PP^{\text{v}} = 60^\circ\ 12'$
$\beta\beta' = 37^\circ\ 56'$
$\beta\beta^{\text{v}} = 81^\circ\ 5'$
$\omega\omega' = 27^\circ\ 24'$
$\omega\omega^{\text{v}} = 72^\circ\ 37'$

Twins: tw. pl. (1) *c*, penetration-twins; also comp. face often ⊥ *c* as in f. 5. (2) *r*, less common, usually as polysynthetic twinning lamellæ[5], producing a fine striation on *c*, and giving rise to a distinct parting or pseudo-cleavage ∥ *r*. Crystals often thick to thin tabular ∥ *c*, and grouped in parallel position or in rosettes; *c* faces striated ∥ edge *c*/*d* and other forms due to oscillatory combination; also in cube-like rhombohedrons; rhombohedral faces *u* horizontally striated and often rounded over in convex forms. Also columnar to granular, botryoidal, and stalactitic shapes; also lamellar, laminæ joined parallel to *c*, and variously bent, thick or thin; also granular, friable or compact.



Ural, Kk.

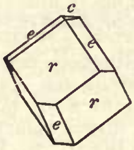
Parting: *c*, due to lamellar structure; also *r*, caused by twinning. Fracture subconchoidal to uneven. Brittle in compact forms; elastic in thin laminæ; soft and unctuous in some loosely adherent scaly varieties. H. = 5·5–6·5. G. = 4·9–5·3; of crystals mostly 5·20–5·25; of some compact varieties, as low as 4·2. Luster metallic and occasionally splendent; sometimes dull. Color dark steel-gray or iron-black; in very thin particles blood-red by transmitted light; when earthy, red. Streak cherry-red or reddish brown. Opaque, except when in very thin laminæ. Optically negative, artif. cryst., Michel. Sometimes feebly magnetic, and occasionally magnetipolar. Electrical conductivity $\parallel c$ nearly double that $\perp c$, the conductivity for both electricity and heat conforming to the crystalline symmetry, Bäckström[6].

Var. 1. *Specular.* Luster metallic, and crystals often splendent, whence the name *specular iron* (Glanzeisenerz *Germ.*). (*b*) When the structure is foliated or micaceous, the ore is called *micaceous* hematite (Eisenglimmer *Germ.*); some of the micaceous varieties are soft and unctuous (Eisenrahm *Germ.*).

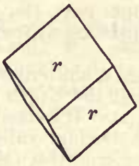
2. *Compact columnar;* or fibrous. The masses often long radiating; luster submetallic to metallic; color brownish red to iron-black. Sometimes called *red hematite*, the name hematite among the older mineralogists including the fibrous, stalactitic, and other solid massive varieties of this species, also limonite and turgite. Often in reniform masses with smooth fracture, called *kidney ore* (rother Glaskopf, Blutstein, Eisenniere, *Germ.*).

3. *Red Ocherous. Reddle* or *Ruddle* (Röthel *Germ.*). Red and earthy. Often specimens of the preceding are red ocherous on some parts. *Reddle* and *red chalk* are red ocher, mixed with more or less clay.

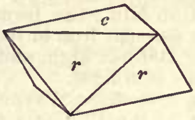
1.



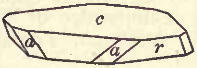
2.



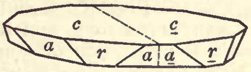
3.



4.



5.



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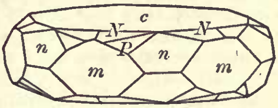

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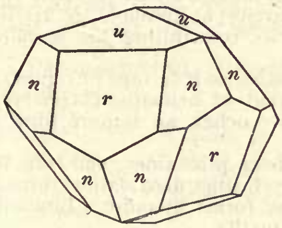

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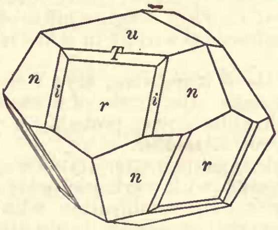

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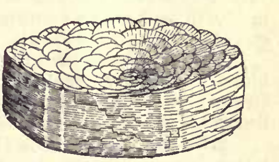


1–4, Simple forms. 5, Vesuvius, Sbk. 6, Binnenthal, Calderon. 7, 8, Elba. 9, St. Gothard.

4. *Clay Iron-stone; Argillaceous hematite.* Hard, brownish black to reddish brown, often in part deep red; of submetallic to unmetallic luster; and affording, like all the preceding, a red streak. It consists of oxide of iron with clay or sand, and sometimes other impurities. (*b*) When reddish in color and jasper-like in texture, often called *jaspery* clay iron-stone. (*c*) When consisting of minute flattened concretions, it is the *lenticular iron ore;* also called *fossil ore.* Foerste has shown that this oölitic ore in the Clinton group consists largely of the fragmental remains of bryozoan corals. *Itabiryte* is a schist resembling mica-schist, but containing much specular ore in grains or scales, or in the micaceous form.

**Comp.**—Iron sesquioxide, $Fe_2O_3$ = Oxygen 30, iron 70 = 100. Sometimes contains titanium and magnesium, and passing into ilmenite, wh. see.

**Pyr., etc.**—B.B. infusible; on charcoal in R.F. becomes magnetic; with borax gives the iron reactions. With soda on charcoal in R.F. is reduced to a gray magnetic metallic powder. Soluble in concentrated hydrochloric acid.

**Obs.**—This ore occurs in rocks of all ages. The specular variety is mostly confined to crystalline or metamorphic rocks, but is also a result of igneous action about some volcanoes, as at Vesuvius. Many of the geological formations contain the argillaceous variety or clay iron-stone, which is mostly a marsh-formation, or a deposit over the bottom of shallow, stagnant water; but this kind of clay iron-stone (that giving a red powder) is less common than the corresponding variety of limonite. The beds that occur in metamorphic rocks are sometimes of very great thickness, and, like those of magnetite in the same situation, have resulted from the alteration of stratified beds of ore, originally of marsh origin, which were formed at the same time with the enclosing rocks, and underwent metamorphism, or a change to the crystalline condition, at the same time.

Beautiful crystallizations of this species are brought from the island of Elba, which has afforded it from a very remote period, and is described by Ovid as "Insula inexhaustis chalybdum generosa metallis." The surfaces of the crystals often present an irised tarnish and brilliant luster. St. Gothard affords beautiful specimens, composed of crystallized tables grouped in the form of rosettes (*Eisenrosen*), and accompanying crystals of adularia. Near Limoges, France, it occurs in large crystals. Fine crystals are the result of volcanic action at Etna and Vesuvius, and particularly in Fossa Cancharone, on Monte Somma, where it incrusts the ejected lavas; also formed in most recent eruptions about the fumaroles; in that of 1855, in fine crystallizations about the fumaroles, some so thin as to be blood-red by transmitted light (Scacchi). Arendal in Norway, Långban and Nordmark in Sweden, Framont in Lorraine, Dauphiné, Binnenthal and Tavetsch, Switzerland, also Cleator Moor in Cumberland, afford splendid specimens. Red hematite occurs in reniform masses of a fibrous concentric structure, near Ulverstone in Lancashire, in Saxony, Bohemia, and the Harz. In Westphalia it occurs as pseudomorphs after calcite. In Brazil it is associated with quartz. In Spain, also Chili, there are immense beds.

In *N. America*, widely distributed, and sometimes in beds of vast thickness in rocks of the Archæan age, as in the upper peninsula of Michigan, in the Marquette district, also in Menominee county and west of Lake Agogebic in Gogebic county; further through northern Wisconsin, Florence, Ashland and Dodge Cos., and in Minnesota near Vermilion lake, St. Louis Co.; in Missouri, at the Pilot Knob and the Iron Mtn.; the former 650 feet high, consisting mainly of an Archæan quartz rock, and having specular iron in the upper part, the iron ore in heavy beds interlaminated with quartz; the latter 200 feet high, and consisting at surface of massive hematite in loose blocks, many 10 to 20 tons in weight.

In New York, in Oneida, Herkimer, Madison, Wayne Cos., a lenticular argillaceous var. (*fossil ore*), constituting one or two beds in the Clinton group of the Upper Silurian; the same in Pennsylvania, and as far south as Alabama; and in Canada, and Wisconsin to the west; in Alabama, there are extensive beds along each border of the anticlinal valleys, through Jackson, Marshall, Blount, Cherokee, Etowah, Jefferson, Tuscaloosa counties (Min. Res. U. S., 1887); prominent mines are near Birmingham.

Besides these regions of enormous beds, there are numerous others of workable value, either crystallized or argillaceous. Some of these localities, interesting for their specimens, are in northern New York, at Gouverneur, Antwerp, Hermon, Edwards, Fowler, Canton, etc.; Woodstock and Aroostook, Me.; at Hawley, Mass., a micaceous variety; at Piermont, N. H., id.; in North and South Carolina a micaceous variety in schistose rocks, constituting the so-called *specular schist*, or *itabiryte*.

Named *hematite* from *αἷμα*, *blood*, it seeming, says Theophrastus, as if formed of concreted blood. This old Greek author speaks afterwards of a second kind of hematites (*'Αιματίτης ξανθή*), which was of a yellowish white color, probably a yellow ocher, an impure form of limonite, the species long called *brown hematite*.

**Alt.**—By deoxidation through organic matter forms *magnetite* or protoxides; and from the latter comes siderite by combination with carbonic acid; or by further deoxidation through sulphureted hydrogen forms *pyrite*. By combination with water forms limonite. Limonite, magnetite, and pyrite constitute occurring pseudomorphs after hematite.

**Artif.**—Formed in crystals by the action of steam on ferric chloride, regarded as the probable method of origin of the hematite of lavas; also by the action of ferric chloride on lime (Daubrée); by the action of a stream of hydrochloric acid gas on $Fe_2O_3$, the application being made very slowly, lest it be all converted to chloride. etc.

On the formation of hematite by sublimation, see Arzruni, Zs. Kr., **18**, 44, 1890, who also gives literature.

**Ref.**—[1] Vesuvius, Min. Russl., **1**, 3, 1853; Mohs gives 94° 2′; Lévy, Mlr., 93° 50′. [2] Cf. Mlr., Min., 236, 1852; also earlier, Hbg., Min. Not., **5**, 43, 1863, **6**, et seq., 1864 (list of planes on p. 6), **8**, 33, 41, **9**, 52, 1870; Rath, Pogg., **128**, 420, 1866; Svr., Att. Acc. Torino, **7**, 377, 1872; Scc., Contr. Min., II, 1 (Att. Acc. Napoli, **6**, 1873). Also Bkg., Zs. Kr., **1**, 562, 1877, **2**, 416, 1878.

[3] Flink, Pajsberg, also the following rhombohedrons not all above doubt: $1\cdot0\cdot\bar{1}\cdot10$, $2\cdot0\cdot\bar{2}\cdot15$, $10\bar{1}7$, $10\bar{1}6$, $10\bar{1}5$, $0\cdot1\cdot\bar{1}\cdot11$, $01\bar{1}7$, $01\bar{1}6$, Ak. H. Stockh., Bihang, **13** (2), 7, 25, 1888. [4] Id., Nordmark, ibid., p. 32.

[5] Bauer, Zs. G. Ges., **26**, 186, 1874; Mgg., Jb. Min., **1**, 216, 1884, **2**, 35, 1886. This seems to have been observed by Mohs as noted by Strüver, Rend. Accad. Linc., **4**, 347, 1888. [6] Bäckström, Öfv. Ak. Stockh., **45**, 533, 1888; also thermo-electric behavior, ibid., p. 553.

MARTITE. Martit *Breith.*, Char., 233, 1832. Martite is iron sesquioxide under an isometric form, occurring in octahedrons or dodecahedrons like magnetite, and believed to be pseudomorphous after magnetite; perhaps in part also after pyrite. Parting octahedral like magnetite. Fracture conchoidal. H. = 6–7. G. = 4·809–4·832, Brazil, Breith.; 4·65, Puy-de Dôme; 4·35, Frassem, Dewalque; 5·15, Brazil, Rg.; 5·194–5·205, Brazil, Lcx.; 5·33, Monroe, N. Y., Hunt. Luster submetallic. Color iron-black, sometimes with a bronzed tarnish. Streak reddish brown or purplish brown. Not magnetic, or only feebly so. The crystals are sometimes embedded in the massive sesquioxide. They are distinguished from magnetite by the red streak, and very feeble, if any, action on the magnetic needle.

Found at the localities mentioned; also in Vermont at Chittenden; in the Marquette iron region south of Lake Superior, where crystals are common in the ore, as if all of it, or the greater part, were martite; Bass lake, Ontario; at Monroe, N. Y.; in a rock containing quartz, feldspar, and hornblende, and embedded in each of these minerals in Digby county, Nova Scotia; at the Cerro de Mercado, Durango, Mexico, in large octahedrons (Silliman, Am. J. Sc., **24**, 375, 1882); in the schists of Minas Geraes, Brazil; at the Rother Adler mine near Rittersgrün, Saxony; in Moravia, near Schönberg, in granite.

The martite of Monroe contains some FeO, Brush. The octahedral crystals from Chittenden, Vt., according to D. Olmstead, are part true magnetite, with a black powder; part give a slightly reddish streak, with little FeO; and part give a red powder and contain no FeO.

Whether the crystals of martite are original crystals or pseudomorphs after either magnetite or pyrite, or both, is still questioned (cf. Lcx., Bull. Soc. Min., **12**, 49, 1889); but the latter seems to be much the most probable view. Rammelsberg found 1·83–2·30 p. c. FeO in the Brazil crystals. The octahedrons from the fumaroles of Vesuvius afforded him (Min. Ch., 159, 1860) $Fe_2O_3$ 92·91, FeO 6·17, MgO 0·82 = 99·90; G. = 5·235. The crystals from Frassem, France, contain 0·2 p. c. of sulphur, which suggests that these may be pseudomorphs after pyrite. The Brazilian crystals are pure $Fe_2O_3$, as found by Lacroix.

RAPHISIDERITE. Rafisiderite *A. Scacchi*, Att. Accad. Napoli, Mem., **3**, read Dec. 1, 1888. A form of iron sesquioxide occurring in the tufa of Pianura and Fiano in the Campania; it appears in minute acicular crystals for which an orthorhombic form is suggested.

**233. ILMENITE** or MENACCANITE. Specular Iron pt., Eisensand pt., of last cent. Menachanite (fr. Cornwall) *Wm. McGregor*, J. de Phys., 72, 152, 1791, Crell's Ann., 1791, and Kirwan's Min., 1796 (making it to consist of iron and an oxide of a probably new metal). Eisenhaltige Titanerz, Menakanit (from Cornwall) *Klapr.*, Beitr., **2**, 226; (fr. Aschaffenberg) ib., 232, 235, 1797. Titane oxydé ferrifère *H.*, Tr., 1801. Mänaken *Karst.*, Tab., 74, 1808. Titaneisenstein, Titaneisen, *Germ.* Titanic or Titaniferous Iron. Crichtonite (spelled Craitonite) *Bourn.*, Cat., 430, 1813. Axotomes Eisenerz (fr. Gastein) *Mohs*, Grundr., **2**, 462, 1824, = Kibdelophan *Kbl.*, Schweig. J., **64**, 1832. Ilmenit (fr. L. Ilmen) *A. T. Kupffer*, Kastn. Arch., **10**, 1, 1827. Mohsite (fr. Dauphiné) *Lévy*, Phil. Mag., **1**, 221, 1827. Hystatisches Eisenerz, Hystatite (fr. Arendal), *Breith.*, Uib., 64, 1830, Char., 236, 1832. Haplotypite *Breith.* Basanomelan (fr. St. Gothard, = Eisenrose) *Kbl.*, Grundr., 318, 1838. Washingtonite (fr. Conn.) *Shep.*, Am. J. Sc., **43**, 364, 1842. Titanioferrite *Chapm.*, Min., 1843. Paracolumbite (fr. Taunton) *Shep.*, ib., **12**, 209, 1851. Parailmenite, ib., **20**, 56, 1880. Titanjern, Titanjernmalm *Swed.*

Rhombohedral; tetartohedral. Axis $\dot{c} = 1·38458$; $0001 \wedge 10\bar{1}1 = *57° 58' 30''$ Koksharov[1].

**Forms**[2]:
*c* ($0001$, *O*)
*m* ($10\bar{1}0$, *I*)
*a* ($11\bar{2}0$, *i*-2)
*u* ($10\bar{1}4$, $\frac{1}{4}$)
*ζ* ($20\bar{2}5$, $\frac{2}{5}$)
*r* ($10\bar{1}1$, *R*)
*l* ($50\bar{5}2$, $\frac{5}{2}$)
*e* ($01\bar{1}2$, $-\frac{1}{2}$)
*s* ($02\bar{2}1$, $-2$)
*p* ($05\bar{5}1$, $-5$)
*π* ($\bar{1}2\bar{1}3$, $\frac{2}{3}$-2 l)
*n* ($22\bar{4}3$, $\frac{4}{3}$-2 r)
$n_,$ ($24\bar{2}3$, $\frac{4}{3}$-2 l)
*ξ* ($5·5·\overline{10}·3$, $\frac{10}{3}$-2)
*x* ($6·4·\overline{10}·5$, $\frac{2}{5}^{5}$ l)

$cu = 21° 47'$
$c\zeta = 32° 36'$
$cl = 75° 57'$
$ce = 38° 38'$
$cs = 72° 38'$
$cp = 82° 52'$
$uu' = 37° 30'$
$\zeta\zeta' = 55° 37\frac{1}{2}'$
$rr' = 94° 29'$
$ll' = 114° 38'$
$ee' = 65° 28'$
$ss' = 111° 29\frac{1}{2}'$
$pp' = 118° 29'$
$c\pi = 42° 42\frac{1}{2}'$
$cn = 61° 33'$
$c\xi = 77° 46\frac{1}{2}'$
$\pi\pi_, = 39° 39'$
$nn_, = 52° 10'$

Twins: (1) tw. pl. *c*; (2) *r*, as tw. lamellæ, less common than with hematite. Crystals usually thick tabular; also acute rhombohedral. Often in thin plates or laminæ. Massive, compact; in embedded grains, also loose as sand.

Fracture conchoidal. H. = 5–6. G. = 4·5–5. Luster submetallic. Color iron-black. Streak submetallic, powder black to brownish red. Opaque. Influences slightly the magnetic needle.

**Comp., Var.**—If normal, $FeTiO_3$ = Oxygen 31·6, titanium 31·6, iron 36·8 = 100, or Titanium dioxide 52·7, iron protoxide 47·3 = 100; or $(Fe,Ti)_2O_3$ since $Fe_2O_3$ and $Ti_2O_3$ are isomorphous. The ratio of titanium to iron varies widely, usually corresponding (Rg.) to $m FeTiO_3 . n Fe_2O_3$. Sometimes also contains magnesium, replacing the ferrous iron.

The varieties recognized arise mainly from the proportions of iron to titanium. They have been named as follows, commencing with that containing the most titanium. No satisfactory external distinctions have yet been made out, and their true relations are in many cases in doubt.

1. *Kibdelophane.* About 30 p. c. titanium. In crystals, but usually massive, or in thin plates; *rr'* = 94° 1'; G. = 4·661, Gastein, Mohs; 4·723–4·735, ib., Breith.

2. *Crichtonite.* Composition essentially like that of the preceding. In acute rhombohedrons, with basal cleavage; G. = 4·79, from St. Cristophe (original); 4·689, same compound from Ingelsberg, Rg.; luster bright.

3. *Ilmenite.* Contains 26–30 p. c. titanium, and near the preceding in composition, but with more sesquioxide of iron (anal. 9). Crystallized and massive; G. = 4·895, from Ilmen Mts. (original), Breith.; 4·81–4·873, ib., Rg. For same compound fr. Egersund, 4·744–4·791, Rg.; fr. Kragerö 4·701.

4. *Menaccanite.* About 25 p. c. of titanium, and with more iron sesquioxide than in the preceding. Massive, and in grains or as a sand (Eisensand). G. = 4·7–4·8, fr. near Menaccan, Cornwall (orig.). Similar compound from Iserwiese, 4·676–4·752, Rg.

5. *Hystatite.* 15–20 p. c. titanium, and much $Fe_2O_3$. $rr'$ = 93° 50'; G. = 5, Arendal (orig.). *Washingtonite* belongs here. Occurs in large tabular rather dull crystals; $rr'$ = 94° approximately; G. = 4·963, Westerly, R. I., and 5·016, Litchfield, Ct. (orig.), Shepard; for latter, 4·986, Rg.

6. *Uddevallite* D. About 10 p. c. titanium and 70 p. c. of $Fe_2O_3$. The Aschaffenberg titanic iron is near this. It occurs massive and in plates, and has G. = 4·78.

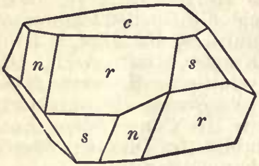
7. *Basanomelan* (*Eisenrosen* of the Alps). 6 to 8 p. c. Ti, and 75 to 83 of $Fe_2O_3$; G. = 4·95–5·21. It is properly a titaniferous hematite. See hematite.

8. *Kragerö hematite.* Containing less than 3 p. c. of titanium.

9. *Magnesian Menaccanite; Picrotitanite* D. Contains 10 to 15 p. c. of magnesia; formula $(Fe,Mg)TiO_3$; G. = 4·293–4·313. Named from *πίκρος, bitter,* in allusion to the magnesia.

The *Mohsite* is of uncertain locality and composition. Crystals tabular; in twins; no cleavage observable.

1.



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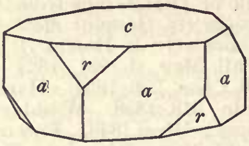

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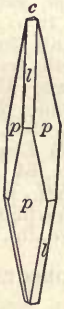

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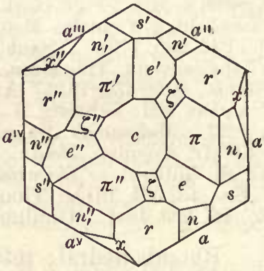

1, Ilmen Mts., Kk. 2, Washingtonite. 3, Crichtonite, Dx. 4, Ilmen Mts., Kk.

The loose *Iron-sand* of Iserwiese, called *iserine,* is in part, at least, in isometric octahedrons; and the *trappisches Eisenerz,* Breith., is similar. See iserine beyond.

*Paracolumbite* or *Parailmenite* of Shepard is an iron-black mineral from 1 m. S. W. of Taunton, Mass., having H. about 5. Pisani has proved it to be this species. He found G. = 4·353, H. 4·5.

**Anal.**—1, Marignac, Ann. Ch. Phys., **14**, 50, 1845. 2, Rg., Pogg., **104**, 497 et seq., 1858; Min. Ch., 148 et seq., 1875. 3, 4, H. F. Keller, Am. Phil. Soc., **23**, 42, 1885. 5, Mackintosh, Am. J. Sc., **29**, 342, 1885. 6, 7, Rg., l. c. 8, Tamm, G. För. Förh., **2**, 46, 1874. 9, 10, Rg. 11, Petersen, Ber. Ak. München, 146, 1873. 12, Cathrein, Zs. Kr., **12**, 44, 1886. 13–16, Rg. 17, Mgc., l. c. 18, Rg. 19, Knerr and Brunner, Am. Ch. J., **6**, 413, 1884. 20, Rg. 21, Cohen, Jb. Min., 695, 1877. 22–25, Rg.

Also Harrington, Geol. Canada, 1874; Heddle, Trans. R. Soc., Edinburgh, **30**, 438, read Feb., 1882. 5th Ed., p. 144–145.

| | | G. | $TiO_2$ | $Fe_2O_3$ | FeO | MnO | MgO | |
|---|---|---|---|---|---|---|---|---|
| 1. | St. Cristophe, *Crichtonite* | 4·727 | 52·27 | 1·20 | 46·53 | — | — | = 100 |
| 2. | Gąstein, *Kibdelophane* | 4·689 | 53·03 | 2·66 | 38·30 | 4·30 | 1·65 | = 99·94 |
| 3. | Carter's Mine, N. Carolina | 4·67 | 52·73 | 8·08 | 33·08 | — | 5·33 | $SiO_2$ 0·14 = 99·36 |
| 4. | " " " | 4·68 | 52·64 | 10·07 | 31·11 | — | 5·33 | = 99·15 |
| 5. | Brazil | 4·2 | 59·20 | 32·11 | 4·90 | 1·73 | — | $SiO_2$ 1·16 = 99·10 |
| 6. | Egersund | **4·744–4·791** | 51·30 | 8·87 | 39·83 | — | 0·40 | = 100·40 |
| 7. | " | " | 45·77 | 14·10 | 39·51 | — | 1·14 | = 100·52 |
| 8. | " | | 41·96 | 22·22 | 31·16 | 0·28 | 3·16 | $SiO_2$ 0·60. $P_2O_5$ 0·02, [CaO 0·55 = 99·95 |
| 9. | Ilmen Mts., ***Ilmenite*** | **4·811–4·873** | 45·93 | 14·30 | 36·52 | 2·72 | 0·59 | = 100·06 |
| 10. | Kragerö | 4·701 | 46·92 | 11·48 | 39·82 | — | 1·22 | = 99·44 |
| 11. | Frauenberg | 4·70 | 46·21 | 12·32 | 40·50 | *tr.* | 1·54 | $Cr_2O_3$ *tr.* = 100·57 |
| 12. | Fürstschlagl, Zamserthal | | 44·50 | 19·55 | 33·72 | — | 3·03 | = 100·80 |

| | | G. | $TiO_2$ | $Fe_2O_3$ | FeO | MnO | MgO | | |
|---|---|---|---|---|---|---|---|---|---|
| 13. | Iserwiese, *Iserine* | 4·676 | 42·20 | 23·36 | 30·57 | 1·74 | 1·57 | | = 99·44 |
| 14. | " | 4·745 | 41·64 | 28·87 | 25·00 | 1·00 | 4·66 | | = 101·17 |
| 15. | " | | 39·70 | 27·02 | 30·34 | | 2·23 | | = 99·29 |
| 16. | " | 4·752 | 37·13 | 28·40 | 29·20 | 3·01 | 2·97 | | = 100·71 |
| 17. | Litchfield, *Washingtonite* | 4·992 | 22·21 | 59·07 | 18·72 | — | — | | = 100 |
| 18. | " " | | 23·72 | 53·71 | 22·39 | 0·25 | 0·50 | | = 100·57 |
| 19. | Adamstown, Pa. | 4·6 | 13·31 | 53·36 | 32·38 | — | — | $SiO_2$ 0·50 | = 99·55 |
| 20. | Warwick | 4·303 | 57·71 | — | 26·82 | 0·90 | 13·71 | | = 99·14 |
| 21. | Du Toit's Pan, S. Africa | 4·436 | 53·79 | 7·05 | 27·05 | — | 12·10 | | = 99·99 |
| 22. | Snarum | 4·943 | 10·47 | 80·63 | 8·90 | — | — | | = 100 |
| 23. | Binnenthal | 5·127–5·150 | 9·18 | 81·92 | 8·60 | — | — | | = 99·70 |
| 24. | St. Gothard, *Eisenrose* | 5·187 | 9·10 | 83·41 | 7·63 | 0·44 | — | | = 100·58 |
| 25. | Krager̈ö | 5·24 | 3·55 | 93·63 | 3·26 | — | — | | = 100·44 |

On the composition of titanic iron, see Rg., Pogg., **104**, 497, 1858, Min. Ch., 148, 1875 Friedel and Guérin, Ann. Ch. Phys., **8**, 38, 1876, who describe artif. cryst. of $Ti_2O_3$ with $cr = 56° 40'$, also isomorphous mixtures of $Ti_2O_3$ and $Fe_2O_3$

**Pyr., etc.**—B.B. infusible in O.F., although slighly rounded on the edges in R.F. With borax and salt of phosphorus reacts for iron in O.F., and with the latter flux assumes a more or less intense brownish red color in R.F.; this treated with tin on charcoal changes to a violet-red color when the amount of titanium is not too small. The pulverized mineral, heated with hydrochloric acid, is slowly dissolved to a yellow solution, which, filtered from the undecomposed mineral and boiled with the addition of tin-foil, assumes a beautiful blue or violet color. Decomposed by fusion with bisulphate of sodium or potassium.

**Obs.**—Occurs in beds in gneiss and other crystalline rocks; also in small particles in many crystalline rocks, often associated with magnetite. The principal European localities of this species have been enumerated above in connection with the statement of varieties. One of the most remarkable is at Kragerö, Norway, where it occurs in veins or beds in diorite, which sometimes afford crystals weighing over 16 pounds. Others are Egersund, Arendal, Snarum in Norway; Miask in the Ilmen Mts.; Bourg d'Oisans, Dauphiné; St. Gothard, etc.

Fine crystals, sometimes an inch in diameter, occur in Warwick, Amity, and Monroe, Orange Co., N. Y., embedded in serpentime and white limestone, and associated with spinel, chondrodite, rutile, etc.; also 4 m. west of Edenville, and near Greenwood furnace with spinel and chondrodite; also at Chester and South Royalston, Mass.; Litchfield, Conn. (*washingtonite*); Troy, Vt., with chlorite. Vast deposits or beds of titanic ore occur at Bay St. Paul in Quebec, Canada, in syenite; one bed, 90 feet thick, continues on in view for 300 feet, and probably far beyond; also in the Seignory of St. Francis, Beauce, mixed with magnetite as a bed 45 feet thick in serpentine; G. = 4·56–4·66; also with labradorite at Château Richer. Grains are found in the gold sand of California.

ISERINE. Titaneisenstein pt., Magnetischer Eisen-Sand pt., *Wern.* Iserin (fr. Iser) *Wern.*, Letztes Min., 26, 52, 1817, Hoffm. Min., **4**, 258, 1817. Oktaëdrisches Titaneisen-Oxyd *Wern.* Iserin *Breith.*, Char., 51, 1820. Hexaedrisches Eisen-Erz *Mohs*, 436, 1839. Iserite. Supposed to be isometric titanic iron, and, like martite, to be pseudomorphous. Anals. 13–16, above. The locality of Iserwiese gave the name to this mineral. The titanic iron-sand is partly in octahedral forms, and this portion, if not all, is the *iserine*. Yet it is still doubted whether the octahedrons are regular octahedrons, or whether they are acute rhombohedrons with truncated apices, and therefore true ilmenite. Similar sands come from many other localities, as from Bohemia, Saxony, Calabria, Puy-de-Dôme in France.

**Alt.**—The titanic iron of massive rocks is extensively altered to a dull white opaque substance, called leucoxene by Gümbel (Die paläolith. Eruptivgesteine d. Fichtegebirges, 22, 1874). This for the most part is to be identified with titanite. Cf. Cathrein, Zs. Kr., **6**, 244, 1881, also Rosenb., Mikr. Phys. Min., 332, 1885.

**Ref.**—[1] Min. Russl., **6**, 350, 1874. [2] Cf. Kk., ib., **1**, 16 and l. c., also Mlr., Min., p. 239, 1852. A crystal from the Binnenthal, regarded as tetartohedral and distinct from the associated hematite, gave Bkg., $T\,(\bar{1}2\bar{1}5, \frac{2}{5}\text{-}2\,1), q\,(\bar{1}2\bar{1}6, \frac{1}{3}\text{-}2\,1)$, Zs. Kr., **1**, 576, 1877. Cf. also Sbk., Jb. Min., 287, 1878. Planes on crystals from Cavradi, and on the Swiss "Eisenrosen," are referred to hematite. Bücking includes in his list of planes a large number of forms given by Strüver for *corundum!*

HYDROILMENITE *C. W. Blomstrand*, Minnesskrift Fys. Sällsk., Lund, No. 3, p. 4, 1878.

A partially altered variety of ilmenite. It forms thin curved plates with tolerably distinct rhombohedral cleavage [pseudo-cleavage]; $rr' = 93°–94°$. G. = 4·066–4·136. Color iron-black. Streak dark gray. Luster metallic. Not magnetic. Analysis:

| $TiO_2$ | $SiO_2$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 54·23 | 1·40 | 14·99 | 21·91 | 6·34 | 0·45 | 0·19 | 1·33 | = 100·84 |

The mineral decomposes readily, and finally becomes coated with a yellowish white crust consisting essentially of $TiO_2$. Probably altered from normal ilmenite by the assumption of water. From Småland, Sweden.

FERROZINCITE *Adam*, Tabl. Min., 78, 1869. A hydrous mineral containing $Fe_2O_3$ and ZnO.

## III. Intermediate Oxides.

The species here included are retained among the oxides, although chemically considered they are properly oxygen-salts, aluminates, ferrates, manganates, etc., and hence in a strict classification to be placed in section 5 of the Oxygen-salts.

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### Spinel Group. $\overset{\text{II}}{R}\overset{\text{III}}{R}_2O_4$ or $\overset{\text{II}}{R}O.\overset{\text{III}}{R}_2O_3$. Isometric.

| | | |
|---|---|---|
| 234. | **Spinel** | $MgO.Al_2O_3$ |
| | Ceylonite | $(Mg,Fe)O.Al_2O_3$ |
| | Chlorospinel | $MgO.(Al,Fe)_2O_3$ |
| | Picotite | $(Mg,Fe)O.(Al,Fe,Cr)_2O_3$ |
| 235. | **Hercynite** | $FeO.Al_2O_3$ |
| 236. | **Gahnite** | $ZnO.Al_2O_3$ |
| | Automolite | |
| | Dysluite | $(Zn,Fe,Mn)O.(Al,Fe)_2O_3$ |
| | Kreittonite | $(Zn,Fe,Mg)O.(Al,Fe)_2O_3$ |
| 237. | **Magnetite** | $FeO.Fe_2O_3$ |
| | | $(Fe,Mg)O.Fe_2O_3$ |
| 238. | **Magnesioferrite** | $MgO.Fe_2O_3$ |
| 239. | **Franklinite** | $(Fe,Zn,Mn)O.(Fe,Mn)_2O_3$ |
| 240. | **Jacobsite** | $(Mn,Mg)O.(Fe,Mn)_2O_3$ |
| 241. | **Chromite** | $FeO.Cr_2O_3$ |
| | | $(Fe,Mg)O.(Cr,Fe)_2O_3$ |

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| | | | | $\breve{a} : \bar{b} : \dot{c}$ |
|---|---|---|---|---|
| 242. | **Chrysoberyl** | $BeO.Al_2O_3$ | Orthorhombic | 0·4701 : 1 : 0·5800 |

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| | | | | |
|---|---|---|---|---|
| 243. | **Hausmannite** | $MnO.Mn_2O_3$ | Tetragonal | $\dot{c} = 1·1743$ |
| 244. | **Minium** | $2PbO.PbO_2$ | | |
| 245. | **Crednerite** | $3CuO.2Mn_2O_3$ | Monoclinic | |
| | | | | $\breve{a} : \bar{b} : \dot{c}$ |
| 246. | **Pseudobrookite** | $2Fe_2O_3.3TiO_2$ | Orthorhombic | 0·8878 : 1 : 0·8778 |
| 247. | **Braunite** | $3Mn_2O_3.MnSiO_3$ | Tetragonal | $\dot{c} = 0·9850$ |

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**234. SPINEL.** 1. RUBY SPINEL. *῎Ανθραξ* pt., *῎Ανθρακα περὶ Μίλητον*, *Theophr.* Carbunculus pt., Lychnis pt. [rest ruby sapphire]. *Plin.*, **37**, 25, 29. Spinella, Carbunculus pt., Rubinus pt., Carb. ruber parvus, = *Germ.* Spinel, Ballagius (a pallido colore videtur appellasse), = *Germ.* Ballas, Lychnis, = *Germ.* Gelblichter Rubin, *Agric.*, Foss., 293, Interpr., 463, 1846. Rubin orientales octaedrici, seu octo hedris comprehensi, quæ modo triangula sunt, modo trapezia, aliquando hedræ oblongæ angulos solidos occupant, etc., *Cappeler*, Prod. Crystallogr. Lucerne, 1723. Rubinus pt. (Spinell, Ballas, Rubicelle), *Wall.*, Min., 115, 1447. Rubis spinelle octaëdre (Spinelle, Balais), *de Lisle*, Crist., **2**, 224, 1783 [by *de L.* first made distinct in species from Ruby Sapphire].

2. CEYLONITE. Ceylanite *Delameth.*, J. de Phys., **42**, 23, 1793. Zeylanit *Karst.*, Tab., 28, 72, 1800. Zeilanite Pleonaste *H.*, Tr., 1801. Ceylonit *Rg.* Candite (fr. Candy, Ceylon) *Bourn.*

3. CHLOROSPINEL *G. Rose*, Pogg., **50**, 652, 1840. Gahnit *B. de Marni*, 1833.

4. PICOTITE *Charpentier*, J. Mines, 32, 321, 1812; Gilb. Ann., **47**, 205, 1814. Chrom-ceylonite.

Isometric. Observed forms[1]:

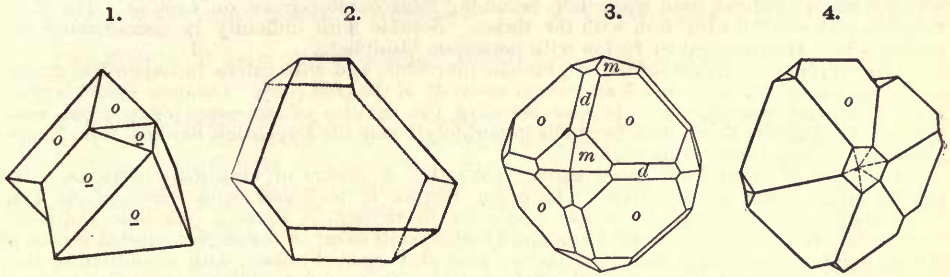
*a* (100, *i-i*)[2] rare
*d* (110, *i*)
*o* (111, 1)
*f* (310, *i*-3)[3]
*π* (776, $\frac{7}{6}$)[6]
*r* (332, $\frac{3}{2}$)
*p* (221, 2)
*q* (331, 3)[2]
*ξ* (771, 7)[3]
*φ* (611, 6-6)[3]
*m* (311, 3-3)
*n* (211, 2-2)[3]
*β* (322, $\frac{3}{2}$-$\frac{3}{2}$)[4]
*x* (531, 5-$\frac{5}{3}$)[3]

Twins: tw.-pl. and comp.-face *o* common (f. 1), hence often called *spinel-twins;* also repeated (f. 4) and polysynthetic[5], producing tw. lamellæ with striations on *o*. Habit octahedral; *o* faces sometimes convex; habit rarely cubic.

Cleavage: *o* imperfect. Fracture conchoidal. Brittle. H. = 8. G. = 3·5–4·1. Luster vitreous; splendent to nearly dull. Color red of various shades, passing into blue, green, yellow, brown and black; occasionally almost white. Streak white. Transparent to nearly opaque. Refractive indices:

$$n_r = 1{\cdot}7121 \text{ Li} \qquad n_y = 1{\cdot}7155 \text{ Na} \qquad n_{bl} = 1{\cdot}7261 \text{ Dx.}^7$$

Phosphorescent with a red light, yielding a crimson line ($\lambda = 6857$ Crookes) in the spectroscope. Etching-figures as with magnetite[8].



1, Spinel twin. 2, Crystal flattened ‖ *o*. 3, Amity, N. Y. 4, Strüver[5].

**Comp., Var.**—Magnesium aluminate, $MgAl_2O_4$ or $MgO.Al_2O_3$ = Alumina 71·8, magnesia 28·2 = 100. The magnesium may be in part replaced by ferrous iron or manganese, and the aluminium by ferric iron and chromium.

**Var.**—1. RUBY SPINEL or *Magnesia Spinel.*—Clear red or reddish; transparent to translucent; sometimes subtranslucent. G = 3·52–3·58; 3·63–3·71 Church. Composition normal, with little or no iron, and sometimes chromium oxide to which the red color has been ascribed. The varieties are: (*a*) *Spinel-Ruby*, deep red; (*b*) *Balas-Ruby*, rose-red; (*c*) *Rubicelle*, yellow or orange-red; (*d*) *Almandine*, violet.

2. CEYLONITE or *Pleonaste, Iron-Magnesia Spinel.*—Color dark green, brown to black, mostly opaque or nearly so; G. = 3·5–3·6. Contains iron replacing the magnesium and perhaps also the aluminium, hence the formula $(Mg,Fe)O\ Al_2O_3$ or $(Mg,Fe)O.(Al,Fe)_2O_3$.

3. CHLOROSPINEL or *Magnesia-Iron Spinel.*—Color grass-green, owing to the presence of copper; G. = 3·591–3·594. Contains iron replacing the aluminium, $MgO.(Al,Fe)_2O_3$.

4. PICOTITE or *Chrome-Spinel.*—Contains chromium and also has the magnesium largely replaced by iron, $(Mg,Fe)O.(Al,Cr)_2O_3$, hence lying between spinel proper and chromite. G. = 4·08. Color dark yellowish brown or greenish brown. Translucent to nearly opaque. The original occurs in disseminated grains, rarely octahedral crystals, in a rock occurring about L. Lherz, called *Lherzolite* by Delametherie (T. T., 2, 281, 1797), and earlier described by Picot de la Peyrouse (Mem. Ac. Toulouse, 3, 410), after whom *picotite* is named.

The analyses of Thomson (Min., 1, 214, 1836), showing considerable lime, *e. g.* 10·6 p. c., in a spinel from Amity, N. Y., are probably erroneous.

A red octahedral mineral from Dornbach is a titaniferous variety (5·68 p. c. $TiO_2$) rich in iron, according to Kosmann. Ber. nied. Ges., p. 144, July 19, 1869.

**Anal.**—1, 2, Abich, Pogg., **23**. 305, 1831, also De Spinello, Inaug. Diss. (in Latin), Berlin, 1831. 3, Vogel, Rg. Min. Ch., 136, 1875. 4, Reuter, ibid. 5, A. M. Thomson, Liversidge, Min. N. S. W., 202, 1888. 6, Gmelin, Berz. JB., **4**, 156, 1825. 7, Lorenzen, Medd Grönl., **7**, 1884. 8, 9, Abich, l. c. 10, Rg., Min. Ch., 135, 1875. 11, Pisani, C. R, **63**, 49, 1866. 12, Wolle, Am. J. Sc., **48**, 350, 1868. 13, Nikolayev, Kk. Min. Russl., **5**, 368, 1866. 14, H. Rose, Pogg., **50**, 652, 1840. 15, Damour, Bull. G. Soc., **19**, 413, 1862. See also 5th Ed., pp. 147, 148.

| | | | $Al_2O_3$ | $Fe_2O_3$ | $Cr_2O_3$ | FeO | MgO | |
|---|---|---|---|---|---|---|---|---|
| 1. | Ceylon, *red* | | 69·01 | — | 1·10 | 0·71 | 26·21 | $SiO_2$ 2·02 = 99·05 |
| 2. | Åker, *blue* | | 68·94 | — | — | 3·49 | 25·72 | $SiO_2$ 2·25 = 100·40 |
| 3. | Franklin, N. J., *grn. black* | | 67·01 | 2·17 | — | 8·55 | 21·97 | = 99·70 |
| 4. | Amity, N. Y., *black* | | 69·71 | 1·62 | — | 4·61 | 24·63 | = 100·57 |
| 5. | Mudgee, N. S. W., " | G. = 3·77 | 64·29 | — | 4·62 | 4·49 | 21·95 | $SiO_2$ 2·75 = 98·10 |
| 6. | Ceylon, *Ceylonite* | | 57·20 | — | — | 20·51 | 18·24 | $SiO_2$ 3·15 = 99·10 |
| 7. | Greenland | | 70·05 | — | — | 9·86 | 21·25 | $SiO_2$ 0·23 = 101·39 |
| 8. | Monzoni | | 66·89 | — | — | 8·07 | 23·61 | $SiO_2$ 1·23 = 99·80 |
| 9. | Vesuvius | | 67·46 | — | — | 5·06 | 25·94 | $SiO_2$ 2·38 = 100·84 |
| 10. | Ramos, Mexico | G. = 3·865 | 68·46 | — | — | 11·64 | 19·90 | = 100 |
| 11. | Auvergne, *blk.* | G. = 3·871 | 59·06 | 10·72 | — | 13·60 | 17·20 | = 100·58 |
| 12. | Peekskill, *green* | G. = 3·58 | 60·79 | 5·26 | — | 21·74 | 12·84 | = 100·63 |
| 13. | Zlatoust, Ural, *pseud.* | G. = 3·589 | 68·96 | — | — | 18·01 | 10·82 | $SiO_2$ 2·96 = 100·75 |
| 14. | Ural, *Chlorospinel* | G. = 3·593 | 64·13 | 8·70 | — | — | 26·77 | CaO 0·27, CuO 0·27 [= 100·14 |
| 15. | L. Lherz, *Picotite* | G. = 4·08 | 56·00 | — | 8·00 | 24·90 | 10·30 | $SiO_2$ 2·00 = 101·20 |

**Pyr., etc.**—B.B. alone infusible; red variety changes to brown, and even black and opaque, as the temperature increases, and on cooling becomes first green, and then nearly colorless, and at last resumes the red color. Slowly soluble in borax, more readily in salt of phosphorus, with which it gives a reddish bead while hot, becoming faint chrome-green on cooling. The black varieties give reactions for iron with the fluxes. Soluble with difficulty in concentrated sulphuric acid. Decomposed by fusion with potassium bisulphate.

**Obs.**—Spinel occurs embedded in granular limestone, and with calcite in serpentine, gneiss, and allied rocks. Ruby spinel is a common associate of the true ruby. Common spinel is often associated with chondrodite. It also occupies the cavities of masses ejected from some volcanoes. Picotite is common in grains in peridotyte and the serpentine derived from it, also enclosed in chrysolite in other rocks.

In Ceylon, in Siam, and other eastern countries, it occurs of beautiful colors, as rolled pebbles in the channels of rivers. In upper Burma it is found with ruby (cf. p. 212). Pleonaste is found at Candy, in Ceylon. At Åker, in Sweden, is found a pale blue and pearl-gray variety in limestone. Small black splendent crystals occur in the ancient ejected masses of Monte Somma, with mica and vesuvianite; also at Pargas, Finland, with chondrodite, etc.; in compact gehlenite at Monzoni, in the Fassa valley. In granular limestone (cipolin) enclosed in gneiss at Mercus and Arignac north of Tarascon, on the borders of l'Ariège, where the association with brucite, chondrodite, scapolite, pyroxene, etc., is very similar to that at Warwick, New York, and at Pargas (Lcx., Bull. Soc. Min., **12**, 518, 1889). In the gold sands of New South Wales at various points.

From Amity, N. Y., to Andover, N. J., a distance of about 30 miles, is a region of granular limestone and serpentine, in which localities of spinel abound; colors, green, black, brown, and less commonly red, along with chondrodite and other minerals. A mile S.W. of Amity, on J. Layton's farm, is a remarkable locality; also on W. Raynor's farm, a mile N.; another half mile N. affording grayish red octahedrons; and others to the south. Localities are numerous about Warwick, and also at Monroe and Cornwall, though less favorable for exploration than those at Amity. Franklin, N. J., affords crystals of various shades of black, blue, green, and red, which are sometimes transparent, and a bluish green ceylonite variety here has the luster of polished steel; Newton, N. J., pearl-gray crystals, with blue corundum, tourmaline, and rutile; at Byram, red, brown, green, and black colors, with chondrodite; Sterling, Sparta, Hamburgh, and Vernon, N. J., are other localities. Light blue spinels occur sparingly in limestone in Antwerp, Jefferson Co., N. Y., 2½ m. S. of Oxbow, and rose and reddish brown in Gouverneur. 2 m. N. and ¾ m. W. of Somerville, St. Lawrence Co.; green, blue, and occasionally red varieties occur in granular limestone at Bolton, Boxborough, Chelmsford, and Littleton, Mass. Octahedral crystals tessellated like chiastolite occur embedded in slate near Springfield, Mass. Soft octahedral crystals occur in Warwick, which are pseudomorphs, consisting partly of steatite or serpentine. With the corundum of North Carolina, as at the Culsagee mine, near Franklin, Macon Co.; similarly at Dudleyville, Alabama. Spinel ruby at Gold Bluff, Humboldt Co., Cal.

Good black spinel is found in Burgess, Ontario; a bluish spinel having a rough cubic form occurs at Wakefield, Ottawa Co.; blue with clintonite at Daillebout, Joliette Co., Quebec.

**Alt.**—Observed altered to steatite, serpentine, hydrotalcite, mica.

**Artif.**—Formed in crystals by heating a mixture of alumina and magnesia with boracic acid, and also, for red spinel, some oxide of chrome; for black, oxide of iron (Ebelmen); by using fluorides of aluminium and magnesium and boracic acid, with heat (Deville & Caron); by action of aluminium chloride in vapor on magnesia (Daubrée). See also Meunier, who uses cryolite and aluminium chloride, Bull. Soc. Min., **10**, 191, 1887; and, in general, Fouqué-Lévy, Synth. Min., 227–232, 1882; Bourgeois, Reprod. Min., 69–76, 1884.

**Ref.**—[1] Mlr., Min., p. 263, 1852. [2] Hbg., Min. Not., **8**, 45, 1868. [3] Svr., pleonaste from the Albani Mts., Zs. Kr., **1**, 233, 1877. [4] Erem., Turkestan, ibid., **4**, 642. [5] Svr., Zs. Kr., **2**, 480, 1878. [6] Cathrein, Monzoni, Min. Mitth., **10**, 398, 1888. [7] Dx., N. R., **204**, 1867. [8] Becke, Min. Mitth., **7**, 224, 1885.

An unknown mineral, occurring in colorless octahedrons and supposed to belong to the spinels, has been noted in the phonolyte of Olbrück; see Bull. Soc. Min., **9**, 85, 1886, also Jb. Min., **2**, 180, 1886.

**235. HERCYNITE.** Hercynit *F. X. Zippe*, Min. Böhm., 1839. Hercinite *bad orthogr.* Iron Spinel.

Isometric. Occurs massive, fine granular.

H. = 7·5–8. G. = 3·91–3·95. Luster vitreous, externally dull. Color black. Streak dark grayish green to leek-green. Opaque.

**Comp.**—Iron aluminate, $FeAl_2O_4$ = Alumina 58·6, iron protoxide 41·4 = 100.

**Anal.**—B. Quadrat, Lieb. Ann., **55**, 357, 1845.

$Al_2O_3$ 61·17 MgO 2·92 FeO 35·67 = 99·76

**Pyr., etc.**—B.B. infusible. The heated powder becomes brick-red, and gives iron reactions. With soda fuses only imperfectly to an olive-green mass.

**Obs.**—From Ronsberg, at the eastern foot of the Böhmerwald, with corundum, iron hydroxide; also scattered through the granulytes of Saxony, Kalkowsky, Zs. G. Ges., **33**, 533, 1871. A related iron-alumina spinel, with about 9 p. c. MgO, occurs with magnetite and corundum in Cortlandt township, Westchester Co., N. Y. (Williams, Am. J. Sc., **33**, 194, 1887).

Named from the Latin of the Bohemian Forest, *Silva Hercynia* (Plin., **4**, 25, 28).

**236. GAHNITE.** Zinc-Spinel. Automolite (fr. Falun) *Ekeberg*, Afh., **1**, 84, 1806. Gahnit *v. Moll*, Efem., **3**, 78, 1807. Spinelle Zincifère *H.*, Tabl., 67, 99, 1809. Dysluite (fr. Sterling, N. J.) *Keating*, J. Ac. N. Sci., Philad., **2**, 287, 1821; *Shep.*, Min., **1**, 158, 1832, **2**, 176, 1835; *Thomson*, Min., **1**, 220, 1836. Kreittonite *Kbl.*, J. pr. Ch., **44**, 99, 1848. Spinellus superius *Breith.*, Handb., 623, 1847.

Isometric. Observed forms:

*a* (100, *i-i*) *d* (110, *i*) *o* (111, 1) *m* (311, 3-3)

Twins: tw.-pl. *o*. Habit octahedral, often with planes striated ‖ edge *d/o*; also less commonly in dodecahedrons and modified cubes.

Cleavage: *o* indistinct. Fracture conchoidal to uneven. Brittle. H. = 7·5–8. G. = 4·0–4·6. Luster vitreous, or somewhat greasy. Color dark green, grayish green, deep leek-green, greenish black, bluish black, yellowish, or grayish brown; streak grayish. Subtransparent to nearly opaque.

**Comp., Var.**—Zinc aluminate, $ZnAl_2O_4$ = Alumina 55·7, zinc oxide 44·3 = 100. The zinc is sometimes replaced by manganese or ferrous iron, the aluminium by ferric iron.

**Var.**—1. AUTOMOLITE, or *Zinc Gahnite.*—$ZnAl_2O_4$, with sometimes a little iron. G. = 4·1–4·6. Colors as above given.

2. DYSLUITE, or *Zinc-Manganese-Iron Gahnite.*—$(Zn,Fe,Mn)O.(Al,Fe)_2O_3$. Color yellowish brown or grayish brown. G. = 4–4·6. Form the octahedron, or the same with truncated edges.

3. KREITTONNITE, or *Zinc-Iron Gahnite.*—$(Zn,Fe,Mg)O.(Al,Fe)_2O_3$. Occurs in crystals, and granular massive. H. = 7–8. G. = 4·48–4·89. Color velvet-black to greenish black; powder grayish green. Opaque.

**Anal.**—1, 2, Abich, l. c. (see p. 221). 3, J. S. Adam, Am. J. Sc., **1**, 28, 1871. 4. Genth, Proc. Ac. Philad., 50, 1889. 5, Id., Proc Am. Phil. Soc., **20**, 397, 1882. 6. H. F. Kellar, ibid. 7, Genth, Am. J. Sc., **33**, 196, 1862. 8, Damour, Bull. Soc. Min., **1**, 93, 1878. 9, A. G. Dana, Am. J. Sc., **29**, 455, 1885. 10, Thomson, Min., **1**, 221, 1836. 11, Mauro, Trans. Acc. Linc., **3**, 65, 1879. 12*a*, Kbl., l. c.; 12*b*, as corrected (Kbl.) for undecomposed mineral, oxidation of iron, etc.

| | | G. | $Al_2O_3$ | $Fe_2O_3$ | ZnO | FeO | MnO | MgO | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | Falun, *Automolite* | | 55·14 | — | 30·02 | 5·85 | *tr.* | 5·25 | $SiO_2$ 3·84 = 100·10 |
| 2. | Franklin furnace | | 1 57·09 | — | 34·80 | 4·55 | *tr.* | 2·22 | $SiO_2$ 1·22 = 99·88 |
| 3. | " " | 4·90 | $\frac{2}{2}$ 49·78 | 8·58 | 39·62 | — | 1·13 | 0·13 | $SiO_2$ 0·57 = 99·81 |
| 4. | Delaware Co., Pa. | 4·587 | 57·22 | — | 38·14 | 3·55 | 0·70 | 0·26 | CuO 0·06 = 99·93 |
| 5. | Mitchell Co., N. C. | 4·576 | 54·86 | 4·50 | 38·05 | 1·14 | 0·29 | 0·79 | CuO 0·30 = 99·93 |
| 6. | Chaffee Co., Col. | | 60·76 | 0·58 | 23·77 | 4·56 | — | 10·33 = 100 | [= 100·35 |
| 7. | Canton Mine, Ga. | | 53·37 | 6·68 | 30·27 | 3·01 | 0·20 | 3·22 | $SiO_2$ 2·37, CuO 1·23 |

| | | G. | $Al_2O_3$ | $Fe_2O_3$ | ZnO | FeO | MnO | MgO | |
|---|---|---|---|---|---|---|---|---|---|
| 8. | Brazil | 4·52–4·56 | 59·41 | — | 33·82 | 6·17 | — | — | ign. 0·14 = 99·54 |
| 9. | Rowe, Mass. | 4·53 | ⅔ 54·83 | 3·00 | 36·92 | 3·37 | *tr.* | 1·93 | $SiO_2$ 0·53 = 100·58 |
| 10. | Sterling, N. J., *Dysl.* | 4·551 | 30·49 | 41·93 | 16·80 | — | 7·60 | — | $SiO_2$ 2·97, $H_2O$ 0·40 [= 100·19 |
| 11. | Calabria | | 63·64 | — | 21·28 | 4·53 | — | 12·34 | $Sb_2O_3$ 0·35 = 102·14 |
| 12*a*. | Bodenmais, *Kreitt.* | | 44·66 | 16·63 | 24·00 | — | 1·30 | 3·05 | *insol.* 10 = 99·64 |
| 12*b*. | " " | | 49·73 | 8·70 | 26·72 | 8·04 | 3·41 | 1·45 = 98·05 | |

**Pyr., etc.**—Gives a coating of zinc oxide when treated with a mixture of borax and soda on charcoal; otherwise like spinel.

**Obs.**—Occurs in talcose schist at Falun, Sweden (*automolite*); at Tiriolo, Calabria; at Bodenmais, Bavaria (*kreittonite*); Minas Geraes, Brazil.

In the U. S., at Franklin Furnace, N. J., with franklinite and willemite; also at Sterling Hill, N. J. (*dysluite*); with pyrite at Rowe, Mass.; at a feldspar quarry in Delaware Co., Penn.; sparingly at the Deake mica mine, Mitchell Co., N. C.; at the Canton Mine, Georgia; with galena, chalcopyrite, pyrite at the Cotopaxi mine, Chaffee Co., Col., in part altered to a chloritic mineral (cf. Genth, l. c.).

Named after the Swedish chemist Gahn. The name *Automolite*, of Ekeberg, is from *αὐτόμολος*, *a deserter*, alluding to the fact of the zinc occurring in an unexpected place. Von Moll objected to such an idea in nature, and named the species the next year after J. G. Gahn, the discoverer (1745–1818). His name is here applied to the whole group of zinc spinels, and automolite retained for the special variety so named.

**Artif.**—Observed with tridymite in a zinc furnace from the alteration of the distillation vessels, Jb. Min., **1**, 120, 1881; also in a fayalite slag at the Freiberg furnaces, ibid., **1**, 170, 1882.

**237. MAGNETITE.** *Ἡράκλεια λίθος* (fr. Heraclea, in Lydia) *Gr.* [*Λίθος*] *σίδηρον αγουσα Theophr.* Not *μαγνῆτις λίθος* [= Talc] *Theophr.* *Μαγνῆς λίθος Dioscor.*, **5**, 147. Magnes, Sideritis, Heraclion, *Plin.*, **36**, 25; Id., *Germ.* Siegelstein *Agric.*, Foss., 243, 466. (1) Minera ferri nigricans, magneti amica. (2) Magnet, (3) Jern Sand, *Wall.*, 256, 262, 1746. Minera Ferri attractoria, Magnet, *Cronst.*, 184, 1758. Magnetischer Eisenstein (incl. Eisensand) *Wern.* Fer oxydulé *H.* Magnetite *Haid.*, Handb., 551, 1845.

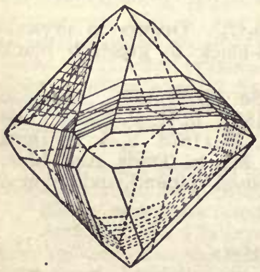
Magnetic Iron Ore: Octahedral Iron Ore; Oxidulated Iron. Magneteisenstein, Magneteisenerz, Eisenoxydoxydul, *Germ.* Magnetjernmalm, Svartmalm, *Swed.* Fer oxydulé, Fer oxydé magnétique, Aimant, *Fr.* Ferro ossidolato, Ferro magnetico, Calamita, *Ital.* Hierro magnético *Span.*

Isometric. Observed forms[1]:

*a* (100, *i*-*i*)
*d* (110, *i*)
*o* (111, 1)
*X* (15·1·0, *i*-15)[7]
*η* (510, *i*-5)[7,8]
*f* (310, *i*-3)[5]
*e* (210, *i*-2)
*L* (950, *i*-$\frac{9}{5}$)[8]
*l* (530, *i*-$\frac{5}{3}$)[6]
*ε* (970, *i*-$\frac{9}{7}$)[6]
*φ* (553, $\frac{5}{3}$)[2]
*p* (221, 2)
*q* (331, 3)
*z* (16·1·1, 16-16)
*y* (10·1·1, 10-10)
*π* (611, 6-6)?
*ρ* (511, 5-5)[7]
*ψ* (722, $\frac{7}{2}$-$\frac{7}{2}$)[3]
*m* (311, 3-3)[2]
*κ* (522, $\frac{5}{2}$-$\frac{5}{2}$)[6]
*λ* (944, $\frac{9}{4}$-$\frac{9}{4}$)[6]
*n* (211, 2-2)[5]
*σ* (533, $\frac{5}{3}$-$\frac{5}{3}$)[7]
*β* (322, $\frac{3}{2}$-$\frac{3}{2}$)[7]
*w* (21·7·5, $\frac{21}{5}$-3)[3]
*v* (531, 5-$\frac{5}{3}$)[2]
*s* (321, 3-$\frac{3}{2}$)
*u* (432, 2-$\frac{4}{3}$)[4]
*ξ* (971, 9-$\frac{9}{7}$)[6]
*V* (543, $\frac{5}{3}$-$\frac{5}{4}$)[7]
*x* (654, $\frac{3}{2}$-$\frac{6}{5}$)[4]
*υ* (13·11·9, $\frac{13}{9}$-$\frac{13}{11}$)[7]

Twins: tw.-pl. *o*, sometimes as polysynthetic twinning lamellæ[9], producing striations on an octahedral face and often a pseudo-cleavage (f. 1). Most commonly in octahedrons, also in dodecahedrons with faces striated ‖ edge *d*/*o* from oscillatory combination (f. 2); in dendrites between plates of mica; crystals sometimes highly modified; cubic forms rare. Massive with laminated structure; granular, coarse or fine; impalpable.

1.



Port Henry, Kemp.

Cleavage not distinct; parting octahedral, often highly developed[9]. Fracture subconchoidal to uneven. Brittle. H. = 5·5–6·5. G. = 5·168–5·180 crystals. Luster metallic and splendent to submetallic and rather dull. Color iron-black. Streak black. Opaque, but in thin dendrites in mica nearly transparent and pale brown to black. Strongly magnetic, sometimes possessing polarity.

Etching-figures developed by acids on an octahedral face are inverted triangular pits, often with truncated edges; on a cubic face, quadrilateral elevations formed by dodecahedral planes or planes nearly coinciding with them; the chief etching-zone, in which the planes forming the figures lie (e.g., 443, 223, 337, etc.), is that of the trigonal trisoctahedrons; a secondary zone is that of the tetragonal trisoctahedrons.

**Comp., Var.**—$\overset{II}{Fe}\overset{III}{Fe}_2O_4$ or $FeO.Fe_2O_3$ = Iron sesquioxide 69·0, iron protoxide 31·0 = 100; or, Oxygen 27·6, iron 72·4 = 100. The ferrous iron sometimes replaced by magnesium, and rarely nickel; also sometimes titaniferous.

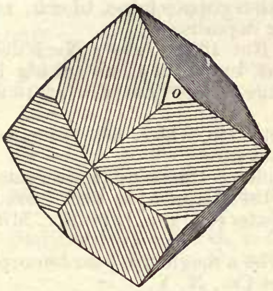
**Var.**—1. *Ordinary.* (*a*) In crystals. (*b*) Massive, with pseudo-cleavage, also granular, coarse or fine. (*c*) As loose sand. The property of polarity which distinguishes the *lodestone* (less properly written loadstone) is exceptional

The Scalotta crystals gave Cathrein: $Fe_2O_3$ 68·51, $Al_2O_3$ 1·10, $Cr_2O_3$ 0·55, FeO 27·70, MnO 0·42, MgO 2·09 = 100·37, Zs. Kr., 12, 37, 1886.

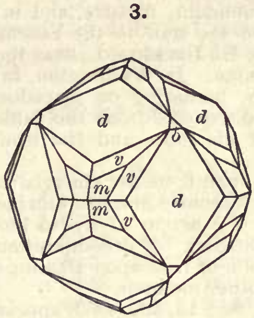
2. *Magnesian.* Talk-eisenerz, *Breith.* Schw. J., 68, 287, 1833.—$(Fe,Mg)O.Fe_2O_3$. G. = 4·41–4·42; luster submetallic; weak magnetic; in crystals from Sparta, N. J. An ore from the Mourne Mts., Ireland, contains 6·45 p.c MgO (Andrews), and an octahedron from Eisenach gave 1·20 p.c. MgO (Rg.). A New Zealand magnetite with G. = 4·67 has 7·15 MgO and 4·63 $Mn_3O_4$ (Chester, Min. Mag., 8, 125, 1889).

3. *Niccoliferous.* Petersen obtained in a magnetite from Pregratten in the Tyrolese Alps: $Fe_2O_3$ 68·92, FeO 29·32, NiO 1·76, $Mn_2O_3,Cr_2O_3,TiO_2$ *tr.* = 100. It occurred in a schistose serpentine in dodecahedral crystals; G. = 5·167. Jb. Min., 836, 1867.

2.



3.



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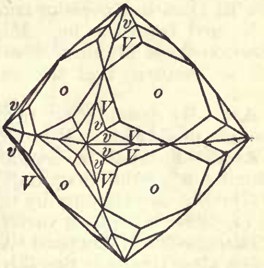


2, Nordmark. Flink. 3. Scalotta, Cathrein. 4, Oberhollersbachthal, Pinzgau, Brugnatelli.

4. *Titaniferous.* Knop found 24·95 p. c. $TiO_2$ in octahedrons from Meiches, Vogelsberg, Lieb. Ann., 123, 348, 1862; also 4·08 $TiO_2$ with 6·85 $Al_2O_3$, 4·57 MgO in a magnetite from Oberbergen, Kaiserstuhl. Nordström gives 6·01 $TiO_2$, Kristianstad, G. För. Förh., 1, 14, 1872; Koenig gives 3·25 $TiO_2$ for a variety from Magnet Cove, Ark., Proc. Ac. Philad., 293, 1877. It is to be noted, however, that rutile, titanite, etc., have been observed in microscopic form intimately associated with magnetite. Cf. Cathrein, Zs. Kr., 8, 321, 1883.

5. *Manganesian, Manganmagnetite.* A variety from Vester Silfberg, Sweden, gave Weibull 3·80 p. c. MnO; another gave 6·27 p. c. G. = 5·064. Min. Mitth., 7, 109, 1886. See also jacobsite. Cf. also results of Chester quoted under 2.

6. *Ocherous.* Eisenmulm *Germ.* A black, earthy variety as that from Siegen. Eisenmohr is in magnetic scales, regarded as pseudomorph after micaceous hematite, as at Johanngeorgenstadt.

A variety containing vanadium and chromium in minute amounts is mentioned by Claassen.

**Pyr., etc.**—B.B. very difficultly fusible. In O.F. loses its influence on the magnet. With the fluxes reacts like hematite. Soluble in hydrochloric acid.

**Obs.**—Magnetite is mostly confined to crystalline rocks, and is most abundant in metamorphic rocks, though found also in grains in eruptive rocks. In the Archæan rocks the beds are of immense extent, and occur under the same conditions as those of hematite. It is an ingredient in most of the massive variety of corundum called emery. The earthy magnetite is found in bogs like bog-iron ore. Occurs in meteorites, and forms the crust of meteoric irons.

Present in dendrite-like forms in the mica of many localities following the direction of the lines of the percussion-figure, and perhaps of secondary origin. A common alteration-product of minerals containing iron protoxide, e.g., present in veins in the serpentine resulting from altered chrysolite.

The beds of ore at Arendal, Norway, and nearly all the celebrated iron mines of Sweden, consist of massive magnetite: Dannemora and the Täberg in Småland are entirely formed of it. Still larger mountains of it exist at Kurunavara and Gelivara, in Lapland. Falun, in Sweden, and Corsica, afford octahedral crystals, embedded in chlorite slate. Splendid dodecahedral crystals occur at Nordmark in Wermland. The most powerful native magnets are found in Siberia, and in the Harz; they are also obtained on the island of Elba. Other localities for the crystallized mineral are Traversella in Piedmont; Achmatovsk in the Ural; Scalotta near Predazzo in Tyrol, also Rothenkopf and Wildkreuzjoch; the Binnenthal; a cubic variety occurs in serpentine near Kraubat in Styria.

In N. America, it constitutes vast beds (some scores of feet thick) in the Archæan, in the Adirondack region, Warren, Essex, and Clinton Cos., in Northern N. York, while in St. Lawrence Co. the iron ore is mainly hematite; fine crystals and masses showing broad parting surfaces and yielding large pseudo-crystals are obtained at Port Henry, Essex Co.; similarly in New Jersey; in Canada, in Hull, Grenville, Madoc, etc.; at Cornwall in Pennsylvania, and Magnet Cove, Arkansas. It occurs also in *N. York*, in Saratoga, Herkimer, Orange, and Putnam Cos.; at O'Neil mine, Orange Co., in crystals; at the Pine Swamp mine, Greenwood, in masses with distinct parting; at the Tilly Foster iron mine, Brewster, Putnam Co., in crystals and massive accompanied by chondrodite, etc. In *Maine*, Raymond, Davis's Hill, in an epidotic rock; at Marshall's island, masses strongly magnetic. In *N. Hampshire*, at Franconia, in epidote and quartz; at Swanzey near Keene, and Unity. In *Vermont*, at Marlboro', Rochester, Bethel, and Bridgewater, in crystals in chlorite slate. In *Conn.*, at Haddam, in crystals, etc. In *N. Jersey*, at Hamburg, near Franklin Furnace and elsewhere. In *Penn.*, at Goshen, Chester Co., and at the French Creek mines; at Webb's mine, Columbia Co.; in dendritic delineations forming hexagonal figures, in mica at Pennsbury and New Providence. In *Maryland*, at Deer Creek. Good lodestones are obtained at Magnet Cove, Arkansas.

In *California*, in Sierra Co., abundant, massive, and in crystals; in Plumas Co.; Mariposa Co., east of the Mariposa estate, on the trail to the Yosemite; Placer Co., Utt's ranch; Los Angeles Co., at Cañada de las Uvas; El Dorado Co., near the Boston copper mine, in oct., and at the El Dorado Excelsior copper mine. In Washington, in large deposits.

Named from the loc. *Magnesia*, bordering on Macedonia. But Pliny favors Nicander's derivation from Magnes, who first discovered it, as the fable runs, by finding, on taking his herds to pasture, that the nails of his shoes and the iron ferrule of his staff adhered to the ground.

**Alt.**—By deoxidation through organic matter changed to protoxide, which may become a carbonate or siderite. By oxidation becomes iron sesquioxide or hematite.

**Artif.**—Formed in crystals by the action of hydrochloric acid on the sesquioxide heated, producing a partial deoxidation (Deville); by decomposition of the sesquioxide with boracic acid (Deville and Caron); by the action of iron upon alkaline sulphates (Gorgeu, Bull. Soc. Min., **10**, 174, 1887); also by a variety of other methods.

*Dimagnetite* of Shepard (Am. J. Sc., **13**, 392, 1852) appears to be a magnetite pseudomorph, perhaps after ilvaite. See 5th Ed., p. 151. From Monroe, Orange Co., N. Y.

**Ref.**—[1] Mlr., Min., p. 259; *z*, *y* by Breithaupt. A summary with authorities is given by Brugnatelli, Zs. Kr., **14**, 237, 1888. Scheibe notes 511, 11·9·7, 11·7·0, but gives no measurements, Zs. G. Ges., **38**, 469, 1886; also Brögger (861, 8-$\frac{4}{3}$)? from the Brevik region, Zs. Kr., **16**, 59, 1890. [2] Scacchi, Vesuvius, Accad. Napoli, 1842. [3] Sbk., Pitorsky, Achmatovsk, Zs. G. Ges., **21**, 489, 1869; *w* also earlier by Kk. Min. Russl., **3**, 51, 1858. [4] Erofeyev, Min. Russl., **8**, 226. [5] Svr., Zs. Kr., **1**, 230, 1877. [6] Cathrein, Scalotta, Zs. Kr., **8**, 219, **9**, 365, 1884. [7] Brugnatelli, Alps, l. c. [8] Flink, Nordmark, Ak. H. Stockh., Bih., **13** (2), 7, 39, 1888; he earlier mentions the vicinal planes 46·9·0, 55·9·9, and 92·9·9, ib., **12** (2), 2, 14. [9] Cathrein, Zs. Kr., **12**, 47, 1886, Min. Mitth., **10**, 53, 1888; Mgg., Jb. Min., **1**, 244, 1889; Kemp, Am. J. Sc., **40**, 62, 1890. [10] Becke, Min. Mitth., **7**, 200, 1885; **9**, 1, 1887.

NICKEL OXIDE. The occurrence of a niccoliferous sand in the gold-washings of the Fraser river, British Columbia, is noted by James Blake (Proc. Cal. Acad., **5**, 200, 1874). It occurs with magnetic-iron sand, from which it is distinguished by its yellow color, resembling pyrite. It is inferred to have the composition $Ni_3O_4$ or $NiO.Ni_2O_3$, analogous to magnetite.

This compound has been formed artificially by Baubigny in regular octahedrons of a gray color, non-magnetic. C. R., **87**, 1082, 1878.

**238. MAGNESIOFERRITE.** Magnoferrit *Rammelsberg*, Pogg., **107**, 451, 1859. Magneferrit *Kenng.*, Ueb. J., 98, 1859, 96, 1860.

Isometric. In octahedrons, and octahedrons with truncated edges.

H. = 6–6·5. G. = 4·568–4·654. Luster, color, and streak as in magnetite. Strongly magnetic.

**Comp.**—$MgFeO_4$ or $MgO.Fe_2O_3$ = Magnesia 20, iron sesquioxide 80 = 100.

Analyses, see 5th Ed., p. 152.

**Pyr., etc.**—B.B. like hematite. Difficultly soluble in hydrochloric acid.

**Obs.**—Formed about the fumaroles of Vesuvius, and especially those of the eruption of 1855, as observed by Scacchi, who particularly described the crystals and their associations. The laminæ of hematite intersecting the octahedrons have rhombohedral planes on their edges. Crystals of hematite occur at the same fumaroles. These crystals have been also described by Rath, Jb. Min., 386, 1876.

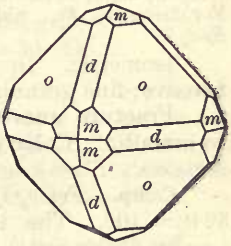
Rammelsberg first detected the magnesian nature of the crystals, and, in allusion to it, named the species *magnoferrite.* But *magno* has its own different signification in Latin; and the word should be *magnesioferrite.*

**Artif.**—Formed in crystals by heating together $Fe_2O_3$ and MgO, and subjecting to the action of hydrochloric acid vapor (Deville).

### 239. FRANKLINITE. Francklinite *Berthier*, Ann. Mines, **4**, 489, 1819.

Isometric. Observed forms:

*a* (100, *i-i*); *d* (110, *i*); *o* (111, 1); *p* (221, 2); *m* (311, 3-3).



Habit octahedral; edges often rounded, and crystals passing into rounded grains. Massive, granular, coarse or fine to compact.

Pseudo-cleavage, or parting, octahedral, as in magnetite. Fracture conchoidal to uneven. Brittle. H. = 5·5–6·5. G. = 5·07–5·22. Luster metallic, sometimes dull. Color iron-black. Streak reddish brown or black. Opaque. Slightly magnetic.

**Comp.**— (Fe,Zn,Mn)O.$(Fe,Mn)_2O_3$, but varying rather widely in the relative quantities of the different metals present, while conforming to the general formula of the spinel group.

**Anal.**—1, 2, Seyms, Am. J. Sc., **12**, 210, 1876. 3–6, Stone, Sch. Mines Q., **8**, 150, 1887. Also 5th Ed., p. 152.

| | | $Fe_2O_3$ | $Mn_2O_3$ | ZnO | MnO | FeO | |
|---|---|---|---|---|---|---|---|
| 1. Mine Hill, N. J. | | $\frac{2}{2}$ 63·40 | 4·44 | 23·12 | 10·46 | — | = 101·42 |
| 2. Sterling Hill, N. J. | | $\frac{4}{4}$ 67·42 | — | 6·78 | 9·53 | 15·65 | $Al_2O_3$ 0·65 = 100 04 |
| 3. Mine Hill | G. = 5·187 | 60·52 | 6·79 | 19·44 | 12·81 | — | = 99 56 |
| 4. " " | G. = 5·136 | 56·57 | 10·52 | 15·91 | 16·37 | — | = 99·37 |
| 5. Sterling Hill | G. = 5·215 | 67·38 | — | 16·28 | 16·38 | — | = 100·04 |
| 6. " " | G. = 5·074 | 66·34 | — | 20·26 | 12·31 | — | = 98·91 |

**Pyr., etc.**—B.B. infusible. With borax in O.F. gives a reddish amethystine bead (manganese), and in R.F. this becomes bottle-green (iron). With soda gives a bluish green manganate, and on charcoal a faint coating of zinc oxide, which is much more marked when a mixture with borax and soda is used. Soluble in hydrochloric acid, sometimes with evolution of a small amount of chlorine.

**Obs.**—Occurs in cubic crystals near Eibach in Nassau; in amorphous masses at Altenberg, near Aix-la-Chapelle.

Abundant at Mine Hill, Franklin Furnace, N. J., with willemite and zincite in granular limestone; also at Sterling Hill, two miles distant, where it is associated with willemite, in a large vein, in which cavities occasionally contain crystals from one to four inches in diameter.

**Artif.**—Formed in crystals by action of ferric chloride and zinc chloride on lime, with heat (Daubrée).

### 240. JACOBSITE. *Damour*, C. R., 69, 168, 1869. Jakobsit. Manganomagnetit *Flink*, Ak. H. Stockh. Bihang, 12 (2), 2, 20, 1886.

Isometric; in distorted octahedrons. Also in cleavage forms bounded by planes which seem to correspond to the hexoctahedron (60·50·3, 20-$\frac{5}{3}$)'.

H. = 6. G. = 4·75. Luster metallic, brilliant. Color deep black. Streak blackish brown. Magnetic.

**Comp.**—(Mn,Mg)O.$(Fe,Mn)_2O_3$.

**Anal.**—1, Damour, l.c., and Rg., Min. Ch., 132, 1875. 2, Lindström, G. För. Förh., **3**, 384, 1877. 3, Flink, l. c. 4, Igelström, G. För. Förh., **12**, 137, 1890.

| | | $Fe_2O_3$ | $Mn_2O_3$ | MnO | MgO | |
|---|---|---|---|---|---|---|
| 1. Jakobsberg | G. = 4·75 | 68·25 | 4·03 | 20·72 | 6·41 | = 99·41 [2·17 = 100·81 |
| 2. Långban | | 58·39 | 6·96 | 29·93 | 1·68 | CaO 0·40, PbO 1·22, $P_2O_5$ 0·06, insol. |
| 3. " | G. = 4·761 | 43·85 | 54·80 | | 0·94 | $SiO_2$ 0·74, CaO 0·41 = 100·74 |
| 4. Glakärn | | 57·55 | | 36·74[a] | 0·72 | insol. 6·02 = 101·03 |

[a] With some $Mn_2O_3$.

**Pyr.**—B.B. infusible. It does not lose weight when ignited. With the fluxes reacts for iron and manganese. Soluble in hydrochloric acid, with a slight evolution of chlorine.

**Obs.**—From Jakobsberg, in Nordmark, Wermland, Sweden, where it occurs associated with white mica and native copper in a crystalline limestone; also at Långban, Wermland, with tephroite and calcite; at the Sjö and also the Glakärn mine, Örebro.

**Ref.**—[1] Flink, l. c., anal. 3.

**241. CHROMITE.** Fer chromaté aluminé (fr. Var) *Vauq.*, Bull. Soc. Philom. 55, 57, 1800. Eisenchrom (fr. Ural) *Meder*, Crell's Ann., **1**, 500, 1798; *Karst.*, Tab., 56, 79, 1800, 74, 1808. Fer chromaté *H.*, Tr., **4**, 1801. Chromate of Iron, Chromic Iron. Chromsaures Eisen, Chromeisenstein *Germ.*, Eisenchrome *Beud.*, 1832. Siderochrome *Huot.*, **1**, 287, 1841. Chromoferrite *Chapm.*, Min., 1843. Chromit *Haid.*, Handb., 550, 1845. Chromjernmalm *Swed.* Fer chromé, Fer chromaté, *Fr.* Siderocromo, Cromite, Cromoferrite, Ferro cromato, *Ital.* Hierro cromado *Span.*

Isometric. In octahedrons; also with *d* (110, *i*), *m* (311, 3-3). Commonly massive; fine granular to compact.

Fracture uneven. Brittle. H. = 5·5. G. = 4·32–4·57. Luster submetallic to metallic. Color iron-black to brownish black, sometimes yellowish red in thin sections. Streak brown. Translucent to opaque. Sometimes feebly magnetic.

**Comp.**—$FeCr_2O_4$ or $FeO,Cr_2O_3$ = Chromium sesquioxide 68·0, iron protoxide 32·0 = 100. The iron may be replaced by magnesium as in magnochromite (magnesiochromite) below; also the chromium by aluminium and ferric iron. The varieties containing but little chromium (up to 10 p. c.) are hardly more than varieties of spinel and are classed under picotite.

Analyses: see 5th Ed., p. 153; Rg., Min. Ch., 141–144, 1885, etc. For an exhaustive table of the analyses which have been published, see Wadsworth, Lithological Studies, 1884, Mem. Mus. Comp. Zool., **11**, Pt. 1.

**Pyr., etc.**—B.B. in O.F. infusible; in R.F. slightly rounded on the edges, and becomes magnetic. With borax and salt of phosphorus gives beads which, while hot, show only a reaction for iron, but on cooling become chrome-green; the green color is heightened by fusion on charcoal with metallic tin.

Not acted upon by acids, but decomposed by fusion with potassium or sodium bisulphate.

**Obs.**—Occurs in serpentine, forming veins, or in embedded masses. It assists in giving the variegated color to verde-antique marble. Not uncommon in meteoric irons, sometimes in nodules as in the Coahuila iron, less often in crystals (Lodran).

Occurs in the Gulsen mountains, near Kraubat in Styria; in crystals in the islands of Unst and Fetlar, in Shetland; in the province of Trondhjem in Norway; in the Department du Var in France; in Silesia and Bohemia; abundant in Asia Minor (Am. J. Sc., **7**, 285, 1849); in the Eastern and Western Urals; in New Caledonia, affording ore for commerce.

At Baltimore, Md., in the Bare Hills, in large quantities in veins or masses in serpentine; also in Montgomery Co., 6 m. north of the Potomac; at Cooptown, Harford Co., and in the north part of Cecil Co., Md. In Pennsylvania, in W. Goshen (crystals), Nottingham, Mineral Hill, and elsewhere; Chester Co., near Unionville, abundant; at Wood's Mine, near Texas, Lancaster Co., very abundant. Massive and in crystals at Hoboken, N. J., in serpentine and dolomite; in the south-western part of the town of New Fane, and in Jay, Troy, and Westfield, Vt.; Chester and Blanford, Mass. In California, in Monterey Co.; also Santa Clara Co., near the N. Almaden mine. On I. à Vache, near San Domingo; at Bolton and Ham, Quebec, Canada.

The two following are properly varieties of chromite:

CHROMPICOTITE *T. Petersen*, J. pr. Ch., **106**, 137, 1869. From the dunyte of Dun Mt., New Zealand. H. = 8. G. = 4·115. Color black. Analysis, Petersen and Senfter: $Cr_2O_3$ 56·54, $Al_2O_3$ 12·13, FeO 18·01, MgO 14·08, MnO 0·46, CoO, NiO *tr.* = 101·22.

MAGNOCHROMITE *Bock* [Inaug. Diss., Breslau 1868], *Websky*, Zs. G. Ges., **25**, 394, 1873. Alumisches Eisenerz *Breith.*, Char., 234, 1832. A magnesian variety of chromite from Grochau, Silesia. Analysis, Bock, after deducting assumed impurities: $Cr_2O_3$ 40·78, $Al_2O_3$ 29·92, FeO 15·30, MgO 14·00 = 100.

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IRITE *Herm.*, J. pr. Ch., **23**, 276, 1841. Described by Hermann as occurring in the Urals in black shining octahedrons, with G. = 6·506, and as consisting of: Iridium 56·04, osmium 9·53, iron 9·72, chromium 9·40, traces of manganese, with a loss of 15·25, which he reckoned as oxygen. But Claus has shown that the mineral is only a mixture of iridosmine, chromite, etc. (ib., **80**, 285, 1860).

PLUMBOFERRITE *L. J. Igelström*, Öfv. Ak. Stockh., **38**, No. 8, 27, 1881.

In cleavable masses. H. = 5. Color nearly black. Streak red, like hematite. Acts very feebly on the magnet. Analysis, deducting 8 p. c. $CaCO_3$:

$Fe_2O_3$ 60·38 PbO 23·12 FeO 10·68 MnO 2·20 MgO 1·95 CaO 1·67 = 100

For this the composition $2FeO.Fe_2O_3.PbO.Fe_2O_3$ is suggested. Dissolves readily in hydrochloric acid with evolution of chlorine and formation of lead chloride.

Found at the Jakobsberg manganese mine, Nordmark, Wermland, Sweden; it occurs in narrow veins in a granular limestone, associated with jacobsite.

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**242. CHRYSOBERYL.** [Not Chrysoberyl (= var. Beryl) of *the Ancients.*] Krisoberil *Wern.*, Bergm. J., 373, 387, 1789; 84, 1790. Chrysoberyll *Karsten, Lenz*, etc. Cymophane *H.*, J. Mines, 4, 5, 1798. Alexandrite *Nordenskiöld*, Schr. Min. Ges., St. Petersb., 1842. Alaunerde + Kieselerde *Klap.*, Beitr., 1, 97, 1795; *Arfvedson*, Ak. H. Stockh., 1822. Aluminate of Glucina, mainly, *Seybert*, Am. J. Sc., 8, 105, 1824; *Bergemann*, De Chrys., Gött., 1826.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}47006 : 1 : 0{\cdot}58002$ Haidinger[1].
$100 \wedge 110 = 25° \ 10\tfrac{1}{2}'$, $001 \wedge 101 = 50° \ 58\tfrac{2}{3}'$, $001 \wedge 011 = 30° \ 6\tfrac{1}{2}'$.

**Forms**[2]:
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)
*c* (001, *O*)[3]

*m* (110, *I*)
*u* (230, *i*-$\breve{\tfrac{3}{2}}$)
*s* (120, *i*-2̆)
*r* (130, *i*-3̆)
*t* (270, *i*-$\breve{\tfrac{7}{2}}$)

*d* (160, *i*-6̆)[3]
*y* (102, $\tfrac{1}{2}$-ī)
*z* (203, $\tfrac{2}{3}$-ī)
*x* (101, 1-ī)

*i* (011, 1-ĭ)
*k* (021, 2-ĭ)[3]
*ρ* (031, 3-ĭ) tw. pl.
*o* (111, 1)

*v* (211, 2-2̄)
*w* (122, 1-2̆)
*n* (121, 2-2̆)
*e* (161. 6-6̆)

*mm‴* = 50° 21′
*uu′* = 109° 37½′
*ss′* = 93° 32′
*rr′* = *70° 41′
*dd′* = 39° 2′

*yy′* = 63° 21′
*zz′* = 78° 53′

*xx′* = 101° 57′

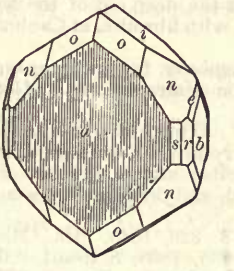
*ii′* = 60° 14′
*kk′* = 98° 28½′
*ρρ′* = 120° 14′

*oo′* = *93° 44′
*oo″* = 107° 29′

*oo‴* = 40° 7′
*vv′* = 129° 48′
*vv″* = 136° 57′
*vv‴* = 24° 35′
*ww′* = 56° 11′
*ww″* = 80° 31′
*ww‴* = 52° 33′

*nn′* = 77° 43′
*nn″* = 118° 53′
*nn‴* = 72° 17′
*bo* = 69° 56′
*bn* = 53° 51′
*be* = 24° 32′

1.



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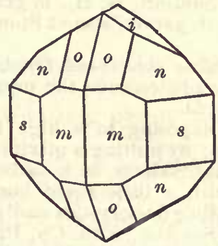

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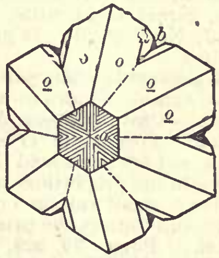

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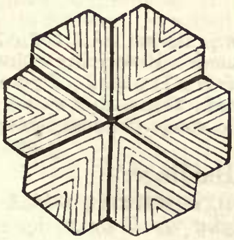

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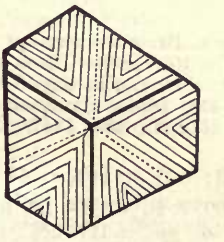

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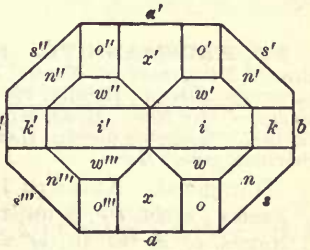


1, Norway, Me. 2, Alexandrite, Cathrein. 3, do., Kk. 4, 5, Haddam: 6, Alexandrite, after Klein.

Twins: tw. pl. *ρ* (031), both contact- and penetration-twins; often repeated and forming pseudo-hexagonal crystals with or without re-entrant angles[4]. Crystals generally tabular ∥ *a*. Face *a* striated vertically, in twins a feather-like striation, cf. f. 3–5.

Cleavage: *i* (011) quite distinct; *b* imperfect, *a* more so. Fracture uneven to conchoidal. Brittle. H. = 8·5. G. = 3·5–3·84. Luster vitreous. Color asparagus-green, grass-green, emerald-green, greenish white, and yellowish green; greenish brown; yellow; sometimes raspberry- or columbine-red by transmitted light. Streak uncolored. Transparent to translucent. Sometimes a bluish opalescence or chatoyancy, and asteriated. Pleochroic, vibrations ‖ $\mathfrak{b}$ ($= \bar{b}$) orange yellow, $\mathfrak{c}$ ($= \dot{c}$) emerald-green, $\mathfrak{a}$ ($= \breve{a}$) columbine-red, cf. Haid., l. c. Optically +. Ax. pl. ‖ *b*. Bx ⊥ *c*. Indices:

$$\alpha = 1{\cdot}7470 \quad \beta = 1{\cdot}7484 \quad \gamma = 1{\cdot}7565 \quad \therefore\ 2V = 45^\circ\ 20' \quad 2E = 84^\circ\ 43'$$

The measured axial angles vary widely because of want of homogeneity. Elevation of temperature causes the axes to unite and open again in a plane ‖ *c*, Dx.[5]

**Var.** 1. *Ordinary.*—Color pale-green, being colored by iron; also yellow and transparent and then used as a gem. G. = 3·597, Haddam; 3·734, Brazil; 3·689, Ural, Rose; 3·835, Orenburg, Kk.

2. *Alexandrite.*—Color emerald-green, but columbine-red by transmitted light; valued as a gem. G. = 3·644, mean of results, Kk. Supposed to be colored by chromium. Crystals often very large, and in twins, like fig. 3, either six-sided or six-rayed.

3. *Cat's Eye.*—Color greenish and exhibiting a fine chatoyant effect; from Ceylon.

**Comp.**—Beryllium aluminate, $BeAl_2O_4$ or $BeO.Al_2O_3$ = Alumina 80·2, glucina 19·8 = 100.

Analyses, see 5th Ed., p. 156.

**Pyr., etc.**—B.B. alone unaltered; with soda, the surface is merely rendered dull. With borax or salt of phosphorus fuses with great difficulty. With cobalt solution, the powdered mineral gives a bluish color. Not attacked by acids.

**Obs.**—In Minas Geraes, Brazil, and also in Ceylon, in rolled pebbles, in the alluvial deposits of rivers; at Marschendorf in Moravia; in the Ural, 85 versts from Ekaterinburg, in mica slate with beryl and phenacite, the variety *Alexandrite*, of emerald-green color, columbine-red by transmitted light; in the Orenburg district, S. Ural, yellow; in the Mourne Mts., Ireland.

In the U. S., at Haddam, Ct., in granite traversing gneiss, with tourmaline, garnet, beryl, automolite, and columbite; in the same rock at Greenfield, near Saratoga, N. Y., with tourmaline, garnet, and apatite; Orange Summit, N. H., in granite at the deep cut of the Northern railroad; Norway, Me., in granite with garnet, also at Stoneham, with fibrolite, at Canton, Peru, and Stowe.

*Chrysoberyl* is from χρυσος, *golden*, βήρυλλος, *beryl*. *Cymophane*, from κῦμα, *wave*, and φαίνω, *appear*, alludes to a peculiar opalescence the crystals sometimes exhibit. *Alexandrite* is after the Czar of Russia, Alexander II.

**Artif.**—Formed in crystals by exposing to a high heat a mixture of 6 of alumina, 1·62 glucina, and 5·0 boric acid (Ebelman); by putting a mixture of beryllium fluoride and aluminium fluoride, in the proportions of their equivalents, in a carbon crucible, and at the center of the fluorides a small carbon crucible with a little fused boric acid, and heating for some hours (Deville and Caron), the process yielding fine crystals easily.

**Ref.**—[1] Pogg., **77**, 228, 1849. [2] See Dx., Ann. Ch. Phys., **13**, 329, 1845; Mlr., Min., 267, 1852; Kk., Min. Russl., **4**, 54, 1862, **5**, 113, 1866; Dana, Min., 155, 1868; Schrauf, Atlas, Tf. XLV, 1877. [3] Klein, Jb. Min., 548, 1869; 479, 1871. [4] Cf. Cathrein, Zs. Kr., **6**, 257, 1881. [5] Dx., Propr. Opt., **1**, 59, 1857, **2**, 28, 1859, N. R., 54, 1867; cf. Mld., Bull. Soc. Min., **5**, 237, 1882.

**243. HAUSMANNITE.** Schwarz Braunsteinerz pt. *Wern.*, Bergm. J., 386, 1789. Schwarz Manganerz pt. *Karst.*, Tab. 72, 100, 1808. Black Manganese. Blättricher Schwarz-Braunstein *Hausm.*, Handb., 293, 1813. Manganèse oxydé hydraté *H.*, Tr., 1822. Pyramidal Manganese Ore *Haid.*, Mohs, Min., **2**, 416, 1824. Hausmannite *Haid.*, Trans. R. Soc. Ed., **11**, 127, 1827. Glanzbraunstein *Hausm.*, Handb., 405, 1847. L'oxyde rouge de manganèse *Fr.* Scharfmanganerz *Germ.*

Tetragonal. Axis $\dot{c} = 1{\cdot}1743$; $001 \wedge 101 = 49^\circ\ 35'$ Haidinger[1].

**Forms**[2]: *c* (001, *O*)[3]; *e* (101, 1-*i*); *s* (113, $\frac{1}{3}$), *σ* (112, $\frac{1}{2}$)[3], *p* (111, 1), *n* (221, 2)[3], *r* (313, 1–3)[3].

Angles: *ee''* = *99° 10′, *ss''* = 57° 56′, *pp''* = 117° 53½′, *ee'* = 65° 9′, *ss'* = 40° 3′, *pp'* = 74° 34′, *ep* = 37° 17′.

Twins: tw. pl. *e*, often repeated as fivelings (f. 2). Habit octahedral; faces *s* usually bright and smooth, *p* striated ‖ edge *p*/*s*, often dull. Also granular massive, particles strongly coherent.

Cleavage: *c* nearly perfect; *e*, *p* indistinct. Fracture uneven. Brittle. H. = 5–5·5. G. = 4·722, 4·856 Rg. Luster submetallic. Color brownish black. Streak chestnut-brown. Opaque.

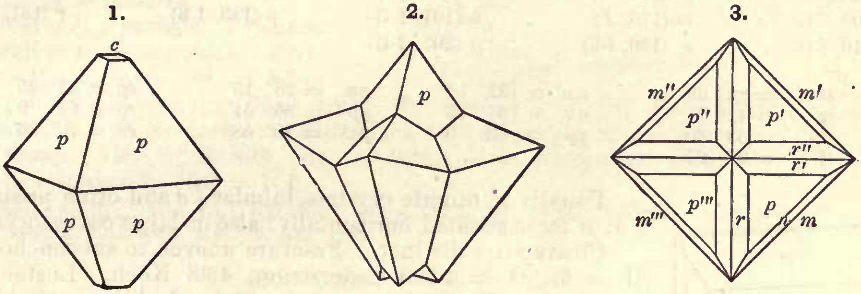
**Comp.**—$Mn_3O_4$ or $MnO.M_2O_3$ = Manganese sesquioxide 69·0, manganese protoxide 31·0 = 100.

Analyses, see 5th Ed., p. 162.

**Pyr., etc.**—B.B. like manganite. Dissolves in heated hydrochloric acid, yielding chlorine.

**Obs.**—Occurs in porphyry, along with other manganese ores, in fine crystals, near Ilmenau in Thuringia; Ilefeld in the Harz; Filipstad in Wermland, Sweden; also, as the chief vein mineral with manganosite, pyrochroite, rhodochrosite, etc., at Långban and at Nordmark; at the Sjö mine, Grythyttan. Reported from Framont in Alsace. Also reported from Lebanon, Penn. (but very doubtful, Genth).

**Artif.**—Obtained by Debray, Deville *et al.* by various methods (cf. Fouqué-Lévy, Synth. Min., 243, 1882); also by Gorgeu in crystals (G. = 4·80) by keeping fused manganese chloride for several hours in an oxidizing atmosphere saturated with water vapor, Bull. Soc. Min., **6**, 136, 1883.


1. 2. 3.

1, Långban, Flink. 2, Haidinger. 3, Långban, Flink.

**Ref.**—[1] L. c., also Ed. J. Sc., **4**, 41, 1826, and Pogg., **7**, 232, 1826. [2] Haid, l. c ; Mlr., Min., 257, 1852. [3] Flink, Långban, Ak. H. Stockh., Bih., **12** (2), No. 7, 40, 1888; he gives $pp' = 74° 14'$. See also p. 1036.

**244. MINIUM.** Mennige *Germ.* Plomb oxidé rouge *H.* Minio, Piombo ossidato rosso *Ital.* Azarcon nativo *Span., Domeyko.*

Pulverulent, occasionally exhibiting, under the microscope, crystalline scales. Also (artif.) in prismatic crystals.

H. = 2–3. G. = 4·6. Luster faint greasy, or dull. Color vivid red, mixed with yellow; streak orange-yellow. Opaque.

**Comp.**—$Pb_3O_4$ or $2PbO.PbO_2$ = Oxygen 9·4, lead 90·6 = 100.

**Pyr.**—In the reducing flame of the blowpipe, on charcoal, globules of lead are obtained.

**Obs.**—Usually associated with galena, and also with calamine, and sometimes constituting pseudomorphs after galena and cerussite.

Occurs at Bleialf in the Eifel; Badenweiler in Baden; Brillon in Westphalia; island of Anglesey; Grassington Moor and Weardale in England; Leadhills in Scotland; Zmeinogorsk mine in Siberia. Reported from Zimapan, Mexico.

In the U. S., found at Austin's mine, Wythe Co., Va., along with cerussite: reported as occurring with native lead at the Jay Gould mine. Alturas Co., Idaho; at the Rock mine, Leadville, Col., having in part the structure of the galena from which it has been derived (Hawkins).

**Artif.**—Obtained in small prismatic crystals by heating amorphous lead carbonate in a bath of potassium and sodium nitrate kept at a temperature near 300° C., Michel, Bull. Soc. Min., **13**, 56, 1890.

**245. CREDNERITE.** Kupferhaltiges Manganerz *Credner*, Jahrb. Min., 5, 1847. Mangankupferoxyd *Hausm.*, Handb., 1582, 1847. Mangankupfererz, Crednerit, *Rg.*, Pogg., **74**, 559, 1848.

Monoclinic. Foliated crystalline.

Cleavage: basal, very perfect; less distinct in two other directions obliquely inclined to one another. H. = 4·5. G. = 4·9–5·1; 4·959, 4·977 Rg. Luster metallic. Color iron-black to steel-gray. Streak black, brownish.

**Comp.**—$Cu_3Mn_4O_9$ or $3CuO.2Mn_2O_3$ (Rg.) = Cupric oxide 43·0, manganese sesquioxide 57·0 = 100.

Analyses, see 5th Ed., p. 166.

**Pyr., etc.**—B.B. fusible only on thin edges. With borax in O.F. gives a dark violet color (manganese); with salt of phosphorus a green glass, which on cooling is blue, and in R.F. becomes red (copper). Soluble in hydrochloric acid with evolution of chlorine.

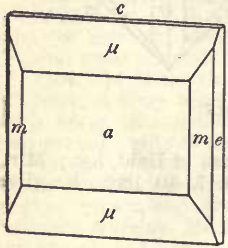
**Obs.**—From Friedrichsrode, with volborthite, malachite, and manganese ores. Rammelsberg observes that this ore is undoubtedly the source of the cupreous manganese (p. 258), a secondary product.

**246. PSEUDOBROOKITE.** *A. Koch*, Min. Mitth., **1**, 77, 344, 1878.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c}$ = 0·87776 : 1 : 0·88475 Schmidt[1].
100 ∧ 110 = *41° 16½′, 001 ∧ 101 = 45° 13⅔′, 001 ∧ 011 = 41° 30′.

**Forms:**
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)
*c* (001, *O*)
*m* (110, *I*)
*e* (130, *i*-3̆)
*n* (102, ½-ī)[3]
*l* (101, 1-ī)
*μ* (201, 2-ī)
*y* (011, 1-ĭ)
*p* (133, 1 3̆)
*q* (132, $\frac{3}{2}$-3̆)[4]?
*r* (131, 3-3̆)[4]?

*mm‴* = 82° 33′
*ee′* = 41° 35′
*nn′* = 53° 30′
*ll′* = 90° 27′
*μμ′* = 127° 14′
*aμ* = *26° 23′
*yy′* = 83° 0′
*pp′* = 28° 15′
*pp″* = 86° 51′
*pp‴* = 79° 58′
*cp* = 43° 25′
*cq* = 62° 9′
*cr* = 70° 36′



Aranyer Berg.

Usually in minute crystals, tabular ∥ *a* and often prismatic ∥ $\bar{b}$; *a* faces striated horizontally; also in large coarse crystals.

Cleavage: *c* distinct. Fracture uneven to subconchoidal. H. = 6. G. = 4·390 Cederström, 4·98 Koch. Luster adamantine; on the fracture greasy. Color dark brown to black, nearly opaque; on thinnest edges red, translucent. Streak ocher-yellow or reddish brown. Optically +. Ax. pl. ∥ *b*. Bx ⊥ *a*. Dispersion $v > \rho$. Axial angle: 2H = 84° 30′ Lattermann[5].

**Comp.**—Probably $Fe_4(TiO_4)_3$ or $2Fe_2O_3.3TiO_2$ = Titanium dioxide 42·9, iron sesquioxide 57·1 = 100, Cederström.

**Anal.**—1, Koch, on 0·1 gr., Min. Mitth., **1**, 344, 1878. 2, Lattermann, Min. Mitth., **9**, 47, 1887. 3, Cederström, Zs. Kr., **17**, 133, 1889.

| | | $TiO_2$ | $Fe_2O_3$ | MgO | |
|---|---|---|---|---|---|
| 1. Aranyer Berg | G. = 4·98 | 52·74 | 42·29[a] | [4·28[b]] | ign. 0·69 = 100 |
| 2. Katzenbuckel | | $\frac{2}{2}$ 46·79 | 48 64 | 4·53 | = 99·96 |
| 3. Bamle | G. = 4·39 | 44·26 | 56·42 | | = 100·68 |

[a] $Al_2O_3$ *tr.* [b] Also CaO.

**Pyr.**—B.B. nearly infusible, with the fluxes reacts for iron and titanium. Decomposed partly by boiling hydrochloric acid, wholly by sulphuric acid.

**Obs.**—Found with hypersthene (the so-called szaboite) in cavities of the andesyte of Aranyer Berg, Transylvania; with hypersthene and tridymite in the trachyte of Riveau Grand, Mt. Dore, Puy-de-Dôme; in the nephelinyte of the Katzenbuckel in the Odenwald; with the apatite from Jumilla, Spain; in andesyte from Berings Is.; on recent lava (1872) from Vesuvius.

In large crystals several inches long, prismatic ∥ $\bar{b}$, at Havredal, Bamle, Norway, embedded in kjerulfine (wagnerite) altered to apatite, also associated with quartz, feldspar, titanic iron (Bgr., G. För. Förh., **10**, 21, 1888, Cederström, l. c.).

**Ref.**—[1] Aranyer Berg [Term. Füz., **4**, No. 4, 1880], Zs. Kr., **6**, 100. The position taken is that originally proposed by Groth showing relation to brookite, ibid., **3**, 306, 1879; with Koch, Groth, 1889, and others, the axes $\bar{b}$ and $\acute{c}$ as here taken are interchanged. The angles vary rather widely, see Koch, l. c., and Zs. Kr., **3**, 306; Lewis, Jumilla, Spain, ib., **7**, 181, 1882; Oebbeke, Mt. Dore, ib., **11**, 370, 1886.

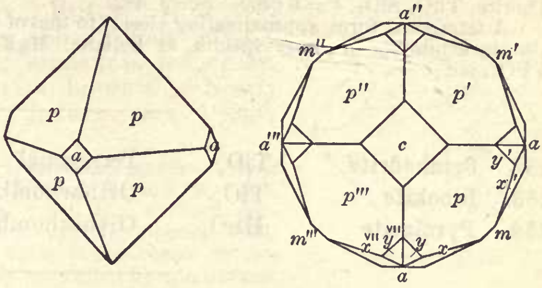
[2] Koch, Groth, l. c. [3] Schmidt, l. c. [4] Oebbeke, l. c. [5] Lattermann, l. c.

**247. BRAUNITE.** Brachytypous Manganese-Ore, Braunite, *Haid.*, Ed. J. Sc., **4**, 48, 1826, Trans. R. Soc., **11**, 137, 1827. Hartbraunstein *Hausm.*, Handb., 222, 1847. Marceline *Beud.*, **2**, 188, 1832. Heteroklin *Breith.*, Pogg., **49**, 204, 1840 (in art. by Evreinov), Handb., **3**, 801, 1847. Leptonématite. Pesillite *Adam*, Tabl. Min., 75, 1869.

Tetragonal. Axis $\dot{c} = 0{\cdot}9850$; $001 \wedge 101 = 44° 34'$ Haidinger[1].

**Forms**[1]: *c* (001, *O*); *a* (100, *i-i*)[3], *m* (110, *I*)[3], *e* (101, 1-*i*)[2] as tw. pl., *p* (111, 1), *s* (221, 2) *y* (423, $\frac{4}{3}$-2)[4], *x* (421, 4-2).

Angles: $cp = 54° 19\frac{1}{2}'$, $cs = 70° 15'$, $cx = 77° 13'$, $pp'' = {*}108° 39'$, $pp' = 70° 7'$, $ss' = 83° 27'$, $xx' = 35° 56'$, $xx^{\text{vii}} = 51° 43'$.



1, 2, Långban, Flink.

Twins: tw. pl. *e*. Commonly in octahedrons, nearly isometric in angle. Faces *c* faintly striated ‖ edge *c*/*p*; *s* uneven and striated ‖ edge *p*/*s*; *x* smooth, even. Also massive.

Cleavage: *p* perfect. Fracture uneven to subconchoidal. Brittle. H. = 6–6·5. G. = 4·75–4·82; 4·752, Elgersburg, Rg.; 4·818, ib., Haid.; 4·77, St. Marcel, Dmr. Luster submetallic. Color dark brownish black to steel-gray. Streak same.

**Comp.**—$3Mn_2O_3.MnSiO_3$ (Rg.) = Silica 10·0, manganese protoxide 11·7, manganese sesquioxide 78·3 = 100.

**Anal.**—1, Rg., Min. Ch., 160, 1875; Pogg., **124**, 515, 1865. 2, Dmr., as given by Rg., l. c. 3, Igelström, Bull. Soc. Min., 8, 421, 1885.

| | $SiO_2$ | MnO | O | CaO | |
|---|---|---|---|---|---|
| 1. Elgersburg | 8·63 | 80·94 | 8·08 | 0·91 | BaO 0·44, $H_2O$ 1·00 = 100 |
| 2. St. Marcel | 7·70 | 81·42 | [8·14] | 1·25 | $Fe_2O_3$ 1·49 = 100 |
| 3. Jakobsberg | ⅝ 8·67 | 80·23 | 8·17 | 0·95[a] | PbO 0·65, FeO 1·33 = 100 |

[a] Including MgO.

Marceline (heterocline) from St. Marcel, Piedmont, is impure braunite. Cf. Dmr., Ann. Mines, **1**, 400, 1842.

**Pyr., etc.**—B.B. infusible. With borax and salt of phosphorus gives an amethystine bead in O.F., becoming colorless in R.F. With soda gives a bluish green bead. Dissolves in hydrochloric acid evolving chlorine, and leaving a residue of gelatinous or flocculent silica (Rg.). Marceline gelatinizes with acids.

**Obs.**—Occurs both crystallized and massive, in veins traversing porphyry, at Oehrenstock, near Ilmenau; at Elgersburg in Thuringia; near Ilefeld in the Harz; at St. Marcel in Piedmont; at Elba; at Botnedal, Upper Tellemark, in Norway; at the manganese mines of Jakobsberg, Sweden, also at Långban, and at the Sjö mine, Grythyttan, and Glakärn, Örebro. At Vizianagram, Bimlipatam and elsewhere in India in large quantity (Mallet, Min. India, 55, 1887). In the Wellington district and elsewhere in New South Wales (Liversidge, Min. N. S. W., 110, 1888).

Named after Mr. Braun of Gotha.

**Ref.**—[1] Ed. J. Sc., **4**, 48, 1826, or Pogg., **7**, 234, 1826. Schuster has attempted to show that the Jakobsberg crystals belong to the rhombohedral system with tetartohedral development, but his conclusions seem very doubtful, Min. Mitth., **7**, 443, 1884. [2] Rath, Pralorgnan mine, St. Marcel, Piedmont, Ber. nied. Ges., Dec. 4, 1882; he gives $pp' = 70° 8'$ and $70° 13'$. [3] Schmidt, Maderanerthal, Zs. Kr., **11**, 603, 1886. [4] Flink, Långban, Ak. H. Stockh., Bih., **12** (2), No. 7, 38, 1888; he gives $pp' = 70° 19'$. See also p. 1029.

## IV. Dioxides, $RO_2$.

### Rutile Group. Tetragonal.

| | | | $\dot{c}$ |
|---|---|---|---|
| **248.** | **Cassiterite** | $SnO_2$ | 0·6723 |
| **249.** | **Polianite** | $MnO_2$ | 0·6647 |
| **250.** | **Rutile** | $TiO_2$ | 0·6442 |
| **251.** | **Plattnerite** | $PbO_2$ | 0·6764 |

With the Rutile group is also sometimes included:

Zircon $ZrO_2.SiO_2$ $\dot{c} = 0{\cdot}6404$.

In this work, however, Zircon is classed among the silicates, with the allied species, Thorite, $ThO_2.SiO_2$, $\dot{c} = 0{\cdot}6402$. See p. 482.

A tetragonal form, approximating closely to that of the species of the Rutile Group, belongs also to a number of other species, as Sellaite, $MgF_2$; Tapiolite, $Fe(Ta,Nb)_2O_6$; Xenotime, $YPO_4$, etc.

---

| | | | | |
|---|---|---|---|---|
| 252. | **Octahedrite** | $TiO_2$ | Tetragonal | $\dot{c} = 1{\cdot}1771$ |
| 253. | **Brookite** | $TiO_2$ | Orthorhombic | $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}8416 : 1 : 0{\cdot}9444$ |
| 254. | **Pyrolusite** | $MnO_2$ | Orthorhombic? | |

---

## Rutile Group.

**248. CASSITERITE.** Ore of the Κασσίτερος *of the Greeks* (*Herod.*, etc.), and of the Plumbum album of *Plin.*, **34**, 47, etc.; not of the Stannum [= a pewter-like alloy] of *Plin.* Zinnsten, Stannum ferro et arsenico min., *Wall.*, Min., 303, 1747. Mine d'Etain, *Fr. Trl.* Wall., 1753. Tin Ore, Tin Stone. Zinnstein, Zinnerz *Germ.* Stannum calciforme (Oxide of Tin) *Bergm.*, Opusc., **2**, 436, 1780; *Klapr.*, Beitr., **2**, 245, 1797. Etain oxydé *Fr.* Cassiterite *Beud.*, **2**, 618, 1832. Kassiterit *Germ.* Tennmalm *Swed.* Stagno ossidato *Ital.*

Tetragonal. Axis $\dot{c} = 0{\cdot}67232$; $001 \wedge 101 = 33° 54\frac{5}{6}'$ Becke[1].

**Forms[2]:**
$c$ (001, $O$)

$a$ (100, $i$-$i$)
$m$ (110, $I$)
$h$ (210, $i$-2)
$r$ (320, $i$-$\frac{3}{2}$)
$\rho$ (750, $i$-$\frac{7}{5}$)[5]

$r_1$ (430, $i$-$\frac{4}{3}$)
$\beta$ (870, $i$-$\frac{8}{7}$)[7]
$k$ (14·13·0, $i$-$\frac{14}{13}$)

$e$ (101, 1-$i$)
$w$ (501, 5-$i$)

$x$ (114, $\frac{1}{4}$)

$y$ (335, $\frac{3}{5}$)
$S$ (223, $\frac{2}{3}$)
$s$ (111, 1)
$\sigma$ (665, $\frac{6}{5}$)[6]
$i$ (552, $\frac{5}{2}$)
$\pi$ (551, 5)
$\eta$ (771, 7)

$\tau$ (514, $\frac{5}{4}$-5)[6]?
$\zeta$ (3·1·12, $\frac{1}{4}$-3)
$t$ (313, 1-3)
$u_3$ (942, $\frac{9}{2}$-$\frac{9}{4}$)
$u_1$ (742, $\frac{7}{2}$-$\frac{7}{4}$)
$\phi$ (645, $\frac{6}{5}$-$\frac{3}{2}$)[6]

$v$ (21·14·18, $\frac{7}{6}$-$\frac{3}{2}$)
$z$ (321, 3-$\frac{3}{2}$)
$\nu$ (752, $\frac{7}{2}$-$\frac{7}{5}$)[3]
$\mu$ (766, $\frac{7}{6}$-$\frac{7}{6}$)[4]
$\xi$ (761, 7-$\frac{7}{6}$)
$u$ (19·16·7, $\frac{19}{7}$-$\frac{19}{16}$)
$u_2$ (17·13·6, $\frac{17}{6}$-$\frac{17}{13}$)

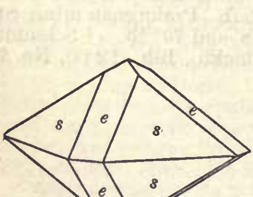
$ee' = 46° 28'$
$ww' = 85° 20'$
$ee'' = 67° 50'$
$ww'' = 146° 52'$
$xx' = 18° 49'$
$yy' = 41° 1'$
$ss' = 58° 19'$

$ii' = 81° 21'$
$\pi\pi' = 87° 34'$
$xx'' = 26° 44\frac{1}{2}'$
$yy'' = 59° 24\frac{1}{2}'$
$ss'' = 87° 7'$
$ii'' = 134° 23'$

$\pi\pi'' = 156° 14\frac{1}{2}'$
$tt' = 29° 58'$
$tt^{vii} = 21° 4'$
$zz' = 20° 53\frac{1}{2}'$
$zz^{vii} = 61° 42'$
$rz = 22° 25'$

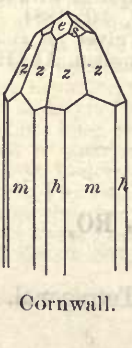
$mz = 24° 59'$
$my = 60° 18'$
$ms = {*}46° 26\frac{2}{3}'$
$mi = 22° 49'$
$ct = 35° 19\frac{1}{2}'$
$cz = 67° 35'$

1.



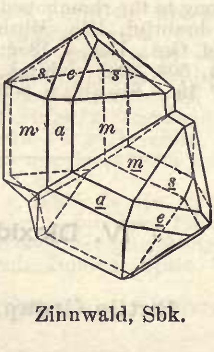
Stoneham, Me.

2.



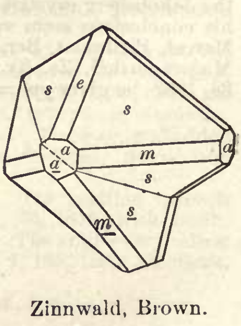
Cornwall.

3.



Zinnwald, Sbk.

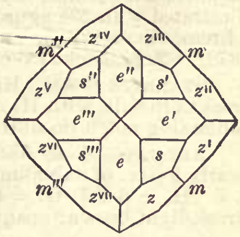
4.



Zinnwald, Brown.

Twins: tw. pl. $e$, both contact- and penetration-twins; often repeated producing complex forms, sometimes stellate fivelings. Faces $c$, $m$ often uneven; faces in zone $s$, $e$, as also those in prismatic zone, often striated parallel to their respective intersections. Often in reniform shapes, structure fibrous divergent; also massive, granular or impalpable; in rolled grains.

5.



Cornwall, Haid.

Cleavage: *a* imperfect; *s* more so; *m* hardly distinct. Fracture subconchoidal to uneven. Brittle. H. = 6–7. G. = 6·8–7·1. Luster adamantine, and crystals usually splendent. Color brown or black; sometimes red, gray, white, or yellow. Streak white, grayish, brownish. Nearly transparent to opaque. Optically +. Indices: $\omega_y = 1·9966$, $\epsilon_y = 2·0934$. Grubenmann (Rosenb.).

**Var.**—1. *Ordinary.* Tin-stone. In crystals and massive. G. of ordinary cryst. 6·96; of colorless, from Tipuani R., Bolivia, 6·832, Forbes; of honey-yellow, from Oruro, 6·704, id.; of very pure crystals from Carabuco, 6·4, id ; of black cryst. fr. Tipuani, 7·021, id. The acute pyramidal variety (f. 2) is called *needle tin ore* (Nadelzinnerz *Germ.*). The twin crystals are called by the German miners, *Zwitter*, *Zinngraupen*.

2. *Wood Tin* (Holzzinnerz *Germ.*). In botryoidal and reniform shapes, concentric in structure, and radiated fibrous internally, although very compact, with the color brownish, of mixed shades, looking somewhat like dry wood in its colors. *Toad's-eye* tin is the same, on a smaller scale. G. of one variety 6·514.

*Stream tin* is the ore in the state of sand, as it occurs along the beds of streams or in the gravel of the adjoining region. It has been derived from the wear and decomposition of the rocks carrying tin ore.

**Comp.**—Tin dioxide, $SnO_2$ = Oxygen 21·4, tin 78·6 = 100. A little $Ta_2O_5$ is sometimes present, also $Fe_2O_3$.

Analysis, by Becke, of a dark colored crystal, l. c.:

| | | | | | |
|---|---|---|---|---|---|
| Schlackenwald | $SnO_2$ 98·74 | $Fe_2O_3$ 0·12 | CaO 0·41 | $SiO_2$ 0·19 | = 99·46. |

Other analyses, see 5th Ed., p. 158, also Genth, Am. Phil. Soc., **24**, 26, 1887. Genth shows of Mexican cassiterite that the red varieties carry $Fe_2O_3$ up to 6 p. c. and more, with G. = 6·54–6·91; the yellow carry $As_2O_5$ to 10 p. c., and ZnO to 3 p. c., with G. = 6·16–6·51; these constituents are to be regarded simply as impurities.

**Pyr., etc.**—B.B. alone unaltered. On charcoal with soda reduced to metallic tin, and gives a white coating. With the fluxes sometimes gives reactions for iron and manganese. Only slightly acted upon by acids.

**Obs.**—Occurs in veins traversing granite, gneiss, mica schist, chlorite or clay schist, and porphyry; also in finely reticulated veins forming the ore-deposits called stockworks, or simply impregnating the enclosing rock. The commonly associated minerals are quartz, wolframite, scheelite, also mica, topaz, tourmaline, apatite, fluorite; further pyrite, arsenopyrite, sphalerite; molybdenite, native bismuth, etc.

Formerly very abundant, now less so, in Cornwall, in fine crystals, and also as *wood-tin* and *stream-tin;* in Devonshire, near Tavistock and elsewhere; County of Wicklow, Ireland; in pseudomorphs after feldspar at Wheal Coates, near St. Agnes, Cornwall; in fine crystals, often twins, at Schlackenwald, Graupen, Joachimsthal, and Zinnwald, etc., in Bohemia; Ehrenfriedersdorf, Altenberg, etc., in Saxony; at Limoges in splendid crystals; also in Galicia; Greenland, with cryolite at Ivigtut; Sweden, at Finbo; Finland, at Pitkäranta.

In the E. Indies, on the Malay peninsula of Malacca and the neighboring islands, Banca, and Bilitong near Borneo. In Australia, abundant, thus: In New South Wales, over an area of 8500 sq. miles, also in Victoria; in Queensland in alluvial deposits over a large area along the Severn river and its tributaries, also in numerous veins in granite. In large amount in Tasmania. In Bolivia, S. A., in the gold region along the Tipuani R.; at Oruro tin mines; and at Carabuco, Bolivia; in Mexico, in Durango; also Guanajuato, Zacatecas, Jalisco.

In the United States, in *Maine*, sparingly at Paris, Hebron, Winslow and Stoneham. In *Mass.*, at Chesterfield and Goshen, a few crystals, with albite and tourmaline. In *N. Hamp.*, at Lyme, and somewhat more abundantly in the town of Jackson. In *Virginia*, sparingly in some gold mines; also more abundantly on Irish Creek, Rockbridge Co., with wolframite, etc., Glenwood, Mason, W. Va. In *Alabama*, in Coosa Co. In *South Dakota* near Harney Peak and near Custer City in the Black Hills, where it has been mined to some extent, but with indifferent success; in the Nigger Hill district in Lawrence Co. In *Wyoming*, in Crook Co. In *Montana*, near Dillon. In *California*, in San Bernardino Co., at Temescal (see p. 1030). In *Idaho*, on Jordan creek, near Boonville.

**Artif.**—Formed in crystals by the action of a stream of hydrochloric acid gas on $SnO_2$ (Deville); by action of steam on chloride or fluoride of tin (Daubrée). Also Bourgeois, Bull. Soc. Min., **11**, 58, 1888.

**Alt.**—Substitution pseudomorphs after orthoclase, quartz, tourmaline occur in Cornwall; also after hematite and magnetite in Mexico (Genth).

**Ref.**—[1] Graupen, Bohemia, Min. Mitth., 243, 1877; Mlr. gives *ce* = 33° 55′·2 ∴ ċ = 0·6725, Min., 230; Nd., Pitkäranta, *ce* = 33° 53½′, ċ = 0·6718, Pogg., **101**, 637, 1857.
[2] Cf. Mlr., also Becke, l. c., the latter for authorities, etc.; also earlier, Hbg., Min. Not., **1**, 28, **6**, 18, 1864; Gadolin, Vh. Min. Ges., 161, 1855–56 (who adds many doubtful planes not included here); Nd., l. c. An early paper by Phillips on the Cornish forms is elaborately illustrated with 235 figures, plates 15–26, Trans. G. Soc., London, **2**, 336, 1814 [3] Becke, l. c. [4] Erem., Transbaikal, Vh. Min. Ges., **11**, 273, 1876. [5] Bodewig, Min.-Samml. Strassburg, 104, 1878. [6] Zeph., Schlackenwald, Lotos, 1880. [7] Busz, Zinnwald, Zs. Kr., **15**, 623, 1889. See p. 1030.

STANNITE *Breith.*, Handb., **3**, 772, 1847. An amorphous, pale yellowish white substance, from Cornwall, with H. = 6·5, G. = 3 545; has been regarded as a pseudomorph after feldspar, containing much tin dioxide as a mixture with the other ingredients.

AINALITE *A. E. Nordenskiöld*, Finl. Min., 162, 1855, 26, 1863. A cassiterite containing nearly 9 p. c. of tantalum pentoxide. Isomorphous with cassiterite, and presenting the planes *e*, *s*. H. = 6–6·5; G. = 6·6–6·8. Luster vitreous to adamantine; color black to grayish black; streak light brown; opaque. Analysis by Nordenskiöld:

$SnO_2$ 88·95 $Ta_2O_5$ 8·78 $Fe_2O_3$ 2·04 CuO 0·78 = 100·55

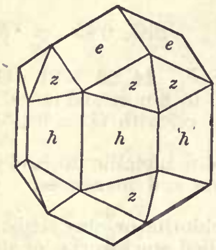
From Pennikoja in Somero, Finland, with tantalite and beryl in albite. Cf. Tapiolite, p. 738.

**249. POLIANITE.** Pyrolusite pt. Lichtes Graumanganerz *Breithaupt*, Char., 231, 1832. Polianit, *id.*, Pogg., **61**, 191, 1844.

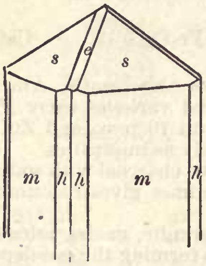
Tetragonal. Axis ċ = 0·66467; 001 ∧ 101 = 33° 36⅔′ E. S. Dana[1].

**Forms**[1]: *a* (100, *i-i*), *m* (110, *I*); *h* (210, *i*-2); *e* (101, 1-*i*), *g* (201, 2-*i*); *s* (111, 1), *n* (221, 2); *z* (321, 3-$\frac{3}{2}$).

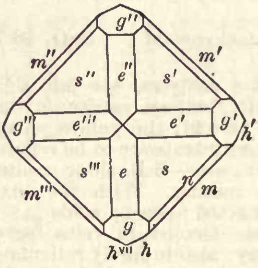
1.



2.



3.



Figs. 1–3, Platten, Bohemia.

*ah* = 26° 34′ *ee''* = 67° 13′ *ss''* = 86° 27′ $zz^{viii}$ = 45° 18′
*hh'* = 36° 52′ *gg''* = 106° 6′ *nn''* = 123° 59′ *ez* = 41° 46½′
*ee'* = 46° 5′ *ss'* = *57° 56′ *zz'* = 20° 51′ *az* = 39° 50′
*gg'* = 68° 49′ *nn'* = 77° 15½′ $zz^{vii}$ = 61° 35′ *mz* = 25° 11′

Often in composite parallel groupings of minute crystals, the resulting form having a rough summit and rhombic form. Also forming the outer shell of crystals having the form of manganite.

Cleavage: *m* perfect. Fracture uneven. Brittle. H. = 6–6·5. G. = 4·992 Pfd.; 4·838, 4·880 Breith.; 5·026 Rg. Luster metallic. Color light steel-gray or iron-gray. Streak black. Opaque.

**Comp.**—Manganese dioxide, $MnO_2$ = Oxygen 36·9, manganese 63·1 = 100.

**Anal.**—1. Plattner, Pogg., **61**, 192, 1844 and Rg., Min. Ch. 174, 1875. 2, Rg., l. c. 3, Penfield, Am. J. Sc., **35**, 247, 1888.

| | MnO | O | $Fe_2O_3$ | $SiO_2$ | $H_2O$ | insol. | |
|---|---|---|---|---|---|---|---|
| 1. G. = 4·84–4·88 | 81·17 | 18·21 | 0·17 | — | 0·32 | 0·13 | = 100 |
| 2. G. = 5·026 | 80·82 | 18·60 | — | — | — | — | = 99·42 |
| 3. G. = 4·992 | 80·81 | 18·16 | 0·16 | 0·36 | 0·28 | 0·16 | = 99·93 |

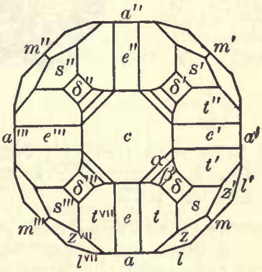
The loss by ignition in (1) was 12·43, in (2) 12·44; in another analysis by Penfield 12·42, with only a trace of $H_2O$. Plattner's analysis gave: $Mn_3O_4$ 87·27, O 12·11.

**Pyr.**—B.B. alone infusible; on charcoal loses oxygen· the usual reactions for manganese with the fluxes. Evolves chlorine when treated with hydrochloric acid.

**Obs.**—Occurs at Platten, Bohemia. It is distinguished from pyrolusite, with which it has often been confounded (though the distinction was insisted upon by Breithaupt) by its hardness and its anhydrous character. Like pyrolusite it is often a pseudomorph after manganite. The name refers to the gray color, from *πολιαίνεσθαι, to become gray*.

**Ref.**—[1] Am. J. Sc., **35**, 243, 1888. The form was earlier regarded as orthorhombic, but only imperfectly made out. Cf. also Breith., l. c., and Köchlin, Min. Mitth., **9**, 29, 1887.

**1.**



Alexander Co., N. C., W.[9]

**250. RUTILE.** Schorl rouge *de Lisle*, Crist., **2**, 421, 1783: *v. Born.*, Cat. de Raab, **1**, 168, 1790. Rother Schorl pt., Titankalk, *Klapr.*, Beitr., **1**, 233, 1795 (discov. of metal Titanium). Red Schorl *Kirw.*, Min., **1**, 271, 1794. Titanite, id., **2**. 329. 1796 [not Titanite *Klapr.*, 1794 = Sphene]. Schorl rouge, Sagenite, *Saussure*, Alpes, **4**, § 1894, 1796. Crispite (fr. Crispalt, St. Gothard) *Delameth.*, T. T., **2**, 333, 1797. Rutil *Wern.*, 1800, Ludwig's Wern, **1**, 55, 1803. Titane oxydé *H.*, Tr., 1801. Edisonite *W. E. Hidden*, Am. J. Sc., **36**, 272, 1888.

Schwarzer Granat *Lampadius*, Samml., **2**, 119, 1797. Eisenhaltiges Titanerz (fr. Oláhpian) *Klapr.*, Beitr., **2**, 235, 1797 = Nigrin *Karst.*, Tab., 56, 79, 1800. Ilmenorutile *Koksharov*, Min. Russl., **2**, 352, 1854.

Tetragonal. Axis $\dot{c}$ = 0·644154; 001 ∧ 101 = 32° 47′ 16″ Miller[1].

**Forms**[2]:
*c* (001, *O*)
*a* (100, *i-i*)
*m* (110, *I*)
*i* (810, *i*-8)[5]
*u* (710, *i*-7)
*x* (410, *i*-4)
*l* (310, *i*-3)
*ψ* (940, *i*-$\frac{9}{4}$)[8]
*h* (210, *i*-2)
*Q* (530, *i*-$\frac{5}{3}$)[8]
*r* (320, *i*-$\frac{3}{2}$)
*k* (430, *i*-$\frac{4}{3}$)[4]
*d* (508, $\frac{5}{8}$-*i*)[5]
*e* (101, 1-*i*)
*v* (301, 3-*i*)
*φ* (902, $\frac{9}{2}$-*i*)[11]
*w* (501, 5-*i*)[3]
*α* (227, $\frac{2}{7}$)[9]
*β* (112, $\frac{1}{2}$)[9]
*δ* (223, $\frac{2}{3}$)[9]
*s* (111, 1)
*μ* (998, $\frac{9}{8}$)
*ρ* (221, 2)
*σ* (441, 4)[6]
*η* (518, $\frac{5}{8}$-5)[5]
*n* (515, 1-5)[5]
*t* (313, 1-3)
*ν* (525, 1-$\frac{5}{2}$)[7]
*g* (212, 1-2)[4]
*ζ* (531, 5-$\frac{5}{3}$)[6]
*f* (323, 1-$\frac{3}{2}$)
*z* (321, 3-$\frac{3}{2}$)
*τ* (651, 6-$\frac{6}{5}$)[6]
*γ* (989, 1-$\frac{9}{8}$)[9]

*ai* = 7° 7½′
*au* = 8° 8′
*ax* = 14° 2′
*al* = 18° 26′
*ah* = 26° 34′
*aQ* = 30° 58′
*ar* = 33° 41′

*ee′* = 45° 2′
*vv′* = 77° 48′
*ww′* = 84° 57′

*dd″* = 43° 51½′
*ee″* = *65° 34′ 32″
*vv″* = 125° 17′
*ww″* = 145° 30′

*ss′* = 56° 52½′
*ρρ′* = 76° 37′
*ss″* = 84° 40′
*μμ″* = 91° 24′
*ρρ″* = 122° 29′

*cα* = 14° 35′

*cβ* = 24° 29′
*cδ* = 31° 16′
*cs* = 42° 20′
*cρ* = 61° 14′
*cσ* = 74° 39′

*ct* = 34° 10
*cg* = 35° 46½′
*cf* = 37° 45′
*cz* = 66° 42′
*nn′* = 35° 28′

$nn^{vii}$ = 12° 22′
*tt′* = 29° 6′
$tt^{vii}$ = 20° 28′
*gg′* = 21° 18′
$gg^{vii}$ = 30° 18′
*ff′* = 13° 47′
$ff^{vii}$ = 39° 42′
*zz′* = 20° 45′
$zz^{vii}$ = 61° 16′
*mt* = 36° 23′
*mz* = 25° 45½′

Twins[10]: tw. pl. (1) *e*, often geniculated; also contact-twins of very varied habit, sometimes sixlings and eightlings. (2) *v* (301) rare, contact-twins (f. 9); rarely both methods observed in the same crystal; sometimes shows tw. lamellæ[11] ‖ *e*, also[11] ‖ 902. Crystals commonly prismatic, vertically striated or furrowed; often slender acicular. Occasionally compact, massive.

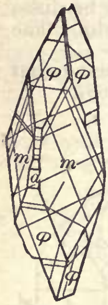
Cleavage: *a* and *m* distinct; *s* in traces. Parting due to twinning ‖ 902[11]. Fracture subconchoidal to uneven. Brittle. H. = 6–6·5. G. = 4·18–4·25; also to 5·2. Luster metallic-adamantine. Color reddish brown, passing into red; sometimes yellowish, bluish, violet, black, rarely grass-green; by transmitted light deep red. Streak pale brown. Transparent to opaque. Optically +. Double refraction strong. Refractive indices high: $\omega_y$ = 2·6158, $\epsilon_y$ = 2·9029 for Na, Bärwald[12]. Sometimes abnormally biaxial, cf. Mld[13].

**Comp., Var.**—Titanium dioxide, $TiO_2$ = Oxygen 40·0, titanium 60·0 = 100. A little iron is usually present, sometimes up to 10 p. c.

**Var.**—1. *Ordinary.* Brownish red and other shades, not black. G. = 4·18–4·25. Transparent quartz is sometimes penetrated thickly with acicular or capillary crystals, and this variety is the *Sagenite* (fr. *σαγήνη*, a net), also named *Crispite*. Dark smoky quartz penetrated with the acicular rutile is apparently the *Veneris crinis* of Pliny (Flêches d'amour *Fr.*, or Venus hair-stone). Acicular crystals often implanted in parallel position on tabular crystals of hematite; also somewhat similarly on magnetite.

*Edisonite* (l. c.) was supposed to be an independent orthorhombic form of $TiO_2$, though approximating closely in angle to rutile ("un mineral qui paraît offrir une forme dimorphe du rutile," Dx., Bull. Soc. Min., 9, 184, 1886). There can be no doubt, however, that it is similar to the forms from the Ural and from Snarum (f. 2), described by Mügge[11], peculiar in showing a parting ‖ $\phi$ (902), $\phi\phi^{iv}$ ($902 \wedge 90\bar{2}$) = 38° 4′. Found very sparingly in the gold washings of Polk Co., N. C. Named after the inventor, Thomas A. Edison.

2.



3.

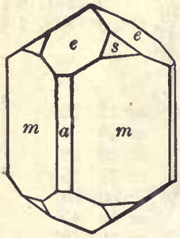
2, Form with parting ‖ 902, Mgg. 3, Pseudomorph after hematite, Binnenthal, Rath.

2. *Ferriferous.* (*a*) *Nigrine.* Color black, whence the name. Contains 2 to 3 p. c. of $Fe_2O_3$. But as ordinary rutile has 1 to 2 p. c., the distinction is very small. G. = 4·249, Oláhpian; 4·242 Freiberg. A jet-black rutile from St. Peter's Dome, Colorado, with 3·77 p. c. FeO (Eakins), and G. = 4·288, belongs here, cf. W. B. Smith, Proc. Col. Soc., 2, 175, 1887. Another black rutile from Colorado closely resembles common twins of cassiterite.

(*b*) *Ilmenorutile.* A black variety from the Ilmen Mts., containing up to 10 p. c. or more of $Fe_2O_3$, and having G. = 5·074–5·133. Cf. Erem.[3], also Kk., Min. Russl., 5, 193.

A black rutile occurring in the granite of the Black Hills, Dakota, is in twin crystals, prismatic and orthorhombic in habit by extension of two pyramidal faces (*s*); it has G. = 5·29-5·31, and contains 8·01 p. c. FeO and 1·35 $SnO_2$ according to W. P. Headden (Am. J. Sc., 41, 249, 1891). A similar form has been described by Miklucho-Maclay, Jb. Min., 2, 88, 1885.

4



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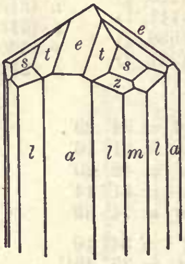

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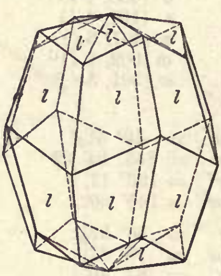

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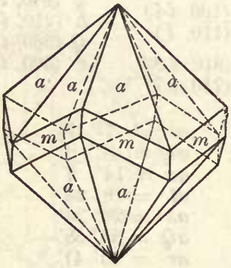

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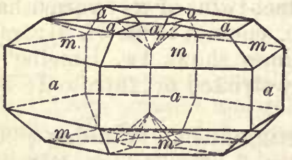

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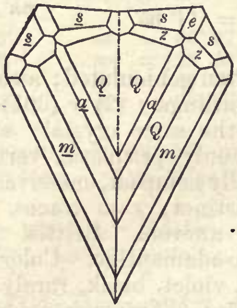

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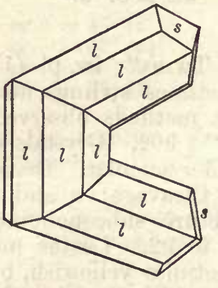


Figs. 4, 5, Common forms. 6, Magnet Cove, Rath. 7, 8, Graves Mt., Rose. 9, Alexander Co., N. C., Rath. 10, Geniculated twin.

3. *Chromiferous.* Titane oxydé chromifère *H.* A grass-green variety, containing chrome, which gives the color Cf. below, also Arzruni, Zs. Kr., 8, 334, 1883.

**Pyr., etc.**—B.B. infusible. With salt of phosphorus gives a colorless bead, which in R F assumes a violet-color on cooling. Most varieties contain iron, and give a brownish yellow or red bead in R.F., the violet only appearing after treatment of the bead with metallic tin on charcoal. Insoluble in acids; made soluble by fusion with an alkali or alkaline carbonate. The solution containing an excess of acid, with the addition of tin-foil, gives a beautiful violet color when concentrated.

**Obs.**—Rutile occurs in granite, gneiss, mica slate, and syenitic rocks, and sometimes in granular limestone and dolomite; common, as a secondary product, in the form of microlites in many slates. It is generally found in embedded crystals, often in masses of quartz or feldspar, and frequently in acicular crystals penetrating quartz; also in phlogopite (wh. see), and has been observed in diamond. It has also been met with in hematite and ilmenite, rarely in chromite. It is common in grains or fragments in many auriferous sands.

Prominent localities are: at Arendal and Kragerö in Norway; Horrsjöberg, Sweden, with lazulite and cyanite; Saualpe, Carinthia; in the Urals; in Tyrol; at St. Gothard; Binnenthal; at Yrieux, near Limoges in France; Krummhennersdorf, near Freiberg; in Castile, in geniculated crystals, often large; at Ohlapian in Transylvania, *nigrine* in pebbles; in large crystals in Perthshire, Scotland; at Crianlarich, at Craig Calleach near Killin, and on Benygloe; in Donegal Co., Ireland. A variety from Karingsbricka in Sweden contains, according to Ekeberg (Ak. H., Stockh., 46, 1803), 3 p. c. of chrome, and is the *titane oxydé chromifère* of Haüy; *grass-green* needles, supposed to be chromiferous, have been found in the Swiss Alps. The *Ilmenorutile* is from the phenacite and topaz mine of the Ilmen Mts., in the Ural.

In *Maine*, at Warren, along with tremolite and chalcopyrite. In *N. Hamp.*, sparingly at Lyme, with tourmaline; near Hanover, acicular crystals in quartz, only in loose masses. In *Vermont*, at Waterbury, Bristol, Dummerston, and Putney; also in loose bowlders in middle and northern Vermont, acicular, some specimens of great beauty in transparent quartz. In *Mass.*, at Barre, in gneiss, crystals occasionally an inch and a half in diameter; at Windsor, in feldspar veins intersecting chlorite slate; at Shelburne, in fine crystals in mica slate; at Leyden, with scapolite; at Conway, with gray epidote. In *Conn.*, at North Guilford; at Lane's mine, Monroe, and in the adjoining town of Huntington. In *N. York*, in Orange Co., 1 m. E. of Edenville, with pargasite in limestone bowlders; 2 m. E. of Warwick, in granite with zircon; 1 m. E. of Amity, in quartz with brown tourmaline, and 2 m. W., with spinel and corundum, and also 2 m. S.W., with red spinel and chondrodite; near Warwick, in slender prisms penetrating quartz; in N. York Co., at Kingsbridge, in veins of quartz, feldspar, and mica traversing granular limestone; in the limestone of Essex Co. In *Penn.*, in fine long crystals, at Sadsbury, Chester Co., and the adjoining district in Lancaster Co.; at Parksburg, Concord, West Bradford, and Newlin, Chester Co.; at the Poor House quarry, Chester Co., in delicate crystals, sometimes iridescent, on dolomite. In *N. Jersey*, at Newton, with spinel. In *N. Car.*, at Crowder's Mountain; at Stony Point, Alexander Co., in splendent crystals of varied habit with dolomite, muscovite, hiddenite, emerald, etc. In *Georgia*, in Habersham Co.; in Lincoln Co., at Graves' Mountain, with lazulite in large and splendent crystals, some $3\frac{1}{2}$ by $2\frac{3}{4}$ in. In *Arkansas*, at Magnet Cove, commonly in twins with brookite and perovskite, also as paramorphs after brookite. In *Colorado* and *Dakota*, as noted above.

In *Canada*, small crystals, with hematite at Sutton, Quebec; in the ilmenite of Bay St. Paul, orange translucent grains, pure $TiO_2$, and probably rutile or brookite.

**Artif.**—Formed in crystals by heating together to redness titanic acid and protoxide of tin, and then heating the mass with silica to a cherry-red heat (Deville); by the action of steam on fluoride or chloride of titanium (Daubrée, Hautefeuille). Hautefeuille observes that in this process crystals of *rutile* are formed when the heat used is red heat; of *brookite*, when it is between that required for volatilizing cadmium and zinc; and of octahedrite, when the heat is a little below that required for the volatilization of cadmium.

Has been observed in crystals as a furnace product by Scheerer.

**Alt.**—Observed as a paramorph after brookite, also pseudomorph after hematite. Cf. Rath, Jb. Min., 397, 1876, Zs. Kr., **1**, 13, 1877. Also altered to ilmenite, Lsx., Zs. Kr., **8**, 55, 1883.

**Ref.**—[1] Phil. Mag., **17**, 268, 1840; the measurements of Koksharov agree very closely, viz.: $ce = 32° 47' 20''$, $\dot{c} = 0·64418$, Min. Russl., **1**, 50. Zeph. obtained $ce = 32° 47'$, $\dot{c} = 0·64404$, Zs. Kr., **6**, 238, 1881. Washington obtained from fine N. Carolina crystals $ce = 32° 47' 30''$, $\dot{c} = 0·64425$, Am. J. Sc., **33**, 501, 1887. These angles show great constancy for the species.

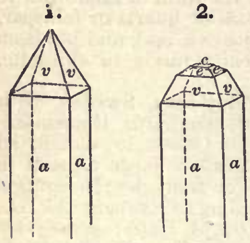
[2] See Kk., l. c. Dx., Ann. Ch. Phys., **13**, 436, 1845. Haid., Ber. Ak. Wien, **39**, 5, 1860. Hbg., Min. Not., **1**, 30, **2**, 11, 1858, **5**, 25, 1863. Arzruni (list of planes, literature, etc.), Zs. Kr., 8, 336, 1883. [3] Erem., ilmenorutile, Vh. Min. Ges., **4**, 201, 1869, **6**, 376. 1871; Bull. Ac. St. Pet., **24**, 534, 1876. [4] Zeph., Stillup Thal, l. c. [5] Arzruni, l. c. [6] Schrauf, Brazil, Zs. Kr., **9**, 461, 1884. [7] Rinne, Binnenthal, Jb. Min., **2**, 20, 1885. [8] Rath, Alexander Co., N. C., Ber. nied Ges., May 3, 1886. [9] Hidden and Washington, Stony Pt., N. C., l. c.

[10] Dx., l. c.; also the valuable paper by Rose, Pogg., **115**, 643, 1862; Rath, l. c., and Magnet Cove, Zs. Kr., **1**, 13, 1877; Dx., Min., **2**, 197, 1874. [11] Mgg., Jb. Min., **1**, 221, 1884, **1**, 147, 1886, **1**, 231, 1889. [12] Zs. Kr., **7**, 167, 1882. [13] Ann. Mines, **10**, 134, 1876; cf. also Lsx., Zs. Kr., **8**, 67, 1883.

ISERITE *Janovsky*, Ber. Ak. Wien, **80** (1), 34, 1886. Found among the black grains of the so-called "iserin" of the Iserwiese, Bohemia. Distinguished from the true iserin by the absence of conchoidal fracture and the brown color. In thin fragments honey-yellow. Crystalline form like rutile, occasionally in twins; cleavage imperfect. G. = 4·52. Analysis. $TiO_2$ 69·51 ($\frac{2}{2}$), FeO 28·67 ($\frac{2}{2}$), MnO 1·41, MgO 0·32, $Nb_2O_5$, $SiO_2$ 0·44 = 100·45. This corresponds to the formula: $FeTi_2O_5$.

**251. PLATTNERITE.** Schwerbleierz *Breith.*, J. pr. Ch., **10**, 508, 1837. Plattnerit *Haid.*, Handb., 504, 1845. Braunbleioxyd *Hausm.*, Handb., 202, 1847.

Tetragonal. Axis $\dot{c} = 0{\cdot}67643$; 001 ∧ 101 = 34° 4½′ Ayres[1].



Figs. 1, 2, Idaho, Ayres.

**Forms:** *c* (001, *O*); *a* (100, *i-i*); *e* (101, 1-*i*), *v* (301, 3-*i*); *x* (332, $\frac{3}{2}$). Angles: *ee′* = 46° 41′, *vv′* = 78° 44′, *ee″* = 68° 9′, *vv″* = *127° 32′, *cx* = 55° 8′, *vx* = 39° 22′.

Rarely in crystals, habit prismatic; usually massive; sometimes in globular or mammillary forms.

Cleavage not observed. Fracture subconchoidal to uneven. Brittle. H. = 5–5·5. G. = 8·5. Luster submetallic. Color iron-black. Streak chestnut-brown. Translucent to nearly opaque. Optically negative[2].

**Comp.**—Lead dioxide, $PbO_2$ = Oxygen 13·4, lead 86·6 = 100.

**Anal.**—1, E. Kinch, Min. Mag., **7**, 63, 1886. 2, W. S. Yeates, priv. contr. Also H. A. Wheeler (G. = 9·41), Am. J. Sc., **38**, 79, 1889, and J. D. & E. N. Hawkins (G. = 7·25), ib., p. 165.

| | | Pb | O | |
|---|---|---|---|---|
| 1. Leadhills | G. = 8·54 | 86·01 | 12·85 | $H_2O, CO_2, Fe_2O_3, CaO$ *tr.* |
| 2. Idaho | G. = 8·56 | 83·20 | 12·93 | $(Fe,Al)_2O_3$ 1·71, Cu 0·14, Ag *tr.*, insol. 0·82 = 98·80. |

**Pyr.**—B.B. fuses at 2, giving off oxygen; yields metallic lead on charcoal. Soluble in acids.

**Obs.**—Described by Plattner (G. = 9·39–9·45) on specimens probably from Leadhills, Scotland, apparently pseudomorphous after pyromorphite. Later identified from Leadhills with cerussite and pyromorphite, and from Wanlockhead (G. = 9·27, Heddle). Also recently obtained, massive, rarely in crystals (figs. 1, 2), at the "As You Like" mine, Mullan, Cœur d'Alene Mts., Idaho, with pyromorphite, limonite, and quartz.

Named for the mineralogist, K. Fr. Plattner (1800–1858).

**Ref.**—[1] E. F. Ayres, priv. contr. [2] Michel, artif. cryst., Bull. Soc. Min., **13**, 56, 1890.

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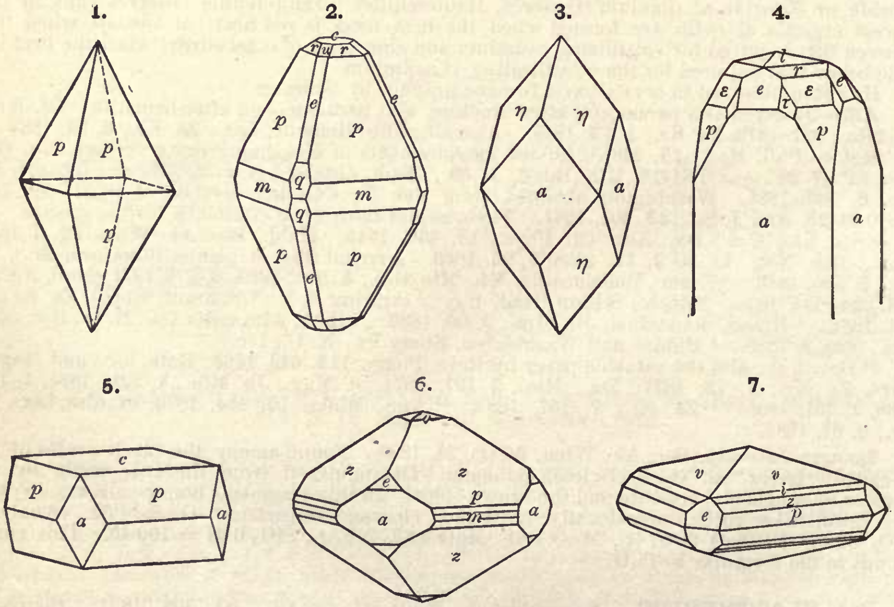
**252. OCTAHEDRITE.** Schorl bleu indigo (fr. Oisans) *Bourn.*, de Lisle's Crist., **2**, 406, 1783; Schorl octaèdre rectangulaire *id.*, J. Phys., **30**, 386, 1787. Octaëdrite *Sauss.*, Alpes, § 1901 1796. Oktaëdrit *Wern.*, 1803, Ludwig's Wern., **2**, 218, 1804. Oisanite *Delameth.*, T. T., **2**, 269, 1797; *H.*, J. Mines, **5**, 273, 1799. Anatase *H.*, Tr., **3**, 1801. Dauphinit.

Tetragonal. Axis $\dot{c} = 1{\cdot}7771$; 001 ∧ 101 = *60° 38′ Miller[1].



Figs. 1, 2, Bourg d'Oisans. 3, 4, Binnenthal, Klein. 5, Brazil, Dx. 6, Binnenthal, Zeph. 7, Binnenthal, Klein.

**Forms**[2]
$c$ (001, $O$)

$a$ (100, $i$-$i$)
$m$ (110, $I$)

$o$ (107, $\frac{1}{7}$-$i$)
$u$ (105, $\frac{1}{5}$-$i$)
$u_1$ (5·0·19, $\frac{5}{19}$-$i$)[6]
$x$ (103, $\frac{1}{3}$-$i$)[7 8]
$e$ (101, 1-$i$)
$q$ (201, 2-$i$)
$d$ (301, 3-$i$)

$\gamma$ (902, $\frac{9}{2}$-$i$)[8]
$g$ (701, 7-$i$)[9]
$E$ (801, 8-$i$)[5]

$\rho$ (1·1·40, $\frac{1}{40}$)[11]
$\nu$ (1·1·28, $\frac{1}{28}$)[11]?
$\mu$ (1·1·14, $\frac{1}{14}$)
$l$ (1·1·10, $\frac{1}{10}$)
$\alpha$ (119, $\frac{1}{9}$)[3]
$\pi$ (118, $\frac{1}{8}$)[3]
$v$ (117, $\frac{1}{7}$)
$v_1$ (3·3·20, $\frac{3}{20}$)[9]

$i$ (116, $\frac{1}{6}$)[4]
$r$ (115, $\frac{1}{5}$)
$f$ (114, $\frac{1}{4}$)
$f_1$ (5·5·19, $\frac{5}{19}$)[4]
$n$ (227, $\frac{2}{7}$)
$z$ (113, $\frac{1}{3}$)
$\psi$ (225, $\frac{2}{5}$)
$\Psi$ (5·5·12, $\frac{5}{12}$)[6]
$\chi$ (337, $\frac{3}{7}$)
$k$ (112 $\frac{1}{2}$)
$X$ (5·5·11, $\frac{5}{11}$)[6]

$\epsilon$ (335, $\frac{3}{5}$)[3]
$\eta$ (223, $\frac{2}{3}$)[3]
$p$ (111, 1)
$w_1$ (15·15·8, $\frac{15}{8}$)
$w$ (221, 2)
$\delta$ (331, 3)

$t$ (21·1·3, 7-21)[7]
$D$ (11·1·4, $\frac{11}{4}$-11)[10]
$\omega$ (39·4·6, $\frac{13}{2}$-$\frac{39}{4}$)[8,9]
$B$ (17·3·2, $\frac{17}{2}$-$\frac{17}{3}$)
$s$ (5·1·20, $\frac{1}{4}$-5)?

$s_1$ (5·1·19, $\frac{5}{19}$-5)
$h$ (513, $\frac{5}{3}$-5)[11]
$b$ (3·1·13. $\frac{3}{13}$-3)[11]
$\phi$ (319, $\frac{1}{3}$-3)[3]
$\tau$ (313, 1-3)[3]
$\beta$ (526, $\frac{5}{6}$ $\frac{5}{2}$)?
$y$ (9·4·12, $\frac{3}{4}$-$\frac{9}{4}$)[11]?
$\sigma$ (2·1·10, $\frac{1}{5}$-2)[11]
$C$ (5 3·20, $\frac{1}{4}$-$\frac{5}{3}$)?
$\vartheta$ (532, $\frac{5}{2}$-$\frac{5}{3}$)[3].

$oo' = 20°\ 2\frac{1}{2}'$
$uu' = 27°\ 24'$
$xx' = 42°\ 15'$
$ee' = 76°\ 5'$
$qq' = 85°\ 48'$
$dd' = 88°\ 3'$

$oo'' = 28°\ 29'$
$uu'' = 39°\ 8'$
$xx'' = 61°\ 17'$

$ee'' = 121°\ 16'$
$qq'' = 148°\ 34'$
$dd'' = 158°\ 45'$

$ll' = 19°\ 51'$
$vv' = 27°\ 39'$
$rr' = 37°\ 2'$
$zz' = 54°\ 1'$
$kk' = 67°\ 11'$
$\eta\eta' = 74°\ 46'$

$pp' = 82°\ 9'$

$ll'' = 28°\ 13'$
$vv'' = 39°\ 30'$
$ii'' = 45°\ 27'$
$rr'' = 53°\ 22'$
$ff' = 64°\ 17'$
$zz'' = 79°\ 54\frac{1}{2}'$
$kk'' = 102°\ 58\frac{1}{2}'$
$\epsilon\epsilon'' = 112°\ 54'$

$\eta\eta'' = 118°\ 20'$
$pp'' = 136°\ 36'$
$ww'' = 157°\ 30'$
$\delta\delta'' = 164°\ 53'$

$ss^{vii} = 9°\ 17'$
$\phi\phi^{vii} = 19°\ 17'$
$\tau\tau^{vii} = 32°\ 24'$
$\vartheta\vartheta' = 27°\ 33'$
$\vartheta\vartheta^{vii} = 60°\ 41'$

Commonly octahedral in habit, either acute ($p$) or obtuse ($v$); also tabular, $c$ predominating; rarely prismatic crystals; frequently highly modified.

Cleavage: $c$ and $p$ perfect. Fracture subconchoidal. Brittle. H. = 5·5–6. G. = 3·82–3·95; sometimes 4·11–4·16 after heating. Luster adamantine or metallic-adamantine. Color various shades of brown, passing into indigo-blue, and black; greenish yellow by transmitted light. Streak uncolored. Transparent to nearly opaque. Optically −. Double refraction rather strong. Indices $\omega_y = 2·554$, $\epsilon_y = 2·493$ Mlr. Sometimes abnormally biaxial, cf. Mld[12].

**Comp.**—Titanium dioxide, $TiO_2$ = Oxygen 40·0, titanium 60·0 = 100.

**Pyr., etc.**—Same as for rutile.

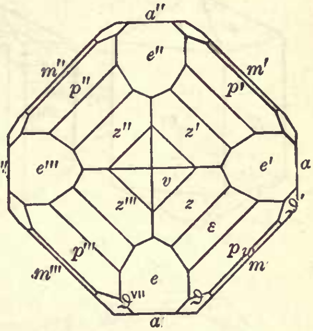
**Obs.**—Most abundant at Bourg d'Oisans, in Dauphiné, with feldspar, axinite, and ilmenite. Found in mica slate in the Grisons; in Bavaria; near Hof in the Fichtelgebirge; Norway; the Urals; in chlorite in Devonshire, near Tavistock; with brookite at Tremadoc, in North Wales; in Cornwall, near Liskeard and at Tintagel Cliffs; in Brazil in quartz, and in detached crystals so splendent as to be sometimes mistaken for diamonds.

In Switzerland in the Binnenthal the variety *wiserine*, long supposed to be xenotime, but correctly determined by Klein (l. c.); also in Cavradi, Tavetsch; Rauris, Salzburg in the Eastern Alps, also at Pfitsch Joch.

In the U. States, at the Dexter lime rock, Smithfield, R. I., in dolomite; in the washings at Brindletown, Burke Co., N. C., in transparent tabular crystals.

De Saussure's name *octahedrite* has the priority, and is particularly appropriate, the crystals being usually octahedrons. Haüy's *anatase* is No. 3 in order of time, and was brought forward after he had once adopted for a while Delametherie's name *oisanite;* it is from ἀνάτασις, *erection*, and was intended to signify, as Haüy says, that the common octahedron was longer than that of other tetragonal species; but *length* is not in the meaning of the Greek word.

8.



Binnenthal, after Zeph.

**Artif.**—Formed in crystals by the action of steam on chloride or fluoride of titanium (Daubrée); by the action of a stream of hydrochloric acid gas on $TiO_2$ (Deville); by fusing $TiO_2$ with salt of phosphorus B.B. in R.F., and then exposing the bead to the point of the blue flame, when minute transparent crystals of octahedrite separate (G. Rose).

**Ref.**—[1] Min., p. 229. [2] Klein gives list of planes, authorities, calculated angles, etc., Jb. Min., 337, 1875. See too Dx., Min., **2**, 200, 1874, and earlier (Brazil) Ann. Ch. Phys., **10**, 418, 1844. [3] Klein, Binnenthal, l. c., and ibid., 900, 1872. [4] Brz. on "wiserine," Min. Mitth., 7, 1872. [5] Klein, Jb. Min., 852, 1875. [6] Groth, Min.-Samml. Strassb., 108, 1878. [7] Vrba, Rauris, Zs. Kr., **5**, 417, 1881. [8] Slg., Binnenthal, Jb. Min, **2**, 269, 1881, **2**, 281, 1882; see also Zeph. [9] Zeph., Lotos, 1880, and Jb. Min., **2**, 325, ref., 1881; Zs. Kr., **6**, 240, 1882. [10] Wein, Zs. Kr., **8**, 532, 1884. [11] Slg., Zs. Kr., **11**, 337, 1886. [12] Ann. Mines, **10**, 137, 1876.

**253. BROOKITE.** Jurinite *Soret*, 1822. Brookite *Lévy*, Ann. Phil., **9**, 140, 1825. Arkansite *Shephard*, Am. J. Sc., **2**, 250, 1846.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}84158 : 1 : 0{\cdot}94439$ Koksharov[1].
$100 \wedge 110 = 40° \ 5'$, $001 \wedge 101 = 48° \ 17\frac{2}{3}'$, $001 \wedge 011 = 43° \ 21\frac{2}{3}'$.

**Forms:**
*a* (100, $i\text{-}\bar{\imath}$)[2]
*b* (010, $i\text{-}\breve{\imath}$)[2]
*c* (001, *O*)[2]

*N* (710, $i\text{-}\bar{7}$)[5]
*g* (23·4·0, $i\text{-}\overline{\tfrac{23}{4}}$)[1]?
*p* (11·2·0, $i\text{-}\overline{\tfrac{11}{2}}$)[1]?
*k* (410, $i\text{-}\bar{4}$)[3]

*β* (320, $i\text{-}\overline{\tfrac{3}{2}}$)[8]
*l* (210, $i\text{-}\bar{2}$)[3]
*m* (110, *I*)[2]
*φ* (120, $i\text{-}\breve{2}$)[12]

*y* (104, $\tfrac{1}{4}\text{-}\bar{\imath}$)[2]
*x* (102, $\tfrac{1}{2}\text{-}\bar{\imath}$)[2]
*ψ* (012, $\tfrac{1}{2}\text{-}\breve{\imath}$)[13]
*δ* (011, $1\text{-}\breve{\imath}$)[8]

*d* (043, $\tfrac{4}{3}\text{-}\breve{\imath}$)[2]
*t* (021, $2\text{-}\breve{\imath}$)[2]

*z* (112, $\tfrac{1}{2}$)[2]
*o* (111, 1)[3]
*r* (221, 2)[1]

*v* (326, $\tfrac{1}{2}\text{-}\overline{\tfrac{3}{2}}$)[4]
*s* (322, $\tfrac{3}{2}\text{-}\overline{\tfrac{3}{2}}$)[1]

*u* (784, $2\text{-}\overline{\tfrac{8}{7}}$)[1]?
*ζ* (3·4·12, $\tfrac{1}{3}\text{-}\breve{\tfrac{4}{3}}$)[7]
*i* (342, $2\text{-}\overline{\tfrac{4}{3}}$)[3]
*Q* (234, $\tfrac{3}{4}\text{-}\breve{\tfrac{3}{2}}$)[10]
*χ* (124, $\tfrac{1}{2}\text{-}\breve{2}$)[5]
*e* (122, $1\text{-}\breve{2}$)[2]
*n* (121, $2\text{-}\breve{2}$)[3]

*θ* (5·14·18, $\tfrac{7}{9}\text{-}\breve{\tfrac{14}{5}}$)[4]
*ϵ* (134, $\tfrac{3}{4}\text{-}\breve{3}$)[8]
*q* (132, $\tfrac{3}{2}\text{-}\breve{3}$)[9]
*f* (3·10·2, $5\text{-}\breve{\tfrac{10}{3}}$)[1]
*w* (272, $\tfrac{7}{2}\text{-}\breve{\tfrac{7}{2}}$)[3]
*λ* (142, $2\text{-}\breve{4}$)[9]
*h* (151, $5\text{-}\breve{5}$)[3]

The symbol of the plane *θ* (5·14·18) has been established by several observers. Dx.[8] adds the vicinal planes near *ϵ*, *λ* (9·22·30 or 6·15·20) and *δ* (5·14·18 or 5·13·16). Schrauf[6], who makes the species monoclinic, gives $\mathfrak{e}$ (940, $i\text{-}\overline{\tfrac{9}{4}}$), $\mathfrak{a}$ (320, $i\text{-}\overline{\tfrac{3}{2}}$); $\mathfrak{r}$ (089, $\tfrac{8}{9}\text{-}\breve{\imath}$); $\pm\mathfrak{p}$ (9·4·18, $\pm\tfrac{1}{2}\text{-}\overline{\tfrac{9}{4}}$), $\pm\mathfrak{g}$ (949, $\pm 1\text{-}\overline{\tfrac{9}{4}}$); *P* (7·5·14, $-\ \tfrac{1}{2}\text{-}\overline{\tfrac{7}{5}}$); $\pm\mathfrak{r}$ (349, $\pm\ \tfrac{4}{9}\text{-}\breve{\tfrac{4}{3}}$), $\pm\mathfrak{q}$ (343, $\pm\ \tfrac{4}{3}\text{-}\breve{\tfrac{4}{3}}$); *Σ* ($\bar{2}$56, $+\ \tfrac{5}{6}\text{-}\breve{\tfrac{5}{2}}$), *Δ* ($\bar{4}$·10·1 3 $+\ \tfrac{10}{13}\text{-}\breve{\tfrac{5}{2}}$); *D* (4·11·14, $-\ \tfrac{11}{14}\text{-}\breve{\tfrac{11}{4}}$); *Ω* (1·22·12, $+\ \tfrac{11}{6}\text{-}22$).

*kk'''* = 23° 46′
*ll'''* = 45° 38½′
*mm'''* = *80° 10′
*φφ'* = 61° 26′

*yy'* = 31° 20½′
*xx'* = 58° 35½′

*ψψ'* = 50° 33′
*δδ'* = 86° 43½′
*dd'* = 103° 5′
*tt'* = 124° 12′

*cz* = 36° 15′
*co* = 55° 43′
*cr* = 71° 10½′
*cχ* = 28° 47′
*ce* = 47° 41′
*cn* = 65° 31½′

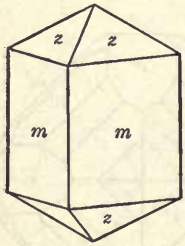
*zz'* = 53° 48′
*oo'* = 78° 25′
*rr'* = 92° 48′
*χχ'* = 28° 28′
*ee'* = 44° 23′

*ii'* = 76° 27′
*nn'* = 55° 24′
*λλ'* = 29° 25′
*QQ'* = 49° 12′
*ϵϵ'* = 25° 47′

*χχ'''* = 48° 54′
*ϵϵ'''* = 68° 35′
*ss'''* = 51° 30′
*vv'''* = 30° 42′
*zz'''* = 44° 46′

*ee'''* = *78° 57′
*qq'''* = 102° 1′
*QQ'''* = 63° 24½′
*λλ'''* = 117° 29′
*oo'''* = 64° 17′
*nn'''* = 102° 58½′
*ww'''* = 131° 6′
*hh'''* = 144° 41′
*me* = 45° 42′
*mt* = 55° 19′

1.



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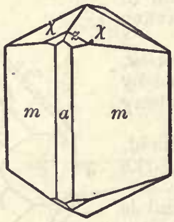

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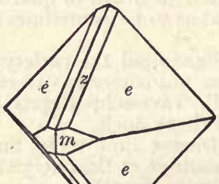

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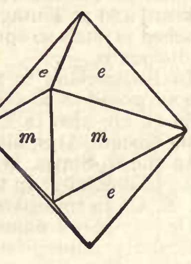

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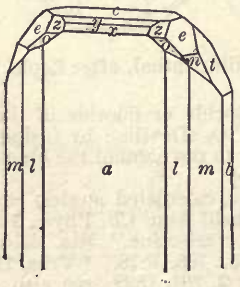

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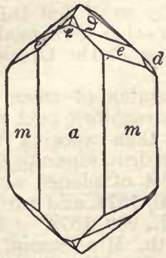

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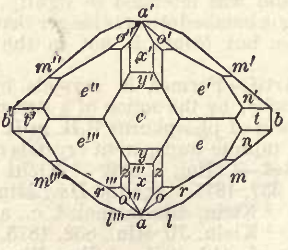


Figs. 1–4, Magnet Cove, *Arkansite*[12]. 5, Ellenville. 6, Tremadoc, Rath. 7, Miask, after Kk.

Only in crystals. Habit varied, often tabular ‖ $a$; faces $a$, and prismatic faces striated vertically. Also prismatic ($m$), sometimes simulating rutile (f. 1); faces $z$, $\chi$ often striated ‖ their intersection-edge. Sometimes in forms with $e$ and $m$, nearly hexagonal (f. 4); since $me = ee'$ nearly, also $mm'''$ and $ee'''$.

Cleavage: $m$ indistinct; $c$ still more so. Fracture subconchoidal to uneven. Brittle. H. = 5·5–6. G. = 3·87–4·01 Tremadoc; 3·96, 4·07 Magnet Cove, Rath; 4·084 Magnet Cove, Pfd. Luster metallic-adamantine to submetallic. Color hair-brown, yellowish, reddish, reddish brown, and translucent; also brown to iron-black, opaque. Streak uncolored to grayish or yellowish.

Optically +. Bx ⊥ $a$. Ax. pl. for red and yellow ‖ $c$; for green and blue ‖ $b$; for yellow-green uniaxial. Rarely ax. pl. for all colors ‖ $c$ with $\rho > v$. A section ‖ $a$ shows four sets of hyperbolic bands. On heating the axes ‖ $b$ approach and those ‖ $c$ open, but temporarily only, unless this is carried carefully to a bright red heat, when the change becomes permanent, Dx.[14] Ax. angles somewhat variable for different localities; as obtained by Zepharovich and Lippich[15]:

$2E_a = 55° 2'$ red, Li 30° 16′ yellow, Na 0° yw.-green 33° 48′ green, Tl

**Var.**—1. *Ordinary.* Thin tabular crystals often highly modified, brilliant luster.

2. *Arkansite.* Stout crystals brown to iron-black; often dull, and on the surface altered by paramorphism to rutile.

**Comp.**—Titanium dioxide, $TiO_2$ = Oxygen 40·0, titanium 60·0 = 100.

**Pyr.**—Same as for rutile.

**Obs.**—Brookite occurs at Bourg d'Oisans in Dauphiné; at St. Gothard, with albite and quartz; Maderaner Thal, Switzerland; in the Ural, district of Zlatoust, near Miask, and in the gold-washings in the Sanarka river and elsewhere; near Markirch in the Vosges, in pseudomorphs after titanite; rarely at Val del Bove, Etna, with rutile; in the gneiss of Beura; at Fronolen near Tremadoc, Wales. In relatively large crystals from the Tyrol, 44 × 39 mm. (Zeph., l. c.)[11].

In the U. S., in thick black crystals (*arkansite*) at Magnet Cove, Ozark Mts., Arkansas, with elæolite, black garnet, schorlomite, rutile, etc.; in small crystals from the gold-washings of North Carolina; at the lead mine of Ellenville, Ulster Co., N. Y., on quartz (f. 5), with chalcopyrite and galena; at Paris, Maine.

Named after the English crystallographer and mineralogist, H. J. Brooke (1771–1857). Jurinite is from the naturalist L. Jurin (1751–1819) of Geneva; Arkansite from the locality.

**Alt.**—Paramorphs of rutile after brookite are not uncommon at Magnet Cove.

**Ref.**—[1] From the Ural, Vh. Min. Ges., 1848–49, 2, and Min. Russl., **1**, 61, 1853; **2**, 273. With some authors $e$ is made 111. [2] Lévy, Ann. Phil., **9**, 140, 1824. [3] Brooke, Snowdon, credited by Mlr. [4] Mlr., Min., 226, 1852. [5] Leuchtenberg, Ural, Vh. Min. Ges., **7**, 82, 1872. [6] Schrauf, Atlas, Tf. XXXIX, 1873, and Ber. Ak. Wien, **74** (1), 535, 1876, see also, Zs. Kr., **1**, 306, 1877, **9**, 444, 1884. [7] Mgc., cf. Dx. [8] Dx., Min., **2**, 203, 1874. [9] Rath, Atliansk, Pogg., **158**, 405, 1876; also ib., **113**, 435, 1861. [10] Groth-Bkg., Maderanerthal, Min. Samml. Strassburg, p. 110, 1878. [11] Zeph., Tyrol, Zs. Kr., **8**, 577, 1884. [12] E. S. D., Magnet Cove, Am. J. Sc., **32**, 314, 1886; also Pfd., ib., **31**, 387, 1886. [13] G. H. Williams, Magnet Cove, priv. contr. [14] Erem., gold-washings, Ural, Zs. Kr., **15**, 542, 1889; also Vh. Min. Ges., **23**, 322, 1887. [15] Dx., l. c., Zeph., l. c. Cf. other observations by Zeph.; also by Schrauf, Zs. Kr., **9**, 444, 1884, who gives $2H_{a.r} = 26°–29°$. Dx. found the axial plane ‖ $c$ with $\rho > v$, for Snowdon crystals.

In addition to the several forms in which the oxide of titanium appears in nature, viz. rutile, octahedrite, brookite, also with iron oxide, ilmenite and pseudobrookite, Riggs has noted a rhombohedral form in thin iron-black scales as inclusions in the tourmaline of Hamburg and De Kalb. It seems to belong to ilmenite, but apparently contains very little iron, not becoming magnetic on heating. Am. J. Sc., **35**, 51, 1888.

EUMANITE *Shepard*, Am. J. Sc., **12**, 211, 1851. Minute crystals occurring with rubellite and microlite in the albite vein of Chesterfield, Mass., suspected to be related to brookite. On the crystalline form, see J. D. D., ib., **12**, 211, 397; **13**, 117, and Syst. Min., 5th Ed., p. 165.

**254. PYROLUSITE.** Lapis manganensis pt. *Cæsalp.*, Metall., 1596. Brunsten = Magnesia pt. *Wall*, 268, 1747; Manganese pt. *Fr. Trl.* Wall., **1**, 483, 1753. Manganaise grise pt. *Forst.*, Cat, 1772. Molybdænum magnesii *Linnæus.* Grau Braunstein pt. *Wern.*, Bergm. J., 386, 1789; id., *Hausm.*, Handb., 288, 1813 Gray Oxyd of Manganese pt.; Anhydrous Binoxyd of Manganese. Mangan Hyperoxyd *Leonh.*, Handb., 240, 1826. Pyrolusite, Prismatic Manganese-Ore, *Haid.*, Trans. R. Soc. Ed., **11**, 136, 1827. Weichbraunstein, Weichmangan, *Germ.* Peroxide of manganese. Manganese dioxide.

Orthorhombic, but perhaps only pseudomorphous (cf. below). Commonly columnar, often divergent; also granular massive, and frequently in reniform coats.

Soft, often soiling the fingers. H. = 2–2·5. G. = 4·82 Turner; 4·73–4·86 Pfd. Luster metallic. Color iron-black, dark steel-gray, sometimes bluish. Streak black or bluish black, sometimes submetallic. Opaque.

**Comp.**—Manganese dioxide, $MnO_2$, like polianite. Commonly contains a little water, it having had usually a pseudomorphous origin (after manganite).

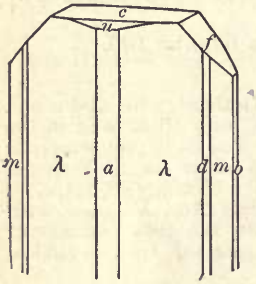
**Anal.**—1–3, Penfield, priv. contr. 4, Jarman, Am. Ch. J., **11**, 39, 1889. Also 5th Ed., p. 166.

| | | MnO | O | $H_2O$ | |
|---|---|---|---|---|---|
| 1. Salisbury | G. = 4·785 | 79·14 | 17·27 | 2·33[a] | CaO 0·25, $SiO_2$ 0·55, L[c] 0·49 = 100·02 |
| 2. " | G. = 4·732 | 78·84 | 17·04 | 2·68[a] | CaO 0·26, $SiO_2$ 0·48, L 0·59 = 99·89 |
| 3. Negaunee | G. = 4·858 | 79·46 | 17·48 | 1·94[a] | CaO 0·56[b], $SiO_2$ 0·18, L 0·31 = 99·93 |
| 4. Augusta Co., Va. | G. = 4·69 | 78·77 | 17·61 | 2·08 | X[d] 1·91 = 99·87 |

[a] Incl. loss at 100°, 0·18, 0·15, 0·17. [b] Incl. 0·38 BaO. [c] L = Limonite.
[d] X = CaO, NiO, CoO, $K_2O$, $Na_2O$, $Fe_2O_3$, insol.

It is uncertain whether pyrolusite is an independent species, with a crystalline form of its own, or only a secondary mineral derived chiefly from the dehydration of manganite; also from polianite (Breith.). Pseudomorphous crystals having distinctly the form of manganite are common (f. 1). Forms have been attributed to pyrolusite in part with prismatic angles of manganite (*mm'''* = 80°), in part with *mm'''* = 86° 20′ Haid. Crystals from Salisbury, Conn., have the form of fig. 2, with *mm'''* ≐ 84° 30′, and another prism, *n*, with *nn'''* = 73° 20; often in skeleton forms, f. 3. Cf. also Köchlin, Min. Mitth., **9**, 34, 1887; and earlier, Haid., l. c.

1.



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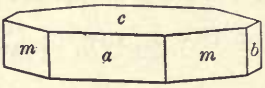

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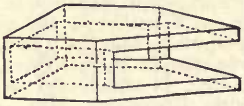

1, Pseudomorph after manganite, Nova Scotia.
2, 3, Pyrolusite, Salisbury, Conn.

**Pyr., etc.**—Like polianite, but most varieties yield some water in the closed tube.

**Obs.**—This ore is extensively worked at Elgersberg near Ilmenau, and other places in Thuringia; at Vorderehrensdorf near Mährish-Trübau, in Moravia, which place annually affords many hundred tons of the ore; at Platten in Bohemia, and elsewhere; near Johanngeorgenstadt; at Hirschberg in Westphalia; Matzka, Transylvania; also found sparingly in Cornwall; in Timor; in Australia; in India.

Occurs in the United States with psilomelane, abundantly in Vermont, at Brandon, Irasburg, Bennington, Monkton, Chittenden, etc., both crystallized and massive; at Conway, Mass., in a vein of quartz; at Plainfield and West Stockbridge, Mass.; at Winchester, N. H.; at Salisbury and Kent, Conn., forming velvet-like coatings on limonite; Crimera and Old Dominion mines, Augusta Co., and elsewhere in Virginia; Pope, Pulaski, Montgomery Cos., Arkansas. In California, on Red island, bay of San Francisco. In New Brunswick, 7 m. fr. Bathurst, in fine cryst.; in Shepody Mtn. and elsewhere; near Upham in King's Co. In Nova Scotia, at Teny cape, cryst. and massive; also at Walton, abundant; near Kentville; Pictou; Amherst; Musquodobit.

The name is from πῦρ, *fire*, and λούειν, *to wash*, because used to discharge the brown and green (FeO) tints of glass; and for the same reason it is whimsically entitled by the French *le savon de verriers*.

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## B. Hydrous Oxides.

**255. Turgite** $2Fe_2O_3.H_2O$

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**Diaspore Group.** $\overset{\text{III}}{R}O(OH)$ or $R_2O_3.H_2O$ Orthorhombic.

$\breve{a} : \bar{b} : \dot{c}$ $\frac{c}{a}$

**256. Diaspore** $Al_2O_3.H_2O$ 0·9372 : 1 : 0·6039 or 0·6443

| | | |
|---|---|---|
| 257. **Göthite** | $Fe_2O_3.H_2O$ | 0·9185 : 1 : 0·6068 or 0·6606 |
| 258. **Manganite** | $Mn_2O_3.H_2O$ | 0·8441 : 1 : 0·5448 or 0·6463 |

| | |
|---|---|
| 259. **Limonite** | $2Fe_2O_3.3H_2O$ |

| | |
|---|---|
| 260. **Xanthosiderite** | $Fe_2O_3.2H_2O$ |
| 261. **Bauxite** | $Al_2O_3.2H_2O$ |

### Brucite Group. $\overset{II}{R}(OH)_2$ or $RO.H_2O$. Rhombohedral.

| | | | |
|---|---|---|---|
| 262. **Brucite** | $MgO.H_2O$ | $rr' = 97° 37\frac{1}{2}'$ | $\acute{c} = 1·5208$ |
| Manganbrucite | $(Mg.Mn)O.H_2O$ | | |
| 263. **Pyrochroite** | $MnO.H_2O$ | $rr' = 94° 52'$ | $\acute{c} \doteq 1·3999$ |

| | | | | |
|---|---|---|---|---|
| | | | $\grave{a}:\bar{b}:\acute{c}$ | $\beta$ |
| 264. **Gibbsite** | $Al(OH)_3$ or $Al_2O_3.3H_2O$ | Monoclinic | 1·7089 : 1 : 1·9184 | 85° 29′ |
| 265. **Sassolite** | $B(OH)_3$ or $B_2O_3.3H_2O$ | Triclinic | $\breve{a}:\bar{b}:\acute{c} = 0·5771 : 1 : 0·5282$<br>$\alpha = 104° 17'$ $\beta = 92° 33'$ $\gamma = 89° 43'$ | |

| | | |
|---|---|---|
| 266. **Hydrotalcite** | $6MgO.Al_2O_3.15H_2O$ | Hexagonal |
| 267. **Pyroaurite** | $6MgO.Fe_2O_3.15H_2O$ | " |

| | | | |
|---|---|---|---|
| | | | $\acute{c}$ |
| 268. **Chalcophanite** | $(Mn,Zn)O.2MnO_2.2H_2O$ | Rhombohedral | 3·5267 |
| 269. **Psilomelane** | $MnO, BaO, MnO_2, H_2O$ | | |

WAD: Bog manganese, asbolite, lampadite.

255. **TURGITE.** Hematite pt. Red Ocher pt. Turgit *Herm.*, Bull. Soc. Nat. Moscow, **1**, 252, 1845. Hydrohæmatit *Breith.*, Handb., 846, 1847. Turjit.

Compact fibrous and divergent, to massive; often botryoidal and stalactitic like limonite. Also earthy, as red ocher.

H. = 5–6. G. = 4·29–4·49, Hof, Breith.; 4·681, Horhausen, Bergemann; 4·14, Salisbury, Brush. Luster submetallic and somewhat satin-like in the direction of the fibrous structure; also dull, earthy. Color reddish black to dark red, bright red when earthy; botryoidal surface often lustrous, like much limonite. Streak red. Opaque.

**Comp.**—$Fe_4H_2O_7$ or $2Fe_2O_3.H_2O$ = Oxygen 28·5, iron 66·2, water 5·3 = 100, or Iron sesquioxide 94·7, water 5·3 = 100.

For analyses, see 5th Ed., p. 168. Heddle (Min. Mag., **5**, 3, 1882) has analyzed cubic crystals, pseudomorphs after pyrite, from the clay slate of the island of Kerrera, Argyllshire, which had the composition of turgite, with G. = 3·534. Turgite is sometimes regarded as an intermediate stage in the alteration of limonite to hematite by loss of water.

**Pyr., etc.**—Heated in a closed tube, flies to pieces in a remarkable manner, and in this is distinct from hematite and limonite; yields water. Otherwise like hematite.

**Obs.**—A common ore of iron, often taken for limonite, with which it is frequently associated, and which it resembles, except in its superior hardness, streak, and decrepitation. It also looks very much like fibrous hematite. Hermann's mineral was from the Turginsk copper mine near Bogoslovsk, in the Ural, and from the Kolyvan district, in the Altai; that of Breithaupt, from near Hof in Bavaria, and Siegen in Prussia; found also with limonite at Düsseldorf in Prussia; at the Louisa mine, Horhausen. In the United States it occurs abundantly, in large botryoidal masses, at the limonite ore bed of Salisbury, Ct. (Brush), usually constituting the exterior layer of the limonite, sometimes an inch or more thick. The line of demarcation between it and the limonite is very distinct, and separation along it is often easy.

**256. DIASPORE.** Diaspore *Haüy*, Tr., 4, 1801. Blättricher Hydrargillit *Hausm.*, Handb., 442, 1813. Empholite *Igelström*, Bull. Soc. Min., 6, 40, 1883; *A. E. Nordenskiöld*, G. För. Förh., 9, 30, 1887.

Orthorhombic. Axes: $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}93722 : 1 : 0{\cdot}60387$ Koksharov[1].

$100 \wedge 110 = 43° 8' 38''$, $001 \wedge 101 = 32° 47' 40''$, $001 \wedge 011 = 31° 7' 35''$.

**Forms**[2]:
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)
*c* (001, *O*)

*h* (210, *i*-2̄)
*m* (110, *I*)
*k* (230, *i*-$\frac{3}{2}$)
*l* (120, *i*-2̆)

*z* (130, *i*-3̆)
*n* (150, *i*-5̆)
*w* (101, 1-ī)[5]
*f* (012, $\frac{1}{2}$-ĭ)

*e* (011, 1-ĭ)
*μ* (098, $\frac{9}{8}$-ĭ)
*p* (111, 1)
*r* (10·1·4, $\frac{5}{2}$-$\overline{10}$)

*s* (212, 1-2̄)
*t* (211, 2-2̄)[3]
*q* (232, $\frac{3}{2}$-$\frac{3}{2}$)[4]
*u* (344, 1-$\frac{4}{3}$)[4]

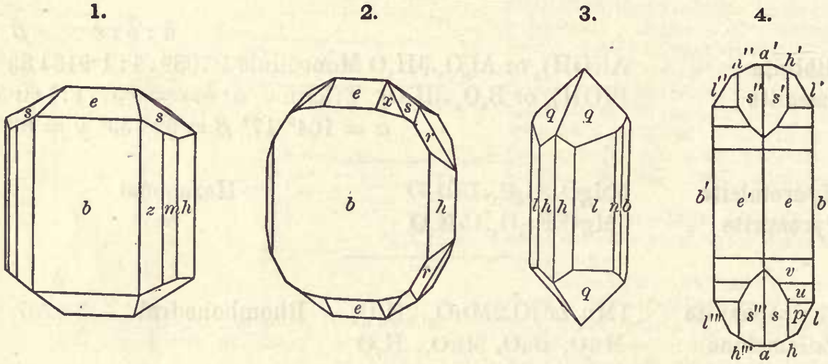
*v* (122, 1-2̆)[4]
*x* (133, 1-3̆)
*o* (292, $\frac{9}{2}$-$\frac{9}{2}$)

*bh'* = *64° 53½'
*hh'''* = 50° 13'
*mm''* = 86° 17¼'
*kk'* = 70° 51'
*ll'* = 56° 9½'
*zz'* = 39° 9½'
*nn'* = 24° 5½'

*ww'* = 65° 35'
*ff'* = 33° 36'
*ee'* = 62° 15'
*pp'* = 57° 45'
*rr'* = 115° 45'
*ss'* = 63° 20'
*tt'* = 95° 37'

*qq'* = 51° 2'
*uu'* = 44° 57'
*vv''* = 30° 50'
*xx'* = 20° 50'
*pp''* = 82° 54'
*qq''* = 96° 3'
*sb* = *75° 45½'

*pp'''* = 53° 50'
*rr'''* = 9° 6'
*ss'''* = 28° 29'
*tt'''* = 40° 38'
*qq'''* = 74° 34'
*uu'''* = 57° 4'
*vv'''* = 59° 47'



Figs. 1, 2, Ural, Kk. 3, Newlin, Penn. 4, Chester, Mass.

Crystals prismatic; usually thin, flattened ∥ *b*; sometimes acicular; faces often rounded, in prismatic zone vertically striated, also in zone *a e*, ∥ edge *p*/*e*. Also foliated massive and in thin scales; sometimes stalactitic.

Cleavage: *b* eminent; *h* less perfect. Fracture conchoidal, very brittle. H. = 6·5–7. G. = 3·3–3·5; 3·432 Haüy; 3·452 Dufr.; 3·30–3·34, fr. Schemnitz. Luster brilliant; pearly on cleavage-face, elsewhere vitreous. Color whitish, grayish white, greenish gray, hair-brown, yellowish, to colorless; sometimes violet-blue in one direction, reddish plum-blue in another, and pale asparagus-green in a third (cf. Haid., l. c.). Transparent to subtranslucent. Optically +. Double refraction strong. Ax. pl. ∥ *b*. Bx ⊥ *a*. Dispersion $\rho < v$, feeble. Axial angles, Dx.[6]:

$2H_{a.r} = 103° 34'$ $\beta_r = 1{\cdot}719$ $\therefore\ 2V_r = 84° 8'$
$2H_{a.y} = 103° 53'$ $\beta_y = 1{\cdot}722$ $\therefore\ 2V_y = 84° 20'$
$2H_{a.bl} = 104° 38'$ $\beta_{bl} = 1{\cdot}729$ $\therefore\ 2V_{bl} = 85° 8'$
$2H_{o.r} = 121° 59'$ $2H_{o.y} = 121° 32'$ $2H_{o.bl} = 120° 48'$

**Comp.**—AlO(OH) or $Al_2O_3.H_2O$ = Alumina 85·0, water 15·0 = 100.

Some varieties yield a little $P_2O_5$ (Hermann, Shepard), probably from impurity. Analyses, see 5th Ed., p. 169.

**Pyr., etc.**—In the closed tube decrepitates strongly, separating into white pearly scales, and at a high temperature yields water. The variety from Schemnitz does not decrepitate. Infusible; with cobalt solution gives a deep blue color. Some varieties react for iron with the fluxes. Not attacked by acids, but after ignition soluble in sulphuric acid.

**Obs.**—Commonly found with corundum or emery in dolomite, chlorite schist, and other crystalline rocks, in nests, or as implanted crystals on corundum and other minerals. Occurs near Kossoibrod, district of Ekaterinburg in the Ural, in granular limestone with emery; at Schemnitz, Hungary, in veins between dolomite and limestone; in a gneissoid rock near Bournac in the Haute-Loire; at Broddbo near Falun; at the Hörrsjöberg, Wermland, Sweden (*empholite*) embedded in pyrophyllite and damourite with tourmaline, rutile, and cyanite; sparingly in the nephelite-syenite veins of southern Norway, sometimes as an inclusion in some secondary minerals, as the "spreustein" (Scheerer, cf. Bgr., Zs. Kr., **16**, 50, 1890); with corundum in dolomite at Campolongo, near Dazio Grande, in the canton of Tessin in Switzerland; Greiner in the Zillerthal; at Gumuch-dagh and Manser, Asia Minor, and the Grecian islands Naxos, Samos, and Nicaria, with emery, as detected by J. L. Smith.

In the U. S. with topaz and margarodite at Trumbull, Ct., but rare; with corundum and margarite at Newlin, near Unionville, Chester Co., Pa.; at the emery mines of Chester, Mass., in large plates and crystals; in cavities in massive corundum at the Culsagee mine, near Franklin, Macon Co., N. Carolina.

Named by Haüy from *διασπείρειν, to scatter*, alluding to the usual decrepitation before the blowpipe. Le Lièvre, as Haüy states, first made known the species, having found it at a mineral-dealer's in Paris, and given it to Vauquelin for analysis. Its original locality is supposed to have been the Ural.

**Ref.**—[1] Min. Russl., **3**, 169, 1858. [2] See Kenng., Ber. Ak. Wien, **9**, 595, 1852; earlier, Haid., Pogg., **61**, 309, 1844; Marignac, Bibl. Univ., **6**, 296, 1847; Kk., l. c. [3] Rath, Campolongo, Pogg., **122**, 400, 1864. [4] E. S. D., *u v*, Chester, Mass., *q*, Newlin, Am. J. Sc., **32**, 388, 1886. [5] Cathrein, Greiner, Min. Mitth., **10**, 62, 1888. [6] Dx., N. R., 55, 1867.

**257. GÖTHITE.** Dünnschuppiger, linsenförmiger, rubinrother, etc. Eisenglimmer (fr. Siegen), *Becker*, Min. Beschr. O.-Nass. Lande, 401, 1789. Kryst. fasriger Brauneisenstein *Mohs*, Null Min. Kab., 3, 403, 1804. Göthit (fr. Eiserfeld near Siegen) *J. G. Lenz*, Tabell. ges. Mineralreich, 46, Jena, 1806, fol., Moll's Efem., 4, 505, 1808, Ullmann's Ueb., 304, 1814. Pyrrhosiderit [not Pyrosiderit] *Ullmann*, Hausm. Handb., 268, 1813, Ullmann's Ueb., 144, 299, 304, 1814 [but given many years before to his class]. Schuppig-fasriger Brauneisenstein (fr. Hollerter Zug) = Lepidokrokit *Ullmann*, Hausm. ib., 269, 1813, Ullmann's Ueb., 148, 316, 1814. Haarförmiger Brauneisenstein *Hausm.* ib., 270, 1813 = Nadeleisenerz *Breith.*, Char., 1823. Brown Iron-stone pt., Brown Iron-ore pt., Brown Hematite pt., of *Jameson*, *Phillips*, etc. Sammteisenerz, Sammetblende pt. = Przibramit in Glock. Handb., 549, 1831. Hierro pardo *Span.* Goethite.

Chileit *Breith.*, J. pr. Ch., **19**, 103, 1840. Onegit (fr. L. Onega) *Andre* (of Brünn), Tageblatt, No. 18, 1802, Moll's Efem., **2**, 109, 112, 1806 = Ore of Titanium *various auth.* for 25 years = Göthite *later auth.*

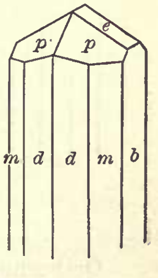
Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}9185 : 1 : 0{\cdot}6068$ Phillips[1].
$100 \wedge 110 = 42^\circ\ 34'$, $001 \wedge 101 = 33^\circ\ 27'$, $001 \wedge 011 = 31^\circ\ 15'$.

**Forms**[2]:
$a$ (100, $i$-$\bar{i}$)
$b$ (010, $i$-$\breve{i}$)
$d$ (210, $i$-$\bar{2}$)
$m$ (110, $I$)
$l$ (120, $i$-$\breve{2}$)
$u$ (101, 1-$\bar{i}$)
$e$ (011, 1-$\breve{i}$)
$g$ (021, 2-$\breve{i}$)[3]
$i$ (052, $\frac{5}{2}$-$\breve{i}$)[4]
$p$ (111, 1)
$r$ (311, 3-$\bar{3}$)
$s$ (212, 1-$\breve{2}$)
$z$ (252, $\frac{5}{2}$-$\frac{5}{2}$)

$dd''' = {*}49^\circ\ 20'$
$mm''' = 85^\circ\ 8'$
$ll' = 57^\circ\ 7\frac{1}{2}'$
$uu' = 66^\circ\ 54'$
$ee' = {*}62^\circ\ 30'$
$gg' = 101^\circ\ 3'$
$ms = 53^\circ\ 59'$
$mp = 48^\circ\ 6\frac{1}{2}'$
$ds = 36^\circ\ 1'$
$rr' = 118^\circ\ 54'$
$ss' = 64^\circ\ 36'$
$pp' = 58^\circ\ 55'$
$zz' = 39^\circ\ 58'$
$rr''' = 30^\circ\ 34\frac{1}{2}'$
$ss''' = 28^\circ\ 25'$
$pp''' = 53^\circ\ 42'$
$zz''' = 103^\circ\ 23'$

In prisms vertically striated, and often flattened into scales or tables ∥ *b*. Also fibrous; foliated or in scales; massive, reniform and stalactitic, with concentric and radiated structure.

Cleavage: *b* very perfect. Fracture uneven. Brittle. H. = 5–5·5. G. = 4·0–4·4; 4·37, cryst., Lostwithiel, Yorke. Luster imperfect adamantine. Color yellowish, reddish, and blackish brown. Often blood-red by transmitted light. Streak brownish yellow to ocher-yellow. Optically +(?). Ax. pl. ∥ *c*. Bx ⊥ *b*. Dispersion strong, $\rho < v$; for red nearly uniaxial; for green and blue, 2E = 50° approx.; cf. Palla, l. c.



**Var.**—1. In thin scale-like or tabular crystals, usually attached by one edge. Such is the original *Göthite* (*Pyrrhosiderite* or *Rubinglimmer*) of Siegen.

2. In acicular or capillary (not flexible) crystals, or slender prisms, often radiately grouped: the *Needle-Ironstone* (*Nadeleisenstein*). It passes into a variety with a velvety surface: the *Przibramite* (*Sammetblende*) of Přibram is of this kind.

*Onegite* is acicular göthite penetrating quartz, like rutile, from an island in L. Onega, Russia, where it was found in loose stones, in 1800, by Mr. Armstrong, an Englishman. It has also been called *Fullonite,* after Mr. Fullon, a brother-in-law of Mr. A., who also possessed specimens.

3. Columnar or fibrous.

4. Scaly-fibrous, or feathery columnar, the lines consisting of more or less distinct scales, somewhat like plumose mica: the *Lepidocrocite* (fr. λεπίς, *scale*, and κροκίς, *fiber*).

5. Also compact massive, with a flat conchoidal fracture, liver-brown to blackish brown and rust-brown color; sometimes reniform or stalactitic with radiated structure.

6. Disseminated microscopic crystals of göthite are one source of the frequent *aventurine* and opalescent character of specimens of different feldspars, and of some other species.

**Comp.**—FeO(OH) or $Fe_2O_3.H_2O$ = Oxygen 27·0, iron 62·9, water 10·1 = 100, or Iron sesquioxide 89·9, water 10·1 = 100.

Analyses, see 5th Ed., p. 170.

**Pyr., etc.**—In the closed tube gives off water and is converted into red iron sesquioxide. With the fluxes like hematite; most varieties give a manganese reaction, and some, treated in the forceps in O.F., after moistening in sulphuric acid, impart a bluish green color to the flame (phosphoric acid). Soluble in hydrochloric acid.

**Obs.**—Found with the other oxides of iron, especially hematite or limonite. Occurs at Eiserfeld near Siegen, in Nassau, in lamelliform and foliated crystallizations of a hyacinth-red color, with limonite; at Zwickau in Saxony; Oberkirchen in Westerwald, etc., near Clifton in Gloucestershire, near Bristol, England; in Cornwall, near Botallack and Lostwithiel, some of the crystals 1½ to 2 in. long and ⅝ in. across; in Somersetshire, at the Providence iron mines.

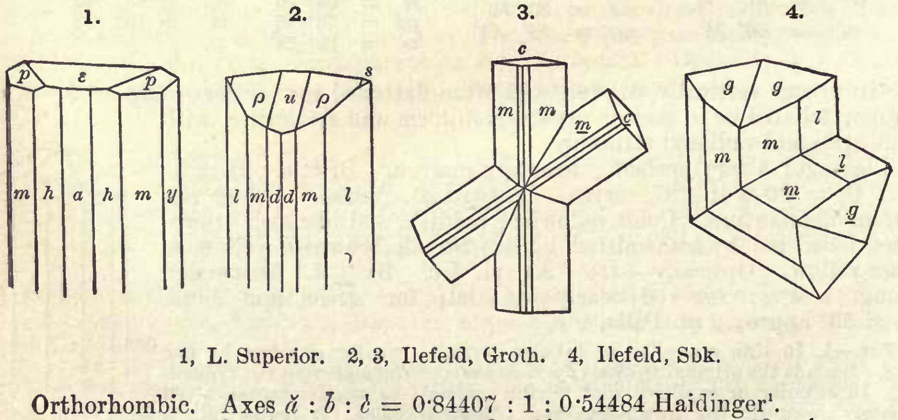
In the U. States, at the Jackson Iron mine, Negaunee, near Marquette, L. Superior, in lamelliform crystals; also in beautiful stalactitic forms with velvety surface and delicate radiated structure, often encrusting hematite; in Conn., at Salisbury; in Penn., near Easton, the var. lepidocrocite with limonite; with calcite in clay-ironstone concretions, Adair county, Mo.; in the Pike's Peak region, Colorado; in California, at Burns Creek, Mariposa Co., in quartz; in Oregon, 16 m. from Portland.

Named *Göthite* (Goethite) after the poet-philosopher Goethe (1749–1832); and *Pyrrhosiderite* from πυῤῥος, *fire-red*, and σίδηρος, *iron*. The name *Onegite* has priority, but it was given without a proper description, and for 25 years the nature of the mineral was unknown.

**Artif.**—By submitting solutions of $FeCl_3$ (30 to 85 pts. in 100) to the action of heat in closed tubes, Rousseau has obtained acicular crystals having the composition of göthite and like it orthorhombic, but, according to Fouqué, differing from it in optical characters. It does not seem certain, however, that there is any essential difference. C. R., **110**, 1032, 1890.

**Ref.**—[1] Min., p. 226, 1823; Palla has discussed the vicinal planes and suggested a monoclinic axial ratio, Zs. Kr., **11**, 23, 1885. [2] Ph., l. c., and Mlr., Min., 273, 1852. [3] Groth, Min.-Samml., 91, 1878. [4] Busz, St. Just, Zs. Kr., **17**, 553, 1890.

**258. MANGANITE.** Manganaise cristallisé *de Lisle,* Crist., 330, 1772, **3**, 101, 1783. Manganèse oxydé metalloïde *H.*, Tr., **4**, 1801 (with figs.). Grau-Braunsteinerz pt. *Wern.*, 1789; *Karsten,* Tab., 1800. Graumanganerz pt. *Karsten*, Tab., 1808. Grau-Braunstein pt. *Hausm.*, Handb., 288, 1813, 390, 1847. Gray Oxide of Manganese pt. Prismatoidisches Mangan-Erz *Mohs*, Grundr., 488, 1824. Manganite *Haid.*, Trans. R. Soc. Edinb., **11**, 122, 1827. Acerdèse *Beud.*, Tr., **2**, 678, 1832. Newkirkite *Thom.*, Min., **1**, 509, 1836.



1, L. Superior. 2, 3, Ilefeld, Groth. 4, Ilefeld, Sbk.

Orthorhombic. Axes $\breve{a} : \breve{b} : \dot{c}$ = 0·84407 : 1 : 0·54484 Haidinger[1].
100 ∧ 110 = 40° 10′, 001 ∧ 101 = 32° 50½′, 001 ∧ 011 = 28° 35′.

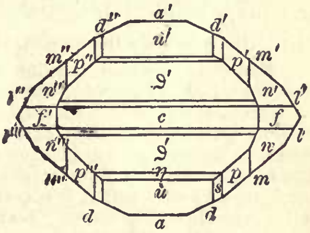
**Forms**[2]:
$a$ (100, $i\text{-}\bar{\imath}$)
$b$ (010, $i\text{-}\breve{\imath}$)
$c$ (001‘ $O$)
$\alpha$ (30·1·0, $i\ \overline{30}$)$^3$
$\beta$ (16·1·0, $i\text{-}\overline{16}$)$^3$
$\psi$ (12·1·0, $i\text{-}\overline{12}$)$^3$
$\mu_1$ (10·1·0, $i\text{-}\overline{10}$)$^3$
$\mu$ (610, $i\text{-}\bar{6}$)$^3$
$h$ (410, $i\text{-}\bar{4}$)
$\lambda$ (310, $i\text{-}\bar{3}$)$^3$
$\pi$ (520, $i\text{-}\overline{\tfrac{5}{2}}$)$^3$
$d$ (210, $i\text{-}\bar{2}$)
$i$ (430, $i\text{-}\overline{\tfrac{4}{3}}$)
$\delta$ (650, $i\ \overline{\tfrac{6}{5}}$)$^3$
$q$ (10·9·0, $i\text{-}\overline{\tfrac{10}{9}}$)$^3$
$m$ (110, $I$)
$\kappa$ (12·13·0, $i\text{-}\breve{\tfrac{13}{12}}$)$^3$
$k$ (230, $i\text{-}\tfrac{3}{2}$)
$z$ (350, $i\text{-}\tfrac{5}{3}$)$^3$
$l$ (120, $i\text{-}\breve{2}$)
$t$ (250, $i\text{-}\tfrac{5}{2}$)
$y$ (130, $i\text{-}\breve{3}$)
$r$ (150, $i\text{-}\breve{5}$)$^3$
$\iota$ (1·0·15, $\tfrac{1}{15}\text{-}\bar{\imath}$)$^3$
$\vartheta$ (2·0·15, $\tfrac{2}{15}\text{-}\bar{\imath}$)$^3$
$\eta$ (105, $\tfrac{1}{5}\text{-}\bar{\imath}$)$^3$
$\epsilon$ (205, $\tfrac{2}{5}\text{-}\bar{\imath}$)$^3$
$u$ (101, $1\text{-}\bar{\imath}$)
$w$ (201, $2\text{-}\bar{\imath}$)
$e$ (011, $1\text{-}\breve{\imath}$)
$f$ (021, $2\text{-}\breve{\imath}$)$^3$
$p$ (111, 1)
$\omega$ (443, $\tfrac{4}{3}$)$^3$
$v$ (221, 2)
$\xi$ (20·1·20, $1\text{-}\overline{20}$)$^3$
$o$ (10·1·10, $1\text{-}\overline{10}$)$^3$
$\tau$ (616, $1\text{-}\bar{6}$)$^3$
$\rho$ (515, $1\text{-}\bar{5}$)$^3$
$\chi$ (414, $1\text{-}\bar{4}$)$^3$
$g$ (313, $1\text{-}\bar{3}$)
$\sigma$ (525, $1\text{-}\overline{\tfrac{5}{2}}$)$^3$
$s$ (212, $1\text{-}\bar{2}$)
$\gamma$ (323, $1\text{-}\overline{\tfrac{3}{2}}$)$^3$
$\nu$ (17·30·30, $1\text{-}\breve{\tfrac{30}{17}}$)$^3$?
$\zeta$ (32·60·45, $\tfrac{4}{3}\text{-}\tfrac{15}{8}$)$^3$?
$x$ (365, $\tfrac{6}{5}\text{-}\breve{2}$)
$n$ (121, $2\text{-}\breve{2}$)
$\phi$ (177, $1\text{-}\breve{7}$)$^3$

$hh''' = 23° 50'$
$\lambda\lambda''' = 31° 26'$
$\pi\pi''' = 37° 19'$
$dd''' = 45° 46'$
$mm''' = {}^*80° 20'$
$kk' = 76° 36'$
$ll' = 61° 17'$
$tt' = 50° 43'$
$yy' = 43° 6'$
$rr' = 26° 40'$
$\iota\iota' = 4° 56'$
$\vartheta\vartheta' = 9° 50'$
$\eta\eta' = 14° 43'$
$\epsilon\epsilon' = 28° 57'$
$uu' = 65° 41'$
$ww' = 104° 29'$
$ee' = {}^*57° 10'$
$ff' = 94° 55'$
$cp = 40° 11'$
$cv = 59° 23'$
$\chi\chi' = 65° 12'$
$gg' = 64° 51'$
$ss' = 63° 50'$
$pp' = 59° 5\tfrac{1}{2}'$
$vv' = 82° 14'$
$xx' = 35° 55'$
$nn' = 47° 9\tfrac{1}{2}'$
$pp'' = 80° 22\tfrac{1}{2}'$
$\omega\omega'' = 96° 48'$
$vv'' = 118° 46'$
$ss'' = 70° 2'$
$nn'' = 103° 23'$
$oo''' = 5° 14\tfrac{1}{2}'$
$\chi\chi''' = 13° 3'$
$ss''' = 25° 47'$
$pp''' = 49° 11\tfrac{1}{2}'$
$vv''' = 67° 26'$
$gg''' = 17° 21'$
$\sigma\sigma''' = 20° 45'$
$nn''' = 84° 57$

Twins: tw. pl. *e*, both contact- and cruciform-twins; often repeated and with comp.-face either parallel or inclined, analogous to rutile. Crystals long prismatic and terminated (1) by *c*, or (2) by zone of macropyramids *ρ*, *s*, *p*, etc.; planes in this zone striated parallel to their mutual intersections. Also short prismatic (3) terminated by *c* and numerous macrodomes; or (4) highly modified with macropyramids predominating; the last two types generally as twins. The prismatic faces deeply striated vertically. Crystals often grouped in bundles. Also columnar; seldom granular; stalactitic.

Cleavage: *b* very perfect; *m* perfect. Fracture uneven. Brittle. H. = 4. G. = 4·2–4·4; 4·315 cryst., Negaunee, Pfd. Luster submetallic. Color dark steel-gray to iron-black. Streak reddish brown, sometimes nearly black. Opaque; minute splinters, sometimes brown by transmitted light.

5.



5, Ilefeld, after Groth.

**Comp.**—$MnO(OH)$ or $Mn_2O_3.H_2O$ = Oxygen 27·3, manganese 62·4, water 10·3 = 100, or Manganese sesquioxide 89·7, water 10·3 = 100.

**Anal.**—Blomstrand, G. För. Förh., 2, 183, 1874. Also 5th Ed., p. 171.

Långban $Mn_2O_3$ 88·51 $Fe_2O_3$ 0·23 MgO 1·51 CaO 0·62 $H_2O$ 9·83 = 100·70

**Pyr., etc.**—In the closed tube yields water; otherwise like braunite, p. 232.

**Obs.**—Occurs in veins traversing porphyry, associated with calcite and barite, at Ilefeld in the Harz; Ilmenau and Oehrenstock in Thuringia; Undenaes and Långban in Sweden; Christiansand in Norway; Cornwall, at various places, occurring crystallized at Botallack mine, St. Just; Callington and at the Royal iron mines; also in Cumberland, Devonshire, Somerset; Aberdeenshire, Scotland; near Ross and elsewhere in Ireland.

In the L. Superior mining region at the Jackson mine, Negaunee, Michigan. Devil's Head, Douglas Co., Colorado. In Nova Scotia, at Cheverie, Hants Co., and Walton; also 10 m. W. of Walton, where it forms a bed of conglomerate, along with quartz pebbles. In New Brunswick, at Shepody mountain, Albert Co.; Tattagouche R., Gloucester Co.; Upham, King's Co.; and Dalhousie, Restigouche Co.

*Newkirkite* of Thomson, from Neukirchen in Alsace, according to Lettsom, is nothing but manganite.

Named acerdèse by Beudant from ἀκερδής, *unprofitable*, because of little value for bleaching purposes (cf. pyrolusite).

**Alt.**—By loss of water changes to pyrolusite, hausmannite, or braunite; pseudomorphs of pyrolusite (see p. 244) are very common. Cf. Breith., Pogg., **61**, 187, 1844.

**Ref.**—[1] Ed. J. Sc., **4**, 41, 1826, or Pogg., **7**, 225, 1826; Groth obtained similar results, also the author for L. Superior crystals. Hemihedrism has been suggested (Haid.) but seems improbable; cf. Köchlin, Min. Mitth., **9**, 24, 1887; Busz mentions crystals from Grettenich, Saarbrücken, with *n* (121) hemihedrally developed, Zs. Kr., **15**, 624, 1889. [2] See Groth, Min.-Samml., Strassburg, 79, 1878, also some other doubtful forms. Brauns adds (17·0·20), Jb. Min., **1**, 252, 1886; also Köchlin on pseudomorphous crystals Σ (10·5·1), l. c. [3] Groth, l. c.

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**259. LIMONITE.** Σχιστὸς λίθος (fr. Iberia) *Diosc.* Schistus, Hæmatites, *Plin.*, **36**, 37, 38. Hæmatites pt., Blodsten, pt. [rest *red* hematite], *Wall.*, 260, 1747, *Cronst.*, 178, 1758. Hématite pt., *Fr. Trl.* Wall., 469, 1753. Braun-Eisenstein (incl. Eisenrahm, Brauner Glaskopf) *Wern.*, Bergm. J., 383, 1789. Brauneisenstein pt. [rest Göthite] *Hausm.*, Handb., 268, 1813. Braun-Eisenstein, Stilpnosiderit, *Ullmann*, Ueb., 146, 305, 148, 313, 1814. Brown Iron Stone pt., Brown Hematite, Brown Ocher, *Jameson*, Min., 253, 261, 1816. Limonite pt. [rest Göthite, Bog Ore] *Beud.*, Tr., **2**, 702, 1832 [not Limonit *Hausm.*, 1813 (= Bog Ore only)]. Brun, Gul Jernmalm, Myrmalm, Sjömalm *Swed.* Hierro arcilloso, globoso, palustre, etc., *Span.*

Ὦχρα [yellow and brown] *Theophr.* ? Sil *Plin.*, **33**, 56. Ochra nativa, *Germ.* Berggeel, *Agric.*, 466, 1546. O. nativa, Sil, Berggelb, Ockergelb, *Gesner*, Foss., 8, 1565. Ochriger Brauneisenstein *Wern.*, *Karst.* Brown Ocher pt., Yellow Ocher pt.

Minera Ferri subaquosa, Min. F. lacustris, v. palustris, Sjömalm, Myrmalm, *Wall.*, 263, 1747. Mine de fer limoneuse *Fr. Trl.* Wall., 1753. Ferrum limosum, etc., *Wall.*, **2**, 256, 1775. Raseneisenstein (incl. Morasterz, Sumpferz, Wiesenerz) *Wern.*, Bergm. J., 383, 1789. Marsh Ore, Bog Ore, Meadow Ore pt., *Kirwan*, *Jameson*, etc. Limonit (= Raseneisenstein or Bog Ore) *Hausm.*, Handb., 283, 1813 [not Limonite of *Beud.*, wh. incl. *all* hydrous oxides of iron]. Limnit *Glock.*, Syn., 62, 1847.

Not crystallized. Usually in stalactitic and botryoidal or mammillary forms, having a fibrous or subfibrous structure; also concretionary, massive; and occasionally earthy.

H. = 5–5·5. G. = 3·6–4·0. Luster silky, often submetallic; sometimes dull and earthy. Color of surface of fracture various shades of brown, commonly dark, and none bright; sometimes with a nearly black varnish-like exterior; when earthy, brownish yellow, ocher-yellow. Streak yellowish brown. Opaque.

**Var.**—(1) *Compact.* Submetallic to silky in luster; often stalactitic, botryoidal, etc. (incl. brauner Glaskopf *Germ.*) (2) *Ocherous* or earthy, brownish yellow to ocher-yellow, often impure from the presence of clay, sand, etc. (3) *Bog ore.* The ore from marshy places, generally loose or porous in texture, often petrifying leaves, wood, nuts, etc. (4) *Brown clay-ironstone,* in compact masses, often in concretionary nodules (including Adlerstein, Klappenstein *Germ.*), having a brownish yellow streak, and thus distinguishable from the clay-ironstone of the species hematite and siderite; it is sometimes (*a*) *pisolitic,* or an aggregation of concretions of the size of small peas (Bohnerz *Germ.; bean ore*); or (*b*) *oolitic.*

Part of the stalactitic iron ore, brown or yellow ocher, bog ore, and clay-ironstone contains more water than true limonite, and hence belongs to the species *xanthosiderite* (or *limnite*).

*Kaliphite* of Ivanov is a mixture of limonite, manganese oxide, silicate of zinc and lime, from Hungary.

**Comp.**—$2Fe_2O_3.3H_2O$ = Oxygen 25·7, iron 59·8, water 14·5 = 100, or Iron sesquioxide 85·5, water 14·5 = 100. In the bog ores and ochers, sand, clay, phosphates, oxides of manganese, and humic or other acids of organic origin are very common impurities.

Analyses, see 5th Ed., p. 172. Analyses are chiefly interesting from the technical side as showing the amount of impurity ($SiO_2$, $P_2O_5$, etc.) present.

**Pyr., etc.**—Like göthite. Some varieties leave a siliceous skeleton in the salt of phosphorus bead, and a siliceous residue when dissolved in acids.

**Obs.**—In all cases a result of the alteration of other ores, or minerals containing iron, through exposure to moisture, air, and carbonic or organic acids; derived largely from the change of pyrite, magnetite, siderite, ferriferous dolomite, etc.; also various species (as mica, pyroxene, hornblende, etc.), which contain iron in the ferrous state (FeO). It consequently occupies, as a bog ore, marshy places, into which it has been borne by streamlets from the hills around; also found at the bottom of lakes as in Sweden (Sjömalm *Swed.*, Seeerz *Germ.*); and in the more compact form it occurs in stalactites as well as in tuberose and other concretionary forms, frequently making beds in the rocks which contain the minerals that have been altered into it. In moist places where a sluggish streamlet flows into a marsh or pool, a rust-yellow or brownish yellow deposit often covers the bottom, and an iridescent film the surface of the water: the deposit is a growing bed of bog ore. The iron is transported in solution as ferrous carbonate in carbonated waters, a sulphate, or as a salt of an organic acid. It is often associatedwith manganese ores. Limonite is a common ore in Bavaria, the Harz, Luxembourg, Scotland, Sweden, etc.

Abundant in the United States. A few localities only are here mentioned; reference may be made to the various geological reports for complete lists. Extensive beds exist at Salisbury and Kent, Conn., also in the neighboring towns of Beekman, Fishkill, Dover, and Amenia, N.

Y., and in a similar situation north; at Richmond, West Stockbridge and elsewhere in Berkshire Co., Mass.; in Vermont, at Bennington, Monkton, Pittsford, Putney, and Ripton; in Pennsylvania widely distributed especially in the south-eastern part of the state; also in Tennessee, Alabama, Ohio, etc.

Named *Limonite* from λειμών, *meadow.* Ullmann's name, *Stilpnosiderite,* from στιλπνός, *shining,* has priority; but the ore is characteristically not a shining ore, although sometimes with a lustrous, varnish-like exterior. The name *limonite* was first appropriated especially to the *bog* ores by Hausmann in 1813. But most bog ores are of the above species, and Beudant, recognizing this, in 1832 used limonite for the *bog* as well as other limonite.

**Alt.**—By deoxidation through organic matter, if carbonic acid is present, may form siderite. By losing water becomes hematite, which occurs as pseudomorphs after limonite. This species also forms numerous pseudomorphs after other species.

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**260. XANTHOSIDERITE.** Gelbeisenstein *Hausm.*, Handb., 279, 1813. Xanthosiderit *E. E. Schmid,* Pogg., **84**, 495, 1851. Yellow Ocher pt. Bog Ore pt.

In fine needles or fibers, stellate and concentric. Also as an ocher.

H. = 2·5, in needles. Luster silky or greasy; pitch-like; also earthy. Color in needles golden yellowish, brown to brownish red; as an ocher, yellow of different shades, more or less brown, sometimes reddish. Streak ocher-yellow.

**Comp.**—$Fe_2O_3.2H_2O$ = Oxygen 24·5, iron 57·1, water 18·4 = 100, or Iron sesquioxide 81·6, water 18·4 = 100.

Analyses, see 5th Ed., p. 174.

**Pyr., etc.**—Like those of limonite.

**Obs.**—Associated with manganese ores at Ilmenau, in silky needles, etc.; as an ocher near Goslar, Bruchberg, Elbingerode in the Harz; as a pitchy ore at Kilbride, Wicklow Co., Ireland, along with limonite and psilomelane.

**Artif.**—This hydrate is formed when oxide of iron is precipitated from hot solutions of its salts; and, according to Gmelin, also from cold solutions.

LIMNITE *Dana,* Min., 178, 1868. Quellerz *Hermann,* J. pr. Ch., **27**, 53, 1842. Raseneisenerz, Sumpferz, Wiesenerz *Germ.* A hydrated iron oxide, for the most part bog ore, recent in origin and containing organic acids with quartz sand, phosphoric acid, etc. The composition $Fe(OH)_3$ or $Fe_2O_3.3H_2O$, has been attributed to it. Cf. Rg., Min. Ch., 187, 1865.

**261. BAUXITE.** Alumine hydratée de Beaux *Berthier,* Ann. Mines, **6**, 531, 1821. Beauxite *Dufr.*, Min. (**2**, 347), **3**, 799, 1847. Bauxite *Deville,* Ann. Ch. Phys., **61**, 309, 1861. Wocheinite *A. Flechner,* Zs. G. Ges., **18**, 181, 1866, Jb. G. Reichs., 1866. Cliachite *Adam,* Tabl. Min., 73, 1869.

In round concretionary disseminated grains. Also massive, oölitic; and earthy, clay-like.

G. = 2·55, fr. Wochein, v. Lill. Color whitish, grayish, to ocher-yellow, brown, and red.

**Var.**—1. In concretionary grains, or oölitic; *bauxite.* 2. Clay-like, *wocheinite;* the purer kind grayish, clay-like, containing very little iron oxide; also red from the iron oxide present.

**Comp.**—Essentially $Al_2O_3.2H_2O$ = Alumina 73·9, water 26·1 = 100; some analyses, however, give $Al_2O_3.H_2O$ like diaspore.

Iron sesquioxide is usually present, sometimes in large amount (up to 50 p. c. Henatsch), in part replacing alumina, in part only an impurity. Silica, phosphoric acid, carbonic acid, lime, magnesia are common impurities.

Analyses, see 5th Ed., pp. 174, 175; also Coquand, Bull. Soc. G. Fr., **28**, 98, 1871; Augé, ibid., **16**, 345, 1888; John, Vh. G. Reichs., 389, 1874; Lang, Ber. Ch. Ges., **17**, 2892, 1884; Henatsch, Inaug. Diss., Breslau, 1879. The analyses are interesting chiefly on the technical side, as showing the amount of impurity present; thus Henatsch gives 9 to 24 p. c. $SiO_2$, 0·8 to 2·5 p. c. $P_2O_5$, etc.

**Obs.**—From Baux (or Beaux), near Arles, France, disseminated in grains in compact limestone, and also oölitic; also at Revest, near Toulon, brown to dark red, and massive, regarded as an iron ore; at Allauch, Dept. of Var, France, massive, oölitic, with a base of like nature, cemented by some calcium carbonate, the most common variety; at Hügel, in the Commune of Baux, a hard and firm variety; at Calabre, massive; also in Nassau; in French Guiana. *Wocheinite* occurs in Carniola, between Feistritz and Lake Wochein, in a deposit 12 feet thick, the junction of the Trias and Jurassic formations, part of it red from iron sesquioxide. The purest bauxite is used for the manufacture of aluminium, and is called *aluminium ore.*

In the U. S., bauxite occurs in Saline and Pulaski Cos., Arkansas.

Augé, l. c., regards bauxite as a hydro-thermal deposit; he calls attention to the occurrence of hydrated alumina in the Yellowstone region.

## Brucite Group. R(OH)$_2$. Rhombohedral.

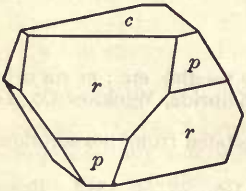
**262. BRUCITE.** Native Magnesia (fr. N. Jersey) *A. Bruce*, Bruce's Min. J., **1**, 26, 1814 (with anal.). Hydrate of Magnesia *A. Aikin*, Min., 236, 1815, *Cleaveland*, Min., 429, 1822. *F. Hall*, Cat. Min., 28, 1824, *S. Robinson*, Cat. Amer. Min., 166, 1825. Brucite, ou Hydrate de magnésie, *Beud.*, Tr., 838 (Index), 1824. Talk-Hydrat, Magnesia-Hydrat. *Germ.* Monoklinoëdrisches Magnesiahydrat oder Texalith (fr. Texas, Pa.) *Herm.*, J. pr. Ch., **82**, 368, 1861. Amianthus (fr. Hoboken) *J. Pierce*, Am. J. Sc., **1**, 54, 1818 = Amianthoid Magnesite, Nemalite, *T. Nuttall*, ib., **4**, 18, 1821 = Brucite (Talk-hydrat, "hierher zu gehören scheint"), *Leonh.*, Handb., 245, 1826; *J. D. Whitney*, J. Soc. N. H., Boston, 36, 1849 (with anal.). Manganbrucit *Igelström*, Öfv. Ak. Stockh., **39**, No. 2, 83, 1882.

Rhombohedral. Axis $\dot{c}$ = 1·52078; 0001 ∧ $10\bar{1}1$ = 60° 20′ 26″ Hessenberg[1].

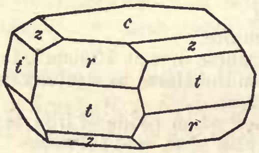
**Forms[2]:** *c* (0001, *O*), *a* ($11\bar{2}0$, *i*-2), *r* ($10\bar{1}1$, *R*), *p* ($20\bar{2}1$, 2); *z* ($01\bar{1}3$, $-\frac{1}{3}$), *e* ($01\bar{1}2$, $-\frac{1}{2}$), *h* ($07\bar{7}5$, $-\frac{7}{5}$), *t* ($04\bar{4}1$, −4).

*cp* = 74° 6½′ *ch* = 67° 52′ *pp′* = 112° 48′ *hh′* = 106° 41′
*cz* = 30° 20½′ *ct* = 81° 54′ *zz′* = 51° 53′ *tt′* = 118° 3′
*ce* = 41° 17′ *rr′* = 97° 37½′ *ee′* = 69° 42′ *rz‴* = *89° 19′

1.



2.



3.

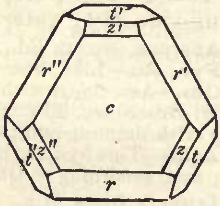


Fig. 1, Low's Mine, Texas, Penn. Figs. 2, 3, Wood's Mine, Texas.

Crystals usually broad tabular. Also commonly foliated massive; fibrous, fibers separable and elastic.

H. = 2·5. G. = 2·38–2·4; 2·388 Ural, Lösch. Cleavage: *c* eminent. Folia separable and flexible, nearly as in gypsum. Sectile. Luster ∥ *c* pearly, elsewhere waxy to vitreous. Color white, inclining to gray, blue or green. Transparent to translucent. Optically +. Indices: $\omega_r$ = 1·559, $\epsilon_r$ = 1·5795 Bauer[3]. Pyroelectric, on cooling the extremities of $\dot{c}$ −, the edges +, Hankel[4].

**Comp., Var.**—Magnesium hydrate, Mg(OH)$_2$ or MgO.H$_2$O = Magnesia 69·0, water 31·0 = 100. Iron and manganese protoxide are sometimes present.

**Var.**—1. *Ordinary.* In plates, white to pale greenish in color; strong pearly luster on the cleavage surface.

2. *Nemalite.* A fibrous variety containing 4 to 5 p. c. iron protoxide, with G. = 2·44 Nuttall.

3. *Manganbrucite.* Granular, massive. Color honey-yellow to brownish red; perhaps originally colorless; contains manganese in considerable amount, anal. 7; cf. also anal. 3.

**Anal.**—1, E. F. Smith, Am. Ch. J., **5**, 281, 1883. 2, 3, F. A. Genth, Am. Phil. Soc., **23**, 40, 1885. 4, Smith, l. c. 5, Rosenblad, G. För. Förh., **7**, 733, 1885. 6, T. Blyth, Mallet, Min. India, 161, 1887. 7, Igelström, l. c.; small amounts of SiO$_2$ and CaCO$_3$ have been deducted. Also 5th Ed., p. 176.

| | | MgO | FeO | MnO | H$_2$O | |
|---|---|---|---|---|---|---|
| 1. Fritz Island | | 66·78 | 0·44[a] | — | 32·52 | = 99·74 |
| 2. " | | 67·64 | 0·82[a] | 0·63 | 30·92 | = 100·01 |
| 3. " | G. = 2·382 | 65·38 | 0·30[a] | 4·04 | 29·70 | = 99·42 |
| 4. Sinking Spring | | 66·19 | 1·24[a] | — | 31·05 | CaO 1·68 = 100·16 |
| 5. Ural | G. = 2·388 | 69·02 | 0·61 | — | 30·23 | CO$_2$ 0·09 = 99·95 |
| 6. Afghánistán, *fibrous* | | 60·95 | 11·14 | — | 29·32 | insol. 0·38 = 101·79 |
| 7. Jakobsberg, *manganbrucite* | | 57·81 | — | 14·16 | 28·00 | = 99·97 |

[a] Fe$_2$O$_3$.

**Pyr., etc.**—In the closed tube gives off water, becoming opaque and friable, sometimes turning gray to brown; the manganesian variety becomes dark brown. B.B. infusible, glows with a bright light, and the ignited mineral reacts alkaline to test-paper. With cobalt solution gives the pale pink color of magnesia. The pure mineral is soluble in acids without effervescence.

**Obs.**—Accompanies other magnesian minerals in serpentine, and has also been found in limestone. Occurs in considerable veins traversing serpentine, at Swinaness in Unst, one of the Shetland Isles, where it is sometimes found in crystals; at Pyshminsk in the Urals; at Goujot in France; at the iron mine of Cogne, valley of Aosta, Italy; near Filipstadt in Wermland, in Sweden, in roundish masses in limestone.

At Hoboken, N. J., in serpentine; at the Tilly Foster iron mine, Brewster, N. Y., well crystallized, also pseudomorph after dolomite and altered to serpentine; in Richmond Co., N. Y.; on the peninsula east of New Rochelle, Westchester Co., N. Y.; at Wood's mine, Texas, Pa., in large plates or masses, and often crystallizations several inches across; at Low's mine, with hydromagnesite; at Fritz Island, near Reading, and near Sinking Spring, Spring Township.

*Nemalite*, the fibrous variety, occurs at Hoboken, and Xettes in the Vosges. *Manganbrucite* occurs with hausmannite and other manganese minerals in the granular limestone of Jakobsberg, Nordmark, Sweden.

Named after A. Bruce (1777–1818), an early American mineralogist, who first described the species.

**Alt.**—Becomes white, pulverulent, and carbonated on exposure, and also crystallized, constituting then the mineral hydromagnesite; the latter is sometimes in pseudomorphous crystals after brucite. Also altered to serpentine (see above).

**Artif.**—Has been noticed in crystalline plates as a deposit in a steam-boiler (Luedecke, Zs. Kr., **7**, 502, 1883). Also obtained by de Schulten from a solution of magnesium chloride precipitated by an excess of caustic potash and heated to 200°; the crystals of brucite separate out on cooling.

**Ref.**—[1] Texas, Penn., Min. Not., **4**, 40, 1861. [2] Cf. Hbg.; also Mlr., Min., 269, 1852, Rose, Zs. G. Ges., **12**, 178, 1860; Schrauf, Atlas, Tf. XL; Erem., Vh. Min. Ges., **16**, 310, 1881. [3] Ber. Ak. Berlin, 958, 1881. [4] Wied. Ann., **6**, 53, 1879. On the percussion-figure, Mgg., Jb. Min., **1**, 57, 1884.

EISENBRUCIT *Sandberger*, Jb. Min., **2**, 288, 1880. A product of partially decomposed brucite from Siebenlehn near Freiberg. An anal. gave Petersen: MgO 38·92, FeO 18·73, $CO_2$ 7·38, $H_2O$ 30·46, $SiO_2$ 4·15, $Al_2O_3$,CaO *tr.* = 99·64. After deducting the $SiO_2$ as quartz, and 24·49 p. c. hydromagnesite believed to be present, the result is: MgO 39·89, FeO 24·92, $H_2O$ 35·19 = 100.

## 263. PYROCHROITE.

Pyrochroit *L. J. Igelström*, Pogg., **122**, 181, 1864, Öfv. Ak. Stockh., **21**, 205, 1864.

Rhombohedral. Axis $\dot{c} = 1·3999$; $cr = {}^*58° 15\frac{1}{2}'$, $rr' = 94° 52'$ Flink[1]. In hexagonal tabular crystals. Usually foliated, like brucite.

H. = 2·5. G. = 3·258 artif., de Schulten. Luster pearly. Color white; but changing on exposure to bronze, and then to black. In thin pieces transparent, and having a flesh-red color by transmitted candle-light. Optically uniaxial, negative.

**Comp.**—Manganese hydrate, $Mn(OH)_2$ or $MnO.H_2O$ = Manganese protoxide 79·7, water 20·3 = 100.

**Anal.**—1, 2, L. Stahre, G. För. Förh., **4**, 163, 1878.

| | MnO | FeO | CaO | MgO | $H_2O$ | $CO_2$ |
|---|---|---|---|---|---|---|
| 1. *Cryst.* | 76·56 | 0·47 | 0·29 | 2·39 | 18·57 | 1·99 = 100·27 |
| 2. *Massive* | 77·67 | 0·20 | *tr.* | 1·33 | 20·00 | 1·07 = 100·27 |

**Pyr., etc.**—In the closed tube a small piece becomes at surface verdigris-green, then dirty green, and finally brownish black. Yields water. B.B. reactions for manganese. In hydrochloric acid forms easily a clear colorless solution.

**Obs.**—Occurs in veins 1 to 2 lines broad in magnetite at Pajsberg, Filipstadt, Sweden; at the Moss mine at Nordmark in Wermland; at the Sjö mine, Grythyttan, Örebro. It is commonly associated with hausmannite. Identified by Roepper at Franklin Furnace, N. J.

Named from πῦρ, *fire*, χρόα, *color*, because of the change of color upon ignition.

**Artif.**—Obtained by de Schulten in hexagonal crystals, Bull. Soc. Min., **10**, 326, 1887.

**Ref.**—[1] Flink, Nordmark, Ak. Handl. Stockh., Bihang, **12** (2), No. 2, 12, 1886.

Kenngott refers here (Jb. Min., 440, 1866) a mineral which Wiser had announced as a hydrous carbonate of manganese, and which Haidinger (Handb., 493, 1845) named *Wiserite*. It is described as yellowish white to gray in color, pearly to silky in luster, fibrous in structure, and as coming from Gonzen near Sarganz, the Canton of St. Gall, in Switzerland, where it is found in seams in a granulitic hausmannite, with rhodochrosite.

**264. GIBBSITE.** Wavellite (fr. Richmond) *C. Dewey*, Am. J. Sc., **2**, 249, 1820; = Water and Alumina, *id.*, ib., **3**, 239, 1821. Gibbsite *J. Torrey*, N. Y. Med. Phys. J., **1**, No. 1, 68, April, 1822. Hydrargillite, Gibbsite of Torrey, *Cleavel.*, 224, 782, 1822. Hydrargillite (fr. Ural) *G. Rose*, Pogg., **48**, 564, 1839.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 1·70890 : 1 : 1·91843$; $\beta = 85° \ 29\frac{1}{6}'$ = 001 ∧ 100 Brögger[1].

100 ∧ 110 = 59° 35¼′, 001 ∧ $\bar{1}$01 = *50° 50′, 001 ∧ 011 = 62° 23¾′.

**Forms:**
$a$ (100, $i$-$\bar{i}$)
$b$ (010, $i$-$\grave{i}$)
$c$ (001, $O$)
$t$ (920, $i$-$\frac{9}{2}$)
$l$ (410, $i$-$\bar{4}$)
$k$ (310, $i$-$\bar{3}$)?
$\nu$ (520, $i$-$\frac{5}{2}$)?
$\mu$ (210, $i$-$\bar{2}$)
$n$ (870, $i$-$\frac{8}{7}$)
$m$ (110, $I$)
$d$ ($\bar{1}$01, 1-$\bar{i}$)
$s$ ($\bar{3}$12, $\frac{3}{2}$-$\bar{3}$)
$u$ ($\bar{6}$23, 2-$\bar{3}$)
$o$ ($\bar{2}$11, 2-$\bar{2}$)?

Angles: $tt'''$ = 41° 28′, $ll'''$ = 46° 8′, $\mu\mu'''$ = 80° 51′ $nn'''$ = 112° 17′ $mm'''$ = *119 10½′, $cm$ = *87° 43′.

Twins: tw. pl. (1) $m$ with $cc$ = − 4° 34′, rare. (2) $a$ with $cc$ = − 9° 2′, not common. (3) $c$, common, usually combined with one of the other laws. (4) tw. pl. ⊥ $c$ and intersecting $c$ in a line inclined 119° 49½′ to the edge $c/a$, and 0° 31½′ to the edge $c/m$; very common, the faces $c$ and $\underline{c}$ falling together, while the zone $ca$ of one crystal coincides with the zone $cm$ of the other; method of grouping very varied, in part analogous to the pericline twins of the triclinic feldspars. Also rare and somewhat uncertain, (5) tw. pl. ($\bar{3}$·1·54, $\frac{1}{18}$-$\bar{3}$?).

Crystals tabular ∥ $c$, the forms $c$ $a$ $m$ most common; hence hexagonal in aspect. Occasionally in lamello-radiate spheroidal concretions. Also stalactitic, or small mammillary and incrusting, with smooth surface, and often a faint fibrous structure within.

Cleavage: $c$ eminent. Tough. Percussion-figure[2] similar to that of mica, with rays normal to the hexagonal edges. H. = 2·5–3·5. G. = 2·3–2·4; 2·385, Richmond, B. Silliman, Jr.; 2·287, Ural, Hermann; 2·420, Norway, Bgr. Color white, grayish, greenish, or reddish white; also reddish yellow when impure. Luster of $c$ pearly; of other faces vitreous; of surface of stalactites faint. Translucent; sometimes transparent in crystals. A strong argillaceous odor when breathed on.

Optically +. For Uralian crystals (Dx.), ax. pl. usually ⊥ $b$, and inclined 41° 26′ to a normal to $c$ for red, dispersion strong $\rho > v$, horizontal inappreciable; increase of temperature causes a gradual change in the axial plane until at 56°·5 and above the ax. pl. becomes ∥ $b$, the angles increasing with $\rho > v$ up to 171° C.; in all cases the bisectrix lies in the plane of symmetry; at 26°·5 nearly uniaxial for blue. In another section, ax. pl. ∥ $b$ at ordinary temperature, and axes inclined respectively 50° 12′ and 35° 9½′ (red) to a normal to $c$. Brazilian crystals (Dx.) similar to those from the Ural. The Norwegian crystals (Bgr.) are sensibly uniaxial with Bx ∧ $\grave{c}$ = − 21°. Refractive indices:

$$\alpha = \beta = 1·53471 \qquad \gamma = 1·55769$$

**Var.**—1. In crystals; the original *Hydrargillite*. 2. Stalactitic; *gibbsite*.

**Comp.**—Aluminium hydrate, $Al(OH)_3$ or $Al_2O_3.3H_2O$ = Alumina 65·4, water 34·6 = 100.

Analyses, see 5th Ed., p. 177. Also Eustis, Brazil, Ch. News, **48**, 98, 1883; da Costa Sena, id., Bull. Soc. Min., **7**, 220, 1884; Jannettaz, French Guiana, ibid., **1**, 70, 1878.

**Pyr., etc.**—In the closed tube becomes white and opaque, and yields water. B.B. infusible, whitens, and does not impart a green color to the flame. With cobalt solution gives a deep blue color. Soluble in concentrated sulphuric acid.

**Obs.**—The crystallized gibbsite (hydrargillite) was discovered by Lissenko in the Shishimsk mountains near Zlatoust in the Ural; it occurs, according to Koksharov, in cavities in a schist containing much magnetite. The larger crystals were 1 to 2 inches long. Also in crystals filling cavities in natrolite on the small islands, Lille-Arö and Eikaholm, in the Langesundfiord, Norway. With corundum at Gumuch-dagh, Asia Minor. In French Guiana. Ouro Preto and Marianna, Minas Geraes, Brazil.

In the U. S. on corundum at Unionville, Pa.(?); in stalactitic form at Richmond, Mass., in a bed of limonite; also at Lenox, Mass.; at the Clove Mine, Union Vale, Dutchess Co., N. Y., on limonite; in Orange Co., N. Y.

Named after Col. George Gibbs, the original owner (after extensive foreign travel) of the large Gibbs cabinet acquired by Yale College early in the century. Cleaveland calls the Richmond mineral *hydrargillite* on p. 224 of his mineralogy, but on p. 782 adopts Torrey's name *gibbsite*.

**Ref.**—[1] Norway, Zs. Kr., **16**, 16, 1890. Earlier regarded as rhombohedral, Kk., Min. Russl., **4**, 88, 1862, but proved by Dx. to be monoclinic, ibid., p. 398, and N. R., 138, 1867. It is shown by Bgr. that the orthopinacoid of Dx. is in fact the prism *m*. [2] Jb. Min., **1**, 56, 1884.

RICHMONDITE. The substance labelled gibbsite from Richmond, Mass., in which Hermann states he found 37 p. c. $P_2O_5$ (see his analysis under gibbsite, 5th Ed., p. 178), has been named *Richmondite* by Kenngott (Vierteljahrschr. nat. Ges. Zürich, **11**, 225).

ZIRLITE *Pichler*, Jb. Min., 57, 1871, 51, 1875. An amorphous aluminium hydrate resembling allophane from near Zirl, Tyrol, also from Nassereit; it occurs in yellowish white incrustations in a sandy marl. Easily soluble in acids.

**265. SASSOLITE.** Sale sedativo naturale *U. F. Hoefer*, Memoria, Firenze, 1778; *Mascagni*, Mem. Soc. Ital., 8, 487. Native Sedative Salt. Acidum boracis, *vulgo* Sal sedativum, *Bergm.*, Sciagr., 1782. Native Boracic Acid *Kirw.*, 1796. Sassolin *Karst.*, Tab., 40, 75, 1800. Acide boracique *Fr.* Boric Acid.

Triclinic. Axes: $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}57711 : 1 : 0{\cdot}52824$; $\alpha = 104° 17\frac{1}{3}'$; $\beta = 92° 33\frac{1}{3}'$; $\gamma = 89° 41\frac{5}{6}'$ Miller[1].

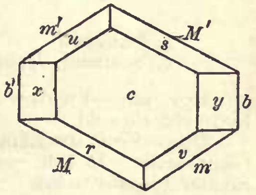
$100 \wedge 010 = 89° 39\frac{2}{3}'$, $001 \wedge 100 = 87° 26\frac{1}{3}'$, $001 \wedge 010 = 75° 42\frac{1}{2}'$.

**Forms**[1]: *m* (110, *I'*) *y* (011, 1-ĭ') *v* (111, 1') *u* ($\bar{1}\bar{1}$1, 1,)
*b* (010, *i*-ĭ) *M* (1$\bar{1}$0, '*I*) *x* (0$\bar{1}$1, '1-ĭ) *s* ($\bar{1}$11, ,1) *r* (1$\bar{1}$1, '1)
*c* (001, *O*)

If the axes $\breve{a}$ and $\bar{b}$ are interchanged, and at the same time the axis $\acute{c}$ doubled, the axial ratio becomes: $\bar{a} : b : c = 1{\cdot}7328 : 1 : 1{\cdot}8306$, which brings it into correspondence with gibbsite (hydrargillite).

*bm* = *59° *cv* = 41° 6' *cr* = 48° 26' *b'r* = 78° 24'
*b'M* = 59° 30' *cm* = *80° 33' *cM* = *95° 3' *bs* = 59° $4\frac{1}{2}'$
*mM* = *61° 30' *cu* = 50° 53' *Mr* = *46° 37' *b'u* = 77° 26'
*cy* = 24° 21' *cs* = 43° 14' *bv* = 59° 51' *ys* = 36° 18'
*cx* = 36° 27'

Twins: tw. axis $\acute{c}$; $c\underline{c} = 29° 2'$ (Mlr.). Crystals tabular ∥ *c*, the plane angles of the basal plane nearly 120°. Usually small scales; sometimes grouped in stalactitic forms.



Cleavage: *c* very perfect. H. = 1. G. = 1·48. Luster pearly. Color white, except when tinged yellow by sulphur; sometimes gray. Feel smooth and unctuous. Taste acidulous, and slightly saline and bitter. Ax. pl. nearly coincident with axis $\bar{b}$ and ⊥ *c*. Bx ⊥ *c*. 2E = 8° Mlr. 2E = 10° to 12° and unchanged by heat (to 75° C.) Dx. Dispersion zero.

**Comp.**—Boric acid, $B(OH)_3$ or $B_2O_3.3H_2O$ = Boron trioxide 56·4, water 43·6 = 100.

**Pyr., etc.**—In the closed tube gives water. B.B. on platinum wire fuses to a clear glass and tinges the flame yellowish green. Some specimens react for sulphur or ammonia in the closed tube. Soluble in water and alcohol. Dissolves in 2·97 parts of water at 100° C., and 10·7 parts at 50° C.

**Obs.**—This long known compound, the *Sal sedativum Hombergii*, was first detected in nature by Hoefer in the waters of the Tuscan lagoons of Monte Rotondo and Castelnuovo, and afterward in the solid state at Sasso by Mascagni. The hot vapors of the lagoons consist largely of boric acid. To collect it the vapors are made to pass through water, which absorbs the boric acid; the waters are then evaporated by means of the steam from the springs. Have yielded seven to eight thousand pounds troy per day. These lagoons spread over a surface of about 30 miles; and in the distance, clouds of vapor are seen rising in large volumes among the mountains.

Exists also in other natural waters, as at Wiesbaden; Aachen; Krankenheil near Fölz; Clear Lake, in Lake Co., California; has been detected in the waters of the ocean.

Occurs also abundantly in the crater of Vulcano, one of the Lipari isles, forming a layer on sulphur, and about the fumaroles, where it was discovered by Dr. Holland in 1813.

**Ref.**—[1] Trans. Phil. Soc. Cambr., 3, 365, 1830, Pogg. Ann., **23**, 558, 1831, Min., p. 281. Kenngott made the artificial crystals monoclinic, Ber. Ak. Wien, **12**, 26, 1854. Cf. also Dx., Min., **2**, 1, 1874, and Haushofer, Zs. Kr., **9**, 77, 1884, who gives new measurements.

**266. HYDROTALCITE.** Hydrotalkit *Hochstetter*, J. pr. Ch., **27**, 376, 1842. Völknerite *Herm.*, J. pr. Ch., **40**, 11, 1847, **46**, 257, 1849.

Hexagonal. Also lamellar-massive, or foliated, and somewhat fibrous.

Cleavage: basal, eminent; lateral, distinct. H. = 2. G. = 2·04–2·09; 2·091 Rg. Color white. Luster pearly. Translucent, or in thin folia transparent. Feel greasy.

**Comp.**—Perhaps $Al(OH)_3.3Mg(OH)_2.3H_2O$ or $Al_2O_3.6MgO.15H_2O$ = Alumina 16·7, magnesia 39·2, water 44·1 = 100.

Analyses (Hermann, Rg., see 5th Ed., p. 179) show the presence of a carbonate in considerable amount (2·6 to 7·3 p. c. $CO_2$, Rg.). so that the true nature of the mineral is not above doubt.

**Pyr., etc.**—In the closed tube yields much water. B.B. infusible, but exfoliates somewhat, and gives out light. A pale rose-red with cobalt solution. With the fluxes intumesces and affords a clear colorless glass. The Snarum mineral reacts for iron.

**Obs.**—Occurs at the mines of Shishimsk, district of Zlatoust, Ural, implanted on schist (*völknerite*); at Snarum, Norway, in serpentine (*hydrotalcite*).

Named *hydrotalcite* in allusion to its resembling talc, but containing much more water; *völknerite*, after Captain Völkner.

HOUGHITE *Shepard*, Am. J. Sc., **12**, 210, 1851. A hydrotalcite derived from the alteration of spinel. From near Oxbow, and near Somerville in Rossie, St. Lawrence Co., New York. Color white; luster faint, pearly. The crystals are in all conditions, from the pure spinel to octahedrons with rounded edges and pitted or irregular surfaces, and it also occurs in flattened nodules. The surfaces are sometimes soft and altered, when the edges or angles have the hardness of spinel. Analysis, see S. W. Johnson, ibid., p. 361, or 5th Ed., p. 179. Associated with dolomite, spinel, phlogopite, graphite, and serpentine. Named for Franklin B. Hough of Somerville.

**267. PYROAURITE.** Pyroaurit *Igelström*, Öfv. Ak. Stockh., **22**, 608, 1865. Igelströmite *Heddle* Min. Mag., **2**, 107, 1878.

Hexagonal. In six-sided tables. Also with obscure fibrous structure.

Luster pearly. Color gold-like or silvery white. Subtranslucent.

**Comp.**—Perhaps $Fe(OH)_3.3Mg(OH)_2.3H_2O$ or $Fe_2O_3.6MgO.15H_2O$ = Iron sesquioxide 23·9, magnesia 35·8, water 40·3 = 100.

**Anal.**—1, Igelström, l. c. 2, Heddle, l. c.; also other analyses with some $CO_2$.

| | $Fe_2O_3$ | MgO | $H_2O$ | $CO_2$ | | |
|---|---|---|---|---|---|---|
| 1. Långban | 23·92 | 34·04 | 34·56 | 7·24 | = | 99·76 |
| 2. Scotland, *Igelströmite* | 23·63 | 36·85 | 40·02 | — | = | 100·50 |

**Pyr., etc.**—Yields water. B.B. infusible, turns brown and becomes magnetic. Soluble in hydrochloric acid.

**Obs.**—From the Långban iron mine in Wermland, Sweden, in gold-like submetallic scales (*pyroaurite*). In thin seams of a silvery white color in serpentine in the island Haaf-Grunay, Scotland (*igelströmite*).

**268. CHALCOPHANITE.** *G. E Moore*, Amer. Chemist, July, 1875.

Rhombohedral. Axis $\dot{c}$ = 3·5267; 0001 ∧ $10\bar{1}1$ = 76° $12\frac{1}{6}'$ Moore.

In druses of minute tabular crystals, with small rhombohedral faces. Angles: $rr'$ = 114° 30′, $rr'''$ = *65° 30′. Also in foliated aggregates; in stalactitic and plumose forms.

Cleavage: basal, perfect. Flexible in thin laminæ. H. = 2·5. G. = 3·907. Luster metallic, brilliant. Color bluish black to iron-black. Streak chocolate-brown, dull. Opaque.

**Comp.**—$(Mn,Zn)O.2MnO_2.2H_2O$ = Manganese dioxide 60·3, manganese protoxide 6·1, zinc protoxide 21·1, water 12·5 = 100; here MnO : ZnO = 1 : 3.

**Anal.**—1, 2, Moore: 1, cryst.; 2, stalactitic, deducting 1·27 p. c. limonite.

| | $MnO_2$ | MnO | ZnO | $Fe_2O_3$ | $H_2O$ | | |
|---|---|---|---|---|---|---|---|
| 1. | 59·94 | 6·58 | $21·70\frac{2}{2}$ | 0·25 | 11·58 | = | 100·05 |
| 2. | $\frac{2}{2}$ 61·57 | 4·41 | 20·80 | — | 12·66 | = | 99·44 |

**Pyr.**—In the closed tube gives off water and oxygen, exfoliates slowly, and changes to a golden bronze color. B.B. becomes yellowish bronze to copper-red in color, and fuses slightly on the edges. With borax a manganese bead; on charcoal with soda a zinc coating. Dissolves in hydrochloric acid with the evolution of chlorine.

**Obs.**—Occurs at the calamine deposits of Sterling Hill, near Ogdensburg, Sussex Co., N. J. It is a product of the decomposition of franklinite. Named from χαλκός, *brass*, and φαινέσθαι, *to appear*, in allusion to the change of color on ignition.

**269. PSILOMELANE.** Derb Brunsten pt. *Wall.*, Min., 268, 1747. Magnesia indurata pt. *Cronst.*, Min., 106, 1758. Schwarz Braunsteinerz pt. *Wern.*, Bergm. J., 386, 1789. Verhärtetes Schwarz-Braunsteinerz pt. *Emmerling*, Min., **4**, 532, *Karsten*, Tab., 54, 1800. Verh. Schwarz-Manganerz pt. *Karst.*, Tab., 72, 1808. Schwarz-Eisenstein pt. *Wern.*, *v. Leonh.*, etc. Black Hematite, Black Iron Ore, Compact Black Manganese Ore. Hartmanganerz. Psilomelane *Haid*, Trans. R. Soc. Edinb., **11**, 129, 1827. Schwarzer Glaskopf *Germ.* Calvonigrit *Laspeyres*, J. pr. Ch., **13**, 226, 1876.

Massive and botryoidal; reniform; stalactitic.

H. = 5–6. G. = 3·7–4·7. Luster submetallic; dull. Streak brownish black, shining. Color iron-black, passing into dark steel-gray. Opaque.

**Comp.**—A hydrous manganese manganate in which part of the manganese is often replaced by barium or potassium, perhaps conforming to $H_4MnO_5$ (Laspeyres). The material analyzed is generally very impure, and the composition hence doubtful.

**Anal.**—1, 2, Laspeyres. J. pr. Ch., **13**, 1, 215, 1876. 3, 4, Langhans, Inaug. Diss., Jena, 1885. 5, 6, Gorgeu, Bull. Soc. Min., **13**, 21, 1890.

Also 5th Ed., p. 180; Rg., Min. Ch., 189–191, 1875; Heddle, Trans. R. Soc. Edinb., **30**, 427, 1882.

| | $MnO_2$ | MnO | O | BaO | CaO | MgO | $Na_2O$ | $K_2O$ | $Li_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Salm Chateau G. = 4·328 | ⅔ | 75·74 | 14·66 | — | 0·26 | 0·08 | 0·84 | 3·38 | 0·48 | 3·76 |
| | [$SiO_2$ 0·13, CuO 0·08, CoO 0·12, $Fe_2O_3$ 0·17, $Al_2O_3$ 2·53 = 102·28 | | | | | | | | | |
| 2. Kalteborn | | 67·87 | 13·66 | 0·20 | 0·10 | 0·20 | 0·39 | 0·38 | 0·21 | 6·42 |
| | [$SiO_2$ 0·36, CuO 1·15, CoO 0·47, $Fe_2O_3$ 3·77, $Al_2O_3$ 6·32 = 101·50 | | | | | | | | | |
| 3. Volle Rose | | 74·97 | 15·06 | 0·61 | 1·18 | 0·52 | 0·18 | 2·59 | — | 3·06 |
| | [PbO 0·06, $Fe_2O_3$ 0·37, $Al_2O_3$ 1·16, insol. 0·21 = 99·97 | | | | | | | | | |
| 4. Heinrichglück | | 69·76 | 13·93 | 6·50 | 0·52 | 0·66 | 0·76 | 2·17 | — | 3·90 |
| | [$Fe_2O_3$ 0·49, $Al_2O_3$ 0·87, $SiO_2$ 2·74, insol. 0·24 = 102·54 | | | | | | | | | |
| 5. Eisenbach | | 67·29 | 12·19 | 6·43 | 1·33 | 0·21 | 0·69 | 1·89 | *tr.* | 3·10 |
| | [CuO 0·50, $Al_2O_3$ 1·10, $Fe_2O_3$ 0·50, $SiO_2$ 3·12, insol. 2·47 = 100·82 | | | | | | | | | |
| 6. Romanèche | 69·2 | 8·5 | — | 16·8 | 0·4 | 0·2 | 0·1 | | — | 4·8 [= 100 |
| 7. Thuringia | 71·6 | 8·2 | — | 8·5 | 1·1 | 0·7 | — | 1·0 | — | 8·9 [= 100 |
| 8. Lorca | 83·6 | 8·2 | — | 1·0 | 0·2 | 0·2 | 1·4 | — | — | 5·4 [= 100 |

The psilomelane from Kalteborn, Siegen (anal. 2), is called *calvonigrite* by Laspeyres (l. c., p. 226).

**Pyr., etc.**—In the closed tube most varieties yield water, and all lose oxygen on ignition; with the fluxes reacts for manganese. Soluble in hydrochloric acid, with evolution of chlorine.

**Obs.**—This is a common ore of manganese. It is frequently in alternating layers with pyrolusite. It occurs in botryoidal and stalactitic shapes, in Devonshire and Cornwall; at Ilefeld in the Harz; also at Johanngeorgenstadt, Schneeberg, Ilmenau, Siegen, etc.; at Elgersburg and Oehrenstock, Thuringia, and Nadabula, Hungary. In the Orkneys.

It forms mammillary masses at Chittenden, Irasburg, and Brandon, Vt. In Independence Co., and elsewhere in Arkansas. With pyrolusite at Douglas, Hants Co., Nova Scotia.

Named from ψιλός, *smooth* or *naked*, and μέλας, *black*.

LITHIOPHORITE *Frenzel*, J. pr. Ch., **2**, 203, 1870; **4**, 353, 1871; Jb. Min., 55, 1879. Lithionpsilomelan *Laspeyres*, J. pr. Ch., **13**, 2, 1876.

A hydrated manganese ore containing (Winkler) 10 to 15 p. c. $Al_2O_3$, 1·2–1·4 p. c. $Li_2O$, and 12·6–15·4 p. c $H_2O$. Occurs in fine scales, also compact, botryoidal. H. = 3. G. = 3·14–3·36 Frenzel. Luster dull to metallic. Color bluish black. Streak blackish gray. Analyses, see Winkler, J. pr. Ch, **4**, 353, 1871, or 5th Ed., App. I, p. 9.

Found associated with quartz in many localities in the Schneeberg mining district, also occurs at Sayn, and near Siegen.

WAD. (A) BOG MANGANESE. Magnesia friabilis terriformis *Cronst.*, Min., 105, 1758. Earthy Ocher of Mang., Black Wad pt., *Kirwan*, Min., 1784. 1796. Schwarz Braunsteinerz Manganschaum, *Karst.*, Tab., 1808. Brauner Eisenrahm *Wern.* Bog Manganese. Ouatite *Huot.*, Min., 241. 1841. Groroilite *Berth.*, Ann. Ch. Phys., **51**, 19, 1832. Reissacherit *Haid.*, Jb. G. Reichs., **7**, 609, 1856. Wackenrodite *Adam*, Tabl. Min., 76, 1869. Vod *Ital.*

(B) ASBOLITE. ?Cobaltum nigrum *Agric.*, Bermann, 459, 1529. Svart Kobolt-Jord. Min.

Cob. terrea fuliginea, *Wall.*, Min., 235, 1747. Kobalt-Mulm, Ochra Cob. nigra, *Cronst.*, Min., 211, 1758. Kobolt-Erde, Schwarzer Erdkobalt, Russkobalt, Kobaltmanganerz, *Germ.* Earthy Cobalt, Black Cobalt Ocher. Cobalt oxydé noir *H.*, Tr., **4**, 1801. Kakochlor (fr. Lausitz) *Breith.*, Char., 240, 1832, Handb., 896, 1847. Asbolan (fr. Kamsdorf, etc.) *Breith.*, Handb., 332. 1847. Aithalite *Adam*, Tabl. Min., 78, 1869.

(C) LAMPADITE. Kupfermangan *Lampadius*, Neue Erfahr. im Gebiete der Ch., etc., **2**, 70. Kupfermanganerz *Breith.*, in Hoffm. Min., **4**, b, 201, 1818. Cupreous Manganese. Kuperschwärze *Germ.*, pt. Pelokonit *G. F. Richter*, Pogg., **21**, 591, 1831. Lampadite *Huot.*, Min., 238, 1841. Lepidophäit *Weisbach*, Jb. Min., **2**, 109, 1880; Schaumiges Wad.

In amorphous and reniform masses, either earthy or compact; also incrusting or as stains. Usually very soft, soiling the fingers; less often hard to H. = 6. G. = 3·0–4·26; often loosely aggregated, and feeling very light to the hand. Color dull black, bluish or brownish black.

The mineral substances here included are mixtures of various oxides, chiefly of manganese ($MnO_2$, also MnO), cobalt, copper, with also iron, and from 10 to 20 p. c. water. They can hardly be regarded as representing distinct mineral species.

The following are the chief varieties; some other closely related substances are described in the pages 259, 260.

A. BOG MANGANESE. Consists mainly of oxide of manganese and water, with some oxide of iron, and often silica, alumina, baryta. The Derbyshire wad sometimes gives the angle of barite, with which mineral it is in part impregnated. The wad of Leadhills is pseudomorphous after calcite. *Groroilite* occurs in roundish masses of a brownish black color, and reddish brown streak; with H. sometimes 6–6·5; it is from Groroi in Mayenne, Vicdessos, and Cautern, in France. *Reissacherite* is an ore analyzed by Hornig which is remarkable for containing a large amount of water. *Wackenrodite* is a wad from Baden containing 12 p. c. Pb (5th Ed., anal. 6, p. 182). The name *wad* is of English origin. Huot's name *ouatite* is from the French spelling of wad. The *wad* of the Cumberland miners is graphite,—a wrong use of the word, says Mawe in his Mineralogy of Derbyshire.

B. ASBOLITE. or *Earthy Cobalt.* Wad containing oxide of cobalt, which sometimes amounts to 32 p. c. Named from *ἀσβόλη*, *soot* (or *Asbolan* from *ἀσβολαῖνω*, to soil like soot). Breithaupt's *kakochlor* includes the ore from Rengersdorf in Lausitz, having H. = 2–2·5, G. = 3·15–3·29.

C. LAMPADITE, or *Cupreous Manganese.* A wad containing 4 to 18 p. c. of oxide of copper, and often oxide of cobalt also. It graduates into black copper (Melaconite or Kupferschwärze). G. = 3·1–3·2. *Peloconite* is a brownish black variety, having a liver-brown streak; H. = 3; G. = 2·508–2·567; from Remolinos in Chili; cf. also Frenzel, Jb. Min., 801, 1873. *Lepidophæite* is a kind from Kamsdorf, Thuringia. Structure fine fibrous and scaly. Very soft, soiling the fingers. G. = 2·89–3·04. Luster silky, dull. Color and streak reddish brown, the latter shining. Analysis, Jenkins: $MnO_2$ 58·77, MnO 9·59, CuO 11·48, $H_2O$ 21·05 = 100·89.

Analyses of the various kinds of wad vary very widely, see 5th Ed., pp. 181, 182. Also the following: A. Gorgeu, Bull. Soc. Min., **13**, 27, 1890; impurities in small amount have been deducted.

| | $MnO_2$ | MnO | BaO | CaO | MgO | CoO | ZnO | CuO | PbO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Loc. unknown | 66·2 | 7·9 | — | 5·0 | 2·0 | — | 1·6 | 0·2 | | *tr.* | 1·8 | [15·3] = 100 |
| 2. Romanèche | 68·1 | 7·6 | 16·2 | 1·7 | *tr.* | — | *tr.* | *tr.* | 0·3 | — | 0·8 | 5·3 = 100 |
| 3. Giessen | 83·1 | 7·1 | — | 0·26 | — | 0·5 | — | 0·5 | — | 4·05 | 1·0 | 3·49 = 100 |

The above ores are results of the decomposition of other ores—partly of oxides and sulphides, partly of manganesian carbonates. They occur at Clausthal, Ilmenau, Siegen, and many other places. Bog manganese is abundant in the counties of Columbia and Dutchess, N. Y., at Austerlitz, Canaan Centre, and elsewhere, where it occurs as a marsh deposit, and, according to Mather, has proceeded from the alteration of brown spar; also in the south-west part of Martinsburg, Lewis Co., in a swamp. There are large deposits of bog manganese at Blue Hill Bay, Dover, and other places in Maine.

*Asbolite* occurs at Riechelsdorf in Hesse; Saalfeld in Thuringia; at Nerchinsk in Siberia; at Alderley Edge in Cheshire; New Caledonia. An earthy cobalt occurs at Mine la Motte, Missouri, which contains 10 or 11 p. c. of oxide of nickel, besides oxide of cobalt and copper, with iron, lead, and sulphur; also near Silver Bluff, South Carolina, affording 24 p. c. of oxide of cobalt to 76 of oxide of manganese.

*Lampadite* is found at Schlackenwald, and at Kamsdorf near Saalfeld; at Lauterberg in the Harz. *Peloconite* is from Remolinos, Chili, where it occurs with chrysocolla, or malachite.

VARVICITE *Phillips*, Phil. Mag., **6**, 281, 1829, **7**, 284, 1830. Varvacite. An altered manganite, approaching wad in composition; from Warwickshire. Some similar substances are noted in 5th Ed., p. 182; another, from Austinville, Wythe Co., Va., has been analyzed by P. H. Walker (Am. Ch. J., **10**, 41, 1888):

G. = 3·27 $MnO_2$ 68·86 MnO 7·51 BaO 14·42 $H_2O$ 5·08 $SiO_2$ 1·98 $Fe_2O_3,Al_2O_3$ 2·23 = 100·08

## Appendix to Oxides.

**Bernonite** *Adam*, Tabl. Min., 73, 1869. Contains: $Al_2O_3$,CaO,$H_2O$.

**Delafossite** *C. Friedel*, C. R., **77**, 211, 1873. In small crystalline plates, cleavable into thin opaque laminæ. H. = 2·5. G. = 5·07. Color dark gray like graphite, with a more decided metallic luster. Streak blackish gray. Analysis, Friedel:

CuO 47·45 $Fe_2O_3$ 47·99 $Al_2O_3$ 3·52 = 98·96

B.B. fusible with difficulty, coloring the flame green. Easily soluble in hydrochloric acid, even in the cold. Found on yellowish white lithomarge from the region of Ekaterinburg, Siberia, perhaps also from Bohemia. Named for the mineralogist G. Delafosse.

**Hetærolite** *G. E. Moore*, Am. J. Sc., **14**, 423, 1877. Hetairite *Naumann-Zirkel*, Min., 11th Ed., p. 371, 1881. In botryoidal coatings with columnar-radiate structure. Brittle. H. = 5. G. = 4·933. Luster metallic to submetallic. Color black. Streak brownish black. Opaque. Contains zinc and manganese, and stated to be a zinc hausmannite, but no analyses published. Occurs intimately associated with chalcophanite (whence name from ἑταῖρος, *companion*) at the Passaic zinc mine, Sterling Hill, near Ogdensburg, Sussex Co., New Jersey.

**Heterogenite** *Frenzel*, J. pr. Ch., **5**, 404, 1872. Amorphous, massive in globular, reniform masses, with little luster. H. = 3. G. = 3·44. Color black, or blackish to reddish brown; streak dark brown. Composition, essentially, CoO.$2Co_2O_3 + 6H_2O$ (Frenzel). Analysis (after deduction of foreign constituents, Cu, Bi, etc.):

$\frac{2}{2}$ CoO 72·0 O 5·98 $H_2O$ 21·33 = 99·31

Soluble in dilute hydrochloric acid, with evolution of chlorine, leaving a residue. Occurs sparsely with calcite and pharmacolite in cobalt and nickel veins at Schneeberg; also at the St. Anton mine, Heubach, near Wittichen, Baden. It is a decomposition-product of smaltite.

**Heubachite.** Kobaltnickeloxydhydrat *F. Sandberger*, Ber. Ak. München, 238, 1876; Erzgänge, 413, 1885. In thin soot-like incrustations; in dendritic or small spherical aggregates. H. = 2·5. G. = 3·75. Color deep black. Streak submetallic. Composition perhaps $3(Co,Ni,Fe)_2O_3 + 4H_2O$. Analysis, Zeitschel, l. c.:

$Co_2O_3$ 65·50 $Ni_2O_3$ 14·50 $Fe_2O_3$ 5·13 $Mn_2O_3$ 1·50 $H_2O$ 12·59 = 99·22

Soluble in concentrated hydrochloric acid, with evolution of chlorine; the solution is deep bluish green, but on diluting with water becomes rose-red. Occurs as a secondary product coating barite at the St. Anton mine, in the Heubachthal, near Wittichen, Baden; also at the mine Eberhard, near Alpirsbach, Würtemberg.

**Hydrated Titanic Oxide.** Oxyde de titane hydraté *Gorceix*, Bull. Soc. Min., **7**, 179, 1884. In small flattened discs, like small beans. H. = 6. G. = 3·96. Color yellow, reddish, with brilliant luster, compact; also grayish with earthy fracture. They contain besides $TiO_2$ also $P_2O_5$, $V_2O_5$, $Al_2O_3$, and small quantities of iron, lime, cerium, didymium, and yttrium. B.B. decrepitate violently and yield acid water in the closed tube. Common in the diamond gravels of the valley of the Jequitinhonha near Diamantina, Brazil. They are called *favas* by the local miners. The existence of the same substance in the diamantiferous gravels was noted by Damour (Bull. Soc. G. Fr., **13**, 552, 1856).

**Hydrofranklinite** *W. T. Roepper*. Stated to be a new hydrous oxide of zinc, manganese, and iron. Occurs in small, very brilliant iron-black regular octahedrons; with highly perfect octahedral cleavage. H. = 4–4·5. G. = 4·06–4·09. From Sterling Hill, near Ogdensburg, Sussex Co., New Jersey. Not yet analyzed.

**Hydroplumbite** *Heddle*, Min. Mag., **8**, 201, 1889. In minute crystalline scales (hexagonal?), forming thin white flakes with pearly luster. Soluble in nitric acid, the solution showing the presence of lead alone. B.B. yields water. Inferred (but on very insufficient grounds) to be $3PbO.H_2O$. Observed with cerussite and pyromorphite upon galena. Locality doubtful, or perhaps from Cumberland or Leadhills.

**Namaqualite** *A. H. Church*, J. Ch. Soc., **23**, 1, 1870. In silky fibers and thin layers. H. = 2·5. G. = 2·49. Luster silky. Color pale blue. Transparent to translucent. Analysis, Church:

$Al_2O_3$ 15·29 CuO 44·74 MgO 3·42 CaO 2·01 $SiO_2$ 2·25 $H_2O$ 32·38 = 100·09

From Namaqualand, S. Africa. Approximates to $Al(OH)_3$. $2Cu(OH)_2$. $2H_2O$.

**Pelagite** *A. H. Church*, Min. Mag., **1**, 50, 1876. A name given by Church to the manganese nodules obtained by the Challenger Expedition from the bottom of the Pacific, between Japan and the Sandwich Is., at a depth of 2740 fathoms. Characters, as follows: Fracture conchoidal; fragile. H. = 3·5. Color brownish black. Powder between blackish brown and clove-brown. The nodules have a concretionary structure, consisting of concentric layers with a core of indurated red clay, and, in one case, of pumice. Anal., Church:

| $SiO_2$ | $MnO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $H_2O$ | |
|---|---|---|---|---|---|
| 10·37 | 30·22 | 3·30 | 20·02 | 34·55[a] | Cl 0·71, MgO, CaO, CuO, $Na_2O$, Cl, $P_2O_5$, etc., 0·83 = 100 |

[a] At a red heat 10·0 p. c.

Other analyses by Schwager (quoted by Gümbel, Ber. Ak. München, 189, 1878). also by Dittmar (Rep. Chall. Ex.), by J. Y. Buchanan (Proc. Roy. Soc. Ed., **9**, 287, 1877; Ch. News, **44**, 253, 1881), of specimens from different localities, show a wide variation in composition. These nodules obviously do not represent a mineral species. Cf. also Report Challenger Exped., **1**, 1885.

RABDIONITE *F. von Kobell*, Ber. Ak. München, 46, 1870. Stalactitic, in columnar or rod-like forms. Very soft, soiling the fingers. G. = 2·80. Luster dull, after rubbing is greasy to submetallic. Color black. Streak dark brown. Analysis:

$Fe_2O_3$ 45·00 $Mn_2O_3$ 13·00 $Al_2O_3$ 1·40 CuO 14·00 MnO 7·61 CoO 5·10 $H_2O$ 13·50 = 99·61

B.B. fuses at 3 to a steel-gray, magnetic globule. Soluble in hydrochloric acid with evolution of chlorine, giving an emerald-green solution. From Nizhni Tagilsk in the Ural. Near asbolite. Named from *ῥάβδιον, a little rod.*

TRANSVAALITE *T. B. McGhie* and *John Clark*, Eng. Mng. J., **50**, 96, 1890. An oxidation-product of cobalt arsenide occurring in black nodular masses forming veins in quartzyte. H. = 4. G. = 3·846. Analysis:

| $Co_2O_3$ | CoO | NiO | $H_2O$ | $Fe_2O_3$ | $Al_2O_3$ | CaO | MgO | $SiO_2$ | $As_2O_5$ |
|---|---|---|---|---|---|---|---|---|---|
| 65·80 | 3·82 | 0·15 | 12·19 | 2·41 | 2·68 | 0·40 | 0·30 | 6·35 | 5·79 = 99·89 |

Dissolves readily in hydrochloric acid with evolution of chlorine. Occurs at the cobalt mine, 30 miles north of Middleburg, Transvaal, South Africa. Cf. heterogenite and heubachite, above; also winklerite.

WINKLERITE *Breithaupt*, Jb. Min., 816, 1872. Amorphous, massive. Fracture conchoidal. H. = 3. G. = 3·432. Luster dull. Color bluish black to violet-black. Streak dark brown. A mixture regarded as containing a hydrated oxide of cobalt and nickel. Analyses.—1, Winkler, after deducting iron sesquioxide and silica. 2, Iwaya, Jb. Min., **2**, 256, 1882; the material analyzed consisted nearly one-half of a copper-calcium arsenate, deducting which the results in *2a* are obtained, for which the formula $(Co,Ni)_2O_3 + 2H_2O$ is calculated.

| | | $As_2O_5$ | CuO | $Co_2O_3$ | CoO | NiO | CaO | $CO_2$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | | 10·83 | 13·89 | 10·86 | 33·10[a] | | 5·62 | 10·90 | 14·80 = 100 | [= 100·49 |
| 2. | G. = 3·72 | 20·50 | 15·01 | — | 23·80 | 12·98 | 9·27 | — | 12·12 | $Bi_2O_3$ 1·70, O 14·11 |
| *2a.* | | — | — | — | 46·2 | 25·2 | — | — | 20·6 | O 8·0 = 100 |

[a] Co : Ni = 11 : 1.

B.B. infusible, coloring the flame green. With the fluxes gives reaction for cobalt. Effervesces with hydrochloric acid, and the solution thus obtained upon heating evolves chlorine.

Found at Oria near Almeria in the Sierra Alhamilla, Spain, occurring with galapectite, also with erythrite and malachite. Formed (Breith.) by the gradual decomposition of erythrite. Named after Dr. Clemens Winkler.

# VI. Oxygen-salts.

## 1. CARBONATES.

A. Anhydrous Carbonates.

B. Acid, Basic and Hydrous Carbonates.

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### A. Anhydrous Carbonates.

#### 1. Calcite Group. $RCO_3$. Rhombohedral.

| | | | | rr′ | ć |
|---|---|---|---|---|---|
| 270. | **Calcite** | $CaCO_3$ | | 74° 55′ | 0·8543 |
| 271. | **Dolomite** | $(Ca,Mg)CO_3$ | Tetartohedral | 73° 45′ | 0·8322 |
| | Normal Dolomite | $CaCO_3.MgCO_3$ | | | |
| 271A. | **Ankerite** | $CaCO_3.(Mg,Fe)CO_3$ | | 73° 48′ | 0·8332 |
| 272. | **Magnesite** | $MgCO_3$ | | 72° 36′ | 0·8112 |
| | Breunnerite | $(Mg,Fe)CO_3$ | | | |
| 272A. | **Mesitite** | $2MgCO_3.FeCO_3$ | | 72° 46′ | 0·8141 |
| | Pistomesite | $MgCO_3.FeCO_3$ | | 72° 42′ | 0·8129 |
| 273. | **Siderite** | $FeCO_3$ | | 73° 0′ | 0·8184 |
| | | $(Fe,Mn)CO_3$ | | | |
| 274. | **Rhodochrosite** | $MnCO_3$ | | 73° 0′ | 0·8184 |
| | Manganosiderite | $(Mn,Fe)CO_3$ | | | |
| | Manganocalcite pt. | $(Mn,Ca)CO_3$ | | | |
| 275. | **Smithsonite** | $ZnCO_3$ | | 72° 20′ | 0·8063 |
| | Monheimite | $(Zn,Fe)CO_3$ | | | |
| 276. | **Sphærocobaltite** | $CoCO_3$ | | | |

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#### 2. Aragonite Group. $RCO_3$. Orthorhombic.

| | | | ă : b̄ : ć |
|---|---|---|---|
| 277. | **Aragonite** | $CaCO_3$ | 0·6224 : 1 : 0·7206 |
| 278. | **Bromlite** | $(Ca,Ba)CO_3$ | |
| 279. | **Witherite** | $BaCO_3$ | 0·6032 : 1 : 0·7302 |
| 280. | **Strontianite** | $SrCO_3$ | 0·6090 : 1 : 0·7239 |
| 281. | **Cerussite** | $PbCO_3$ | 0·6100 : 1 : 0·7230 |

### 3. Barytocalcite Group. Monoclinic.

| | | | $\grave{a} : \bar{b} : \acute{c}$ | $\beta$ |
|---|---|---|---|---|
| 282. | **Barytocalcite** | $CaCO_3.BaCO_3$ | 0·7717 : 1 : 0·6255 | 73° 52′ |

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| | | |
|---|---|---|
| 283. | **Bismutosphærite** | $Bi_2CO_5$ |

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### 4. Parisite Group. Fluocarbonates.

| | | | | |
|---|---|---|---|---|
| 284. | **Parisite**<br>Kischtimite | $(CaF)(CeF)Ce(CO_3)_3$? | Hexagonal | $\acute{c}$ = 3·2891 |
| 285. | **Bastnæsite**<br>Weibyeïte | $[(Ce,La,Di)F]CO_3$ | | |

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### 5. Phosgenite Group. Chlorocarbonate.

| | | | | |
|---|---|---|---|---|
| 286. | **Phosgenite** | $(PbCl)_2CO_3$ | Tetragonal | $\acute{c}$ = 1·0876 |

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### 1. Calcite Group. $RCO_3$. Rhombohedral.

**270. CALCITE.** Marmor (Marble) pt. *Plin.* Lapis calcarius. Saxum calcis (*Calx* in Latin meaning burnt lime), Kalchstein *Agric.*, De Nat. Foss., 320, Interpr., 468, 1546. Kalksten *Wall.*, Min., 1747. Spatig Kalksten, Kalkspat, *Cronst.*, Min., 13, 1758. Kalk, Kalkspath, Kalkstein, *Germ.* Calx aerata *Bergm.*, 1774, and Opusc., 1, 24, 1780. Calc Spar; Calcareous Spar; Limestone; Carbonate of Lime; Calcium carbonate. Chaux carbonatée *Fr.* Calcit *Haid.*, Handb., 498, 1845. Caliza, Espato caliza, *Span.*

Rhombohedral. Axis $\acute{c}$ = 0·85430; $0001 \wedge 10\bar{1}1$ = 44° 36′ 34″ Malus, Wollaston[1].

**Forms**, pt.[2]:
$c\ (0001,\ O)$
$m\ (10\bar{1}0,\ I)$
$a\ (11\bar{2}0,\ i\text{-}2)$
$\zeta\ (31\bar{4}0,\ i\text{-}\frac{4}{3})$
$\pi\ (11\bar{2}3,\ \frac{2}{3}\text{-}2)$
$\alpha\ (44\bar{8}3,\ \frac{8}{3}\text{-}2)$
$\xi\ (22\bar{4}1,\ 4\text{-}2)$
$\delta\ (33\bar{6}1,\ 6\text{-}2)$
$\gamma\ (8{\cdot}8{\cdot}\overline{16}{\cdot}3,\ \frac{16}{3}\text{-}2)$
$u\ (10\bar{1}4,\ \frac{1}{4})$
$r\ (10\bar{1}1,\ R)$
$k\ (50\bar{5}2,\ \frac{5}{2})$
$M\ (40\bar{4}1,\ 4)$
$\tau\ (70\bar{7}1,\ 7)$
$\vartheta\ (10{\cdot}0{\cdot}\overline{10}{\cdot}1,\ 10)$
$\nu\ (13{\cdot}0{\cdot}\overline{13}{\cdot}1,\ 13)$
$\rho\ (16{\cdot}0{\cdot}\overline{16}{\cdot}1,\ 16)$
$\omega\ (28{\cdot}0{\cdot}\overline{28}{\cdot}1,\ 28)$
$e\ (01\bar{1}2,\ -\frac{1}{2})$
$D\ (03\bar{3}5,\ -\frac{3}{5})$
$Z\ (02\bar{2}3,\ -\frac{2}{3})$
$l\ (04\bar{4}5,\ -\frac{4}{5})$
$\epsilon\ (01\bar{1}1,\ -1)$
$L\ (08\bar{8}7,\ -\frac{8}{7})$
$i\ (06\bar{6}5,\ -\frac{6}{6})$
$\phi\ (05\bar{5}4,\ -\frac{5}{4})$
$A\ (04\bar{4}3,\ -\frac{4}{3})$
$\Pi\ (07\bar{7}5,\ -\frac{7}{5})$
$h\ (03\bar{3}2,\ -\frac{3}{2})$
$f\ (02\bar{2}1,\ -2)$
$g\ (05\bar{5}2,\ -\frac{2}{2})$
$\psi\ (03\bar{3}1,\ -3)$
$\chi\ (07\bar{7}2,\ -\frac{7}{2})$
$\eta\ (04\bar{4}1,\ -4)$
$s\ (05\bar{5}1,\ -5)$
$d\ (08\bar{8}1,\ -8)$
$\Sigma\ (0{\cdot}11{\cdot}\overline{11}{\cdot}1,\ -11)$
$\Phi\ (0{\cdot}14{\cdot}\overline{14}{\cdot}1,\ -14)$

Zone *ra*

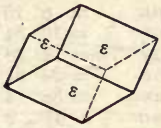
$\upsilon\ (61\bar{7}5,\ 1^{\frac{7}{5}})$
$\sigma\ (51\bar{6}4,\ 1^{\frac{3}{2}})$
$\lambda\ (31\bar{4}2,\ 1^{2})$
$n\ (41\bar{5}3,\ 1^{\frac{5}{3}})$
$v\ (21\bar{3}1,\ 1^{3})$
$\Upsilon\ (53\bar{8}2,\ 1^{4})$
$y\ (32\bar{5}1,\ 1^{5})$
$\varsigma\ (43\bar{7}1,\ 1^{7})$
$\mu\ (54\bar{9}1,\ 1^{9})$
$\Omega_1\ (6{\cdot}5{\cdot}\overline{11}{\cdot}1,\ 1^{11})$
$W\ (13{\cdot}11{\cdot}\overline{24}{\cdot}2,\ 1^{12})$
$X\ (7{\cdot}6\ \overline{13}{\cdot}1,\ 1^{13})$

Zone *re*

$C\ (61\bar{7}8,\ {\frac{5}{8}}^{\frac{7}{5}})$
$q\ (51\bar{6}7,\ {\frac{4}{7}}^{\frac{3}{2}})$
$E\ (41\bar{5}6,\ {\frac{1}{2}}^{\frac{5}{3}})$
$w\ (31\bar{4}5,\ {\frac{2}{5}}^{2})$
$V\ (62\bar{8}1,\ 4^{2})$
$G\ (52\bar{7}9,\ {\frac{1}{3}}^{\frac{7}{5}})$
$t\ (21\bar{3}4,\ {\frac{1}{4}}^{3})$
$H\ (32\bar{5}4,\ {\frac{1}{4}}^{5})$
$\Psi\ (7{\cdot}4{\cdot}\overline{11}{\cdot}15,\ {\frac{1}{5}}^{\frac{11}{3}})$
$Y\ (42\bar{6}5,\ {\frac{2}{5}}^{3})$
$F\ (42\bar{6}1,\ 2^{3})$
$Q\ (8{\cdot}16{\cdot}\overline{24}{\cdot}5,\ {\frac{8}{5}}^{3})$
$\Gamma\ (35\bar{8}4,\ -{\frac{1}{2}}^{4})$
$\varDelta\ (23\bar{5}2,\ -{\frac{1}{2}}^{5})$
$z\ (12\bar{3}5,\ -{\frac{1}{5}}^{3})$
$p\ (4{\cdot}8{\cdot}\overline{12}{\cdot}5,\ -{\frac{4}{5}}^{3})$
$\Theta\ (12\bar{3}1,\ -1^{3})$
$\beta\ (24\bar{6}1,\ -2^{3})$
$x\ (13\bar{4}1,\ -2^{2})$
$B\ (2{\cdot}8{\cdot}\overline{10}{\cdot}3,\ -2^{\frac{5}{3}})$
$K\ (14\bar{5}3,\ -1^{\frac{5}{3}})$
$N\ (4{\cdot}16{\cdot}\overline{20}{\cdot}3,\ -4^{\frac{5}{3}})$
$R\ (25\bar{7}3,\ -1^{\frac{7}{3}})$

1.

2.



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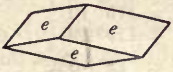

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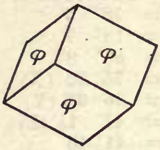

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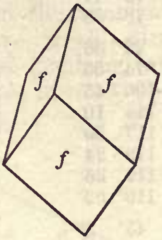

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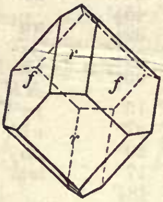

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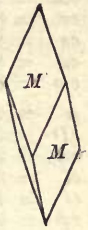

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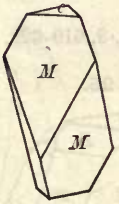

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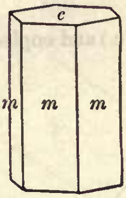

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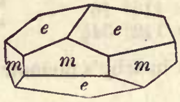

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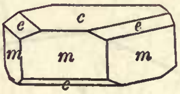

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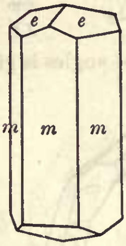

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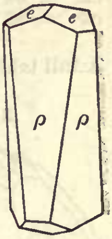

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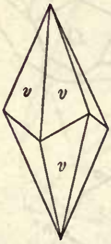

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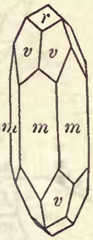

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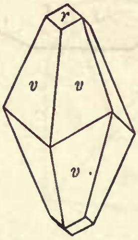

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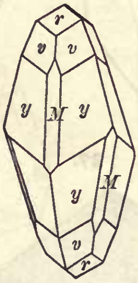

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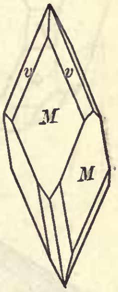

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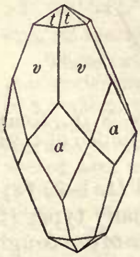

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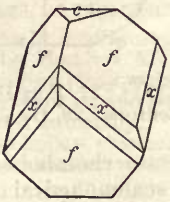

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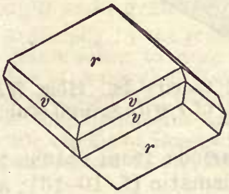

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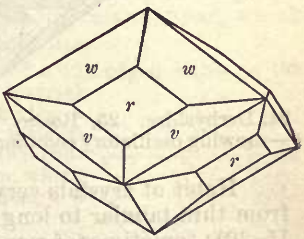


$cu = 13^\circ\ 5'$
$cr = 44^\circ\ 36\tfrac{1}{2}'$
$ck = 67^\circ\ 56'$
$cM = 75^\circ\ 47'$
$c\tau = 81^\circ\ 45\tfrac{1}{2}'$
$c\nu = 85^\circ\ 32\tfrac{1}{2}'$
$c\rho = 86^\circ\ 22\tfrac{1}{2}'$
$c\omega = 87^\circ\ 55\tfrac{1}{2}'$

$ce = 26^\circ\ 15'$
$cD = 30^\circ\ 37'$
$cZ = 33^\circ\ 20'$
$cl = 38^\circ\ 17'$
$ci = 49^\circ\ 48\tfrac{1}{2}'$
$c\phi = 50^\circ\ 57\tfrac{1}{2}'$
$ch = 55^\circ\ 57'$
$cf = 63^\circ\ 7'$
$c\psi = 71^\circ\ 20'$
$c\chi = 73^\circ\ 51'$
$cs = 78^\circ\ 32'$
$cd = 82^\circ\ 47'$
$c\Sigma = 84^\circ\ 44'$
$c\Phi = 85^\circ\ 51\tfrac{1}{2}'$

$c\pi = 29^\circ\ 40'$
$c\alpha = 66^\circ\ 18'$
$c\xi = 73^\circ\ 41'$
$c\delta = 78^\circ\ 58'$

$uu' = 23^\circ\ 56'$
$rr' = {}^*74^\circ\ 55'$
$kk' = 106^\circ\ 45'$
$MM' = 114^\circ\ 10'$
$\tau\tau' = 117^\circ\ 59'$
$\nu\nu' = 119^\circ\ 24'$
$\rho\rho' = 119^\circ\ 36'$
$\omega\omega' = 119^\circ\ 52'$

$ee' = 45^\circ\ 3'$
$DD' = 52^\circ\ 21'$
$ZZ' = 56^\circ\ 50'$
$ll' = 64^\circ\ 53\tfrac{1}{2}'$
$ii' = 82^\circ\ 50'$
$\phi\phi' = 84^\circ\ 32\tfrac{1}{2}'$
$hh' = 91^\circ\ 42'$
$ff' = 101^\circ\ 9'$
$\psi\psi' = 110^\circ\ 16'$
$\chi\chi' = 112^\circ\ 34\tfrac{1}{2}'$

$ss' = 116^\circ\ 9'$
$dd' = 118^\circ\ 27'$
$\Sigma\Sigma' = 119^\circ\ 10'$
$\Phi\Phi' = 119^\circ\ 29'$

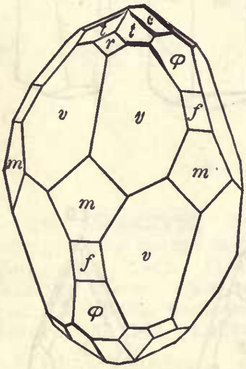
$\upsilon\upsilon^{\mathrm{v}} = 12^\circ\ 0'$
$\lambda\lambda' = 77^\circ\ 49'$
$\lambda\lambda^{\mathrm{v}} = 24^\circ\ 10'$
$nn' = 78^\circ\ 5'$
$nn^{\mathrm{v}} = 18^\circ\ 7'$
$nn^{\mathrm{vi}} = 96^\circ\ 8'$
$vv' = 75^\circ\ 22'$ (X)
$vv^{\mathrm{v}} = 35^\circ\ 36'$ (Y)
$vv^{\mathrm{vi}} = 47^\circ\ 1\tfrac{1}{2}'$ (Z)
$\Upsilon\Upsilon^{\mathrm{v}} = 41^\circ\ 46'$
$yy' = 70^\circ\ 59'$
$yy^{\mathrm{v}} = 45^\circ\ 32'$
$yy^{\mathrm{vi}} = 29^\circ\ 16'$
$\varsigma\varsigma' = 68^\circ\ 21'$
$\varsigma\varsigma^{\mathrm{v}} = 49^\circ\ 50'$
$EE^{\mathrm{v}} = 13^\circ\ 3\tfrac{1}{2}'$
$ww' = 49^\circ\ 23'$
$ww^{\mathrm{v}} = 16^\circ\ 0'$

$VV' = 91^\circ\ 3'$
$VV^{\mathrm{v}} = 27^\circ\ 31'$
$tt' = 41^\circ\ 55'$
$tt^{\mathrm{v}} = 20^\circ\ 36\tfrac{1}{2}'$
$HH^{\mathrm{v}} = 33^\circ\ 50'$
$YY' = 27^\circ\ 21'$
$FF' = 37^\circ\ 30'$
$xx' = 26^\circ\ 44'$
$xx^{\mathrm{v}} = 87^\circ\ 51'$

$a\mu = 8^\circ\ 15'$
$as = 10^\circ\ 34'$
$ay = 14^\circ\ 38'$
$av = 23^\circ\ 31'$
$an = 38^\circ\ 4'$
$a\sigma = 41^\circ\ 2'$
$a\upsilon = 42^\circ\ 59\tfrac{1}{2}'$
$aC^{\mathrm{v}} = 61^\circ\ 18\tfrac{1}{2}'$
$aE^{\mathrm{v}} = 62^\circ\ 56\tfrac{1}{2}'$
$aw^{\mathrm{v}} = 65^\circ\ 19'$
$at^{\mathrm{v}} = 69^\circ\ 2'$
$a\pi^{\mathrm{v}} = 75^\circ\ 40'$
$mv = 28^\circ\ 4'$

A full table of angles is given in Irby's memoir (l. c.) and copied in Zs. Kr., 3, 610–622, 1879.

24.



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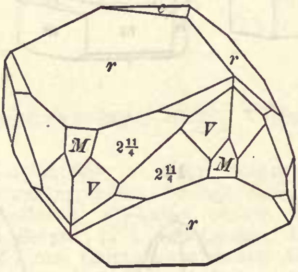

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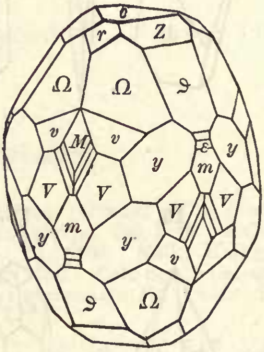

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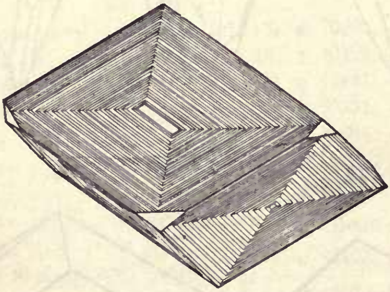
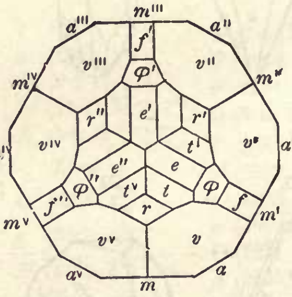


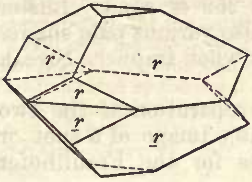
28.



24, Derbyshire. 25, Rossie. 26, Canary Is., Hbg. ($\Omega = \frac{10}{17}^{\frac{35}{9}}$) 27, Port Henry, N. Y., Kemp—showing oscillatory combination of *r* with several scalenohedrons. 28, Basal projection of f. 24.

Habit of crystals very varied: from obtuse to acute rhombohedral (f. 1–9, 14); from thin tabular to long prismatic (f. 10–13); and scalenohedral of many types (f. 15–20); sometimes of wonderful complexity (cf. f. 26). The basal plane *c* often rough and sometimes exhibiting a pearly luster; the rhombohedron *r* not very common except in Iceland Spar; *e* $(01\bar{1}2)$, *f* $(02\bar{2}1)$, *M* $(40\bar{4}1)$, all common; $\phi$ $(05\bar{5}4)$ is the cuboid of Haüy (f. 4); the scalenohedron *v* $(21\bar{3}1)$ very common both alone and in combination, also *y* $(31\bar{5}1)$. Faces in the zone *rr′* over *e* (f. 28) often striated ∥ edge *r*/*r′*, also *e* when alone rounded over in this direction; striations in other zones common. Crystals grouped in parallel position, large scalenohedral crystals thus built up of minute rhombohedrons; also in rosettes and other forms.

29.



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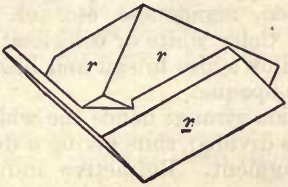

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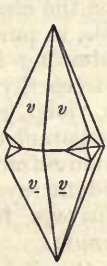

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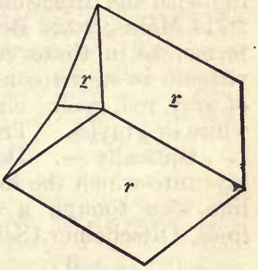

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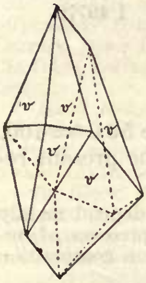
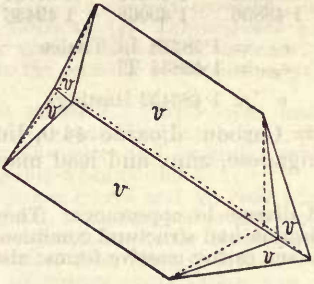


33*a*.



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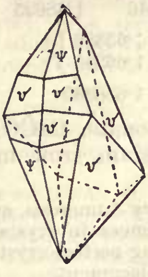

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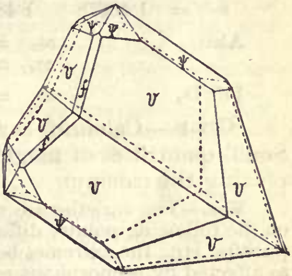

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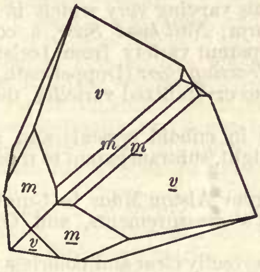

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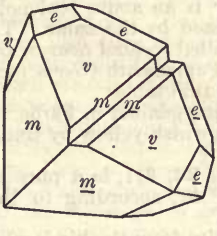

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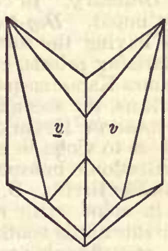
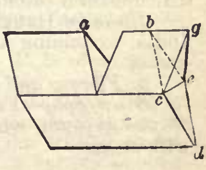


29, 30, Rossie, Pfd. 33–35, Guanajuato, Pirsson—the forms (also f. 36, 37) distorted by the extension of certain of the scalenohedral faces. 36, 37, England, Haid. 38, Sbk.

Twins[3]: (1) tw. pl. *c*, common, the crystals having the same vertical axis (f. 29–31). (2) tw. pl. *e* $(01\bar{1}2)$, very common, the vertical axes inclined 127° 29½′ and 52° 30½′ (f. 32–35); often producing twinning lamellæ as in Iceland Spar, which are, in many cases, of secondary origin as in granular limestones.

These twins can be readily formed artificially by the pressure of a dull-edged knife on the obtuse cleavage edge as at *a* (f. 39), the result being to cause the reversal of a portion, this taking place without loss of transparency and giving a re-entrant angle between *ced* and *ceg*; the corresponding twinning lamellæ can also be produced artificially. These twinning lamellæ are often connected with minute hollow channels (hohle Canäle of Rose) within, which produce a kind of asterism when a candle-flame is viewed through a cleavage mass.

39.



(3) Tw. pl. *r*, not common; the crystals have their vertical axes inclined 90° 46′ and 89° 14′, and have one cleavage face in

common (f. 36, 37). (4) tw. pl. $f\,(02\bar{2}1)$, rare (f. 38); the axes intersect at angles of 53° 46′ and 126° 14′.

Also fibrous, both coarse and fine; sometimes lamellar; often granular; from coarse to impalpable, and compact to earthy. Also stalactitic, tuberose, nodular, and other imitative forms.

Cleavage: $r$ highly perfect. Parting $\parallel e\ (01\bar{1}2)$ due to twinning, also $\parallel a$ less common, Mgg. Fracture conchoidal, obtained with difficulty. H. = 3, but varying with the direction on the cleavage face; earthy kinds softer. G. = 2·713 Gdt., 2·714 Malus, 2·723 Beud., in pure crystals, but varying somewhat widely in impure forms, as in those containing iron, manganese, etc. (cf. p. 269 *et seq.*). Luster vitreous to subvitreous to earthy. Color white or colorless; also various pale shades of gray, red, green, blue, violet, yellow; also brown and black when impure. Streak white or grayish. Transparent to opaque.

Optically −. Double refraction strong; hence the wide separation of the two rays into which the incident ray is divided, thus giving a double image of a spot or line seen though a cleavage fragment. Refractive indices for the Fraunhofer lines, Ditscheiner (Schrauf):

| | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| $\omega$ = | 1·65305 | 1·65454 | 1·65849 | 1·66362 | 1·66812 | 1·67642 | 1·68338 |
| $\epsilon$ = | 1·48378 | 1·48446 | 1·48625 | 1·48856 | 1·49066 | 1·49458 | 1·49770 |

Also $\omega_r$ = 1·65382 Li $\epsilon_r$ = 1·48418 Li Thalen
$\omega_{gr}$ = 1·66285 Tl $\epsilon_{gr}$ = 1·48834 Tl

For $D_2$ $\omega$ = 1·658389 $\epsilon$ = 1·486452 Hastings

**Comp.**—Calcium carbonate, $CaCO_3$ = Carbon dioxide 44·0, lime 56·0 = 100. Small quantities of magnesium, iron, manganese, zinc, and lead may be present replacing the calcium.

**Var.**—The varieties are very numerous, and diverse in appearance. They depend mainly on the following points: differences in crystallization and structural condition, presence of impurities, etc., the extremes being perfect crystals and earthy massive forms; also on composition as affected by isomorphous replacement.

### A. Varieties based chiefly upon crystallization and accidental impurities.

1. *Ordinary.* In crystals and cleavable masses, the crystals varying very widely in habit as already noted. *Dog-tooth Spar* is an acute scalenohedral form; *Nail-head Spar*, a composite variety having the form suggested by the name. The transparent variety from Iceland, used for polarizing prisms, etc., is called *Iceland Spar* or *Doubly-refracting Spar* (Doppelspath, *Germ.*). The names Kanonenspath and Papierspath (*Germ.*) are given to crystallized varieties, the first to long prisms, the second to very thin tables.

*Brunnerite* Esmark, from amygdaloid in Färöe, is calcite in cuboid crystals and massive, smalt-blue to violet in color, brownish-yellow by transmitted light, subtransparent to translucent, and chalcedonic in aspect.

*Reichite* Breith., B. H. Ztg., **24**, 311, is a pure calcite from Alston-Moor in Cumberland, white in color, with $rr' = 74° 40'$, according to Breithaupt's measurements, and G. = 2·666–2·677; this needs confirmation.

As regards color calcite varies from the kinds which are perfectly clear and colorless through yellow, pink, purple, blue, to brown and black. The color is usually pale except as caused by impurities. These impurities may be pyrite, native copper, malachite, sand, etc.; they are sometimes arranged in symmetrical form, as depending upon the growth of the crystals and hence produce many varieties.

*Fontainebleau limestone*, Lassonne, Mem. Ac. Paris, 1775, Chaux carbonatée quartzifère *H.*, 1801. Crystals from Fontainebleau and Nemours, France, which contain a large amount of sand, some 50 to 63 p. c. according to Delesse, with G. = 2·53–2·84. the latter from one containing 57 p. c. of sand. Similar forms occur at other localities, the rhombohedron $f\ (02\bar{2}1, -2)$ being the one commonly observed. A kind from Gersthof near Vienna consists of calcite and quartz grains in the ratio of 2 : 3 (Berwerth, Ann. Mus. Wien, **1**, 31 not., 1886). The well-known crystals from Heidelberg have lost their calcite and are pseudomorphs of red sandstone after scalenohedral calcite; similar forms occur in the Vosges.

*Hislopite* Haughton, Phil. Mag., **17**, 16, 1859. A grass-green cleavable calcite from Central India, containing about 17 p. c. of a siliceous material like glauconite, to which the color is owing.

2. *Fibrous and lamellar kinds.*

*Satin Spar* (Faserkalk, Atlasspath *Germ.*). Fine fibrous, with a silky luster. Resembles fibrous gypsum, which is also called satin spar, but is much harder than gypsum and effervesces with acids.

*Argentine* Kirwan, Min., 1, 104, 1794; *Schieferspath* Hofmann, Bergm., J., 188, 1789; Slate Spar. A pearly lamellar calcite, the lamellæ more or less undulating; color white, grayish, yellowish, or reddish.

*Aphrite,* in its harder and more sparry variety (*Schaumspath* Freiesleben), is a foliated white pearly calcite, near argentine; in its softer kinds (*Schaumerde* W., *Silvery Chalk* Kirwan, *Ecume de Terre* H.) it approaches chalk, though lighter, pearly in luster, silvery white or yellowish in color, soft and greasy to the touch, and more or less scaly in structure.

3. *Granular massive to cryptocrystalline kinds: Limestone, Marble, Chalk.*

*Granular limestone* or *Saccharoidal limestone,* so named because like loaf sugar in fracture. The texture varies from quite coarse to very fine granular, and the latter passes by imperceptible shades into *compact* limestone. The colors are various, as white, yellow, reddish, green, and usually they are clouded and give a handsome effect when the material is polished. When such limestones are fit for polishing, or for architectural or ornamental use, they are called *marbles.* (*a*) *Statuary marble* is pure white, fine grained, and firm in texture. The *Parian* marble from the island of Paros (the *Lychnites* of the ancients), *Pentelican* from the quarries near Athens, *Luni* marbles of the coast of Tuscany, and the *Carrara* of Modena, Italy, are among the best of statuary marbles. *Architectural* marble includes both white and colored. (*b*) The *Cipolin* of Italy is white, with pale greenish shadings from green talc; it does not stand the weather well. (*c*) *Giallo antico* of Italy is ocher-yellow to cream yellow, with some whitish spots. (*d*) The *Siena,* or *Brocatello de Siena,* is yellow, veined or clouded with bluish red, having sometimes a tinge of purple. (*e*) The *Mandelato* is a light red with yellowish white spots. A red kind from Tiree (or Tyree), one of the inner Hebrides, Scotland, has different shades of red, as carnelian, rose red, flesh-red, reddish white; one from Tennessee is clouded with brownish and purplish red. (*f*) The *Bardiglio* is gray with crowded dark well defined cloudings, consisting partly of serpentine, from Corsica. (*g*) *Turquois-blue* marble, from the quarries of Seravezza near Carrara, has a fine grayish blue color, veined with white. (*h*) *Verd-Antique* is clouded green, the color, owing to the presence of serpentine, yellowish green to bluish green (see also serpentine).

*Hard compact limestone.* Varies from nearly pure white, through grayish, drab, buff, yellowish, and reddish shades, to bluish gray, dark brownish gray, and black, and sometimes variously veined. The colors dull, excepting ocher-yellow and ocher-red varieties. Many kinds make beautiful marble when polished.

(*a*) *Black,* (*b*) *yellow,* (*c*) *red* and (*d*) *fetid* kinds are common. Red oxide of iron produces different shades of red, from flesh-red or paler to opaque blood-red and brownish red, according to the proportions present; the latter Hausmann names *Hæmatoconite* (from *ἅιμα, blood,* and *κόνις, powder,* Handb., 1304, 1847), as in the marble *Rosso antico* of Italy. The hydrated oxide causes yellowish to opaque ocher-yellow and yellowish brown; the deeper, *Sideroconite* of Hausmann (ib., 1306). Shades of green are due to iron protoxide, chromium oxide, iron silicate. The black marbles colored by carbonaceous matter are named *Anthraconite* (from *ἄνθραξ, coal*), by v. Moll, *Lucullan* by John, and *Lucullite* by Jameson; they include the *Marmor Luculleum* of Pliny. The *Nero Antico* of the Italians belongs here. The bituminous or *fetid* limestones are also called anthraconite when black; and also, from the odor, *Swinestone* (syn. *Stinkstone; Stinkstine, Saustein, Stinkkalk,* Germ.), some being light gray in color.

The *Portor* (*d*), called sometimes Egyptian marble, is of black color, handsomely veined with yellow dolomite, and comes from Porto-Venere, near Spezia; the rock is of the lower Lias. (*e*) *Panno-di-Morte* (Death's Robe) of Italy is black with some white fossil shells. (*f*) *Marble of Languedoc* is fine deep red or brownish red, with some white and gray due to fossils, and is from St. Beaumé in France. (*g*) *Griotte,* from the Dept. of Herault, France, has a reddish brown base, with somewhat regularly arranged spots of clear red, and some whitish round spots due to goniatites. (*h*) *Sarencolin* marble, from the Pyrenees, is deep red mixed with gray and yellow. (*i*) Bird's-eye marble is gray, with whitish crystalline points, and is from central New York.

(*k*) *Shell-marble* includes kinds consisting largely of fossil shells; (*l*) *Madreporic* marble, those containing corals; (*m*) *Encrinal,* those containing encrinal (crinoidal) remains. (*n*) *Lumachelle* or *fire-marble* is a dark brown shell-marble, with brilliant fire-like or chatoyant internal reflections proceeding from the shells, from Bleiberg in Carinthia; and another kind, with the shells yellow, comes from Astrachan.

(*o*) *Ruin-marble* is a kind of a yellow to brown color, showing, when polished, figures bearing some resemblance to fortifications, temples, etc., in ruins, due to infiltration of iron oxide: from Florence, Italy.

(*p*) *Lithographic stone* is a very even-grained compact limestone, usually of buff or drab color; as that of Solenhofen.

(*q*) *Breccia marble* is made of fragments of limestone cemented together, and is often very beautiful when the fragments are of different colors, or are embedded in a base that contrasts well. The colors are very various.

(*r*) *Pudding-stone* marble consists of pebbles or rounded stones cemented. It is often called improperly breccia marble.

(*s*) *Hydraulic limestone* is an impure limestone which after ignition sets, i.e., takes a solid form under water, due to the formation of a silicate. The French varieties contain 2 or 3 p. c. of magnesia, and 10 to 20 of silica and alumina (or clay). The varieties in the United States contain 20 to 40 p. c. of magnesia, and 12 to 30 p. c. of silica and alumina. A variety worked extensively at Rondout, N. Y., afforded Professor Beck (Min. N. Y., 78): $CO_2$ 34·20, CaO 25·50, MgO 12·35, $SiO_2$ 15·37, $Al_2O_3$ 9·13, $Fe_2O_3$ 2·25. Iron is rather prejudicial to it than otherwise. Vicat observes that in the best French there are 20 to 30 p. c. of clay, and in that only moderately good 10 to 12 p. c. An impure limestone of France, which needs no sand for making the cement, it containing calcite 54 p. c., clay 31, iron oxide 15 = 100, is called *plaster-cement* (Dufr. Min.).

*Soft compact limestone.* (*a*) *Chalk* is white, grayish white, or yellowish, and soft enough to leave a trace on a board. The consolidation into a rock of such softness may be owing to the fact that the material is largely the hollow shells of rhizopods.

The *creta* of the Romans (usually translated *chalk*) was mostly a white clay, true chalk being little known to the ancients. The kind described by Pliny as the most inferior kind of cretaceous earth, and as used for marking the feet of slaves, was probably true chalk.

(*b*) *Calcareous marl* (Mergelkalk *Germ.*) is a soft earthy deposit, often hardly at all consolidated, with or without distinct fragments of shells; it generally contains much clay, and graduates into a calcareous clay.

*Concretionary massive.* (*a*) *Oolite* (Rogenstein *Germ.*) is a granular limestone, but its grains are minute rounded concretions, looking somewhat like the roe of fish, the name coming from *'ωόν*, *egg*. It occurs among all the geological formations, from the Lower Silurian to the most recent, and it is now forming about the coral reefs of Florida. A more or less completely silicified oolite occurs near College Center, Penn. (Barbour and Torrey, Am. J. Sc., **40**, 246, 1890). (*b*) *Pisolite* (Erbsenstein *W.*) consists of concretions as large often as a small pea, or even larger, the concretions having usually a distinct concentric structure. It is formed in large masses in the vicinity of the Hot Springs at Carlsbad in Bohemia.

Minute concretionary forms having a spherical concentric structure within and externally the form of a regular pentagonal dodecahedron (not pyritohedron) have been obtained from a calcareous spring near Eagle Rock, Idaho; their form has not been explained.

*Deposited from calcareous springs, streams, or in caverns, etc.*

(*a*) *Stalactites* (Tropfstein *Germ.*) are the calcareous cylinders or cones that hang from the roofs of limestone caverns, and which are formed from the waters that drip through the roof; these waters hold some calcium bicarbonate in solution, and leave calcium carbonate to form the stalactite when evaporation takes place. Stalactites vary from transparent to nearly opaque; from a crystalline structure with single cleavage directions to coarse or fine granular cleavable and to radiating fibrous; from a white color and colorless to yellowish gray and brown.

(*b*) *Stalagmite* is the same material covering the floors of caverns, it being made from the waters that drop from the roofs, or from sources over the bottom or sides; cones of it sometimes rise from the floor to meet the stalactites above. It consists of layers; but these are very irregularly curved, or bent, owing to the knobs and conelets that are made over the floor; and polished specimens generally owe much of their beauty to the agate-like or onyx-like bandings.

Stalagmite, or a solid kind of travertine (see below) when on a large scale, is the *Alabastrites* or alabaster stone, in part (if not wholly) of Theophrastus, Pliny, and other ancient writers; that is, the stone of which ointment vases, of a certain form called *alabasters*, were made. (See GYPSUM, p. 936.) A locality near Thebes, now well known, was largely explored by the ancients, and the material has often been hence called *Egyptian alabaster*. It was also formerly called *onyx* and *onychites* because of its beautiful banded structure; Horace, in the 3d book of his Odes, speaks of an ointment vase of onyx. Pliny mentions columns of "onyx," or "alabastrites," that were 32 ft. in height, and mentions Damascus as affording a kind whiter than that of Thebes. In the arts it is often now called *Oriental Alabaster* or *onyx marble;* and sometimes also *Gibraltar-stone*, from the occurrence of the material in a cavern at Gibraltar. Very beautiful marble of this kind is obtained in Algeria. *Mexican onyx* is a similar material obtained from Tecali, Puebla, Mexico; also in a beautiful brecciated form from the extinct crater of Zempoaltepec in southern Mexico. Similar kinds occur in Missouri, Arizona, San Luis Obispo Co., California.

(*c*) *Calc-sinter, Travertine, Calc Tufa.* Travertine (*Confetto di Tivoli*) is of essentially the same origin with stalagmite, but is distinctively a deposit from springs or rivers, especially where in large deposits, as along the river Anio, at Tivoli, near Rome, where the deposit is scores of feet in thickness. It has a very cavernous and irregularly banded structure, owing to its mode of formation. It is the *Lapis Tiburtinus* of Vitruvius and Pliny; the word *travertine* being a corruption of *tiburtine*. It includes also, especially under the name of *calc tufa*, cellular depositions from the waters of small springs or sources which often contain fossil leaves, twigs, moss, nuts, or seed, etc. The *Osteocollus* (Beinwelle, Beinbruch) Gesner (p. 31, 1565), "qui ossa fracta intra corpus sumptus," as was thought at the time (*osteocolla* of later authors), is, as long since shown, a cellular calc tufa, consisting of incrustings of fragments of reeds or other marsh plants. It means *bone-glue*. *Inolite*, Gallitzin, is also calc-sinter.

(*d*) *Agaric mineral;* Rock-milk (*Bergmich*, *Montmilch*, Germ.) is a very soft white material, breaking easily in the fingers, deposited sometimes in caverns, or about sources holding lime in solution.

(*e*) *Rock-meal* (*Bergmehl* Germ., *Farina Fossilis* Bruckm., etc.) is white and light, like cotton, becoming a powder on the slightest pressure. It is an efflorescence, and is common near Paris, especially at the quarries of Nanterre.

### B. Varieties based upon composition.

1. *Dolomitic calcite.* Contains magnesium carbonate, thus graduating toward true dolomite.

2. *Baricalcite. Neotyp* Breith., Handb., **2**, 313, 1841. Grayish white, and occurring in rhombohedrons *f* (02$\bar{2}$1, − 2), *rr'* = 74° 57', Breith. G. = 2·819–2·840. Contains some barium carbonate. From Cumberland, England. A "barytocalcite" from Långban, Sweden, has been analyzed by Lundström (G. För. Förh., **3**, 291, 1877): $CO_2$ 29·32, BaO 50·89, CaO 17·64, FeO 0·42, MnO 0·24, MgO 0·40, PbO 0·37, insol. 0·70 = 99·98. It occurs in white granular masses with G. = 3·46; associated with hedyphane, hausmannite, etc. According to Des Cloizeaux this mineral is rhombohedral with a cleavage angle of about 75°. Bourgeois notes that attempts to reproduce barytocalcite have uniformly led to the formation of a rhombohedral carbonate of calcium and barium, Bull. Soc. Min., **12**, 464, 1889.

3. *Strontianocalcite* Genth, Proc. Ac. Sc. Philad., **6**, 114, 1852. In opaque white crystals, occurring in globules which have a surface consisting of the terminations of acute rhombohedrons; H. = 3·5. Contains some strontium carbonate, and hence gives a decided red flame before the blowpipe.

4. *Ferrocalcite.* Contains ferrous carbonate, and turns brown on exposure; one variety of unknown source gave Hunt 4·64 $FeCO_3$, Dana Min., 438, 1854. G. = 2·715.

5. *Manganocalcite,* pt. *Spartaite* Breith., B. H. Ztg., **17**, 53, 1858. *Calcimangite* Shepard. Contains manganese carbonate and becomes black on exposure. Spartaite occurs with franklinite and zincite at Franklin Furnace and Sterling Hill, N. J. *rr'* = 75° 2½' Breith. G. = 2·808–2·818. Jenzsch found in it: 11·09 $MnCO_3$, 0·58 $ZnCO_3$, and G. = 2·788, Pogg., **96**, 147, 1855. A similar variety from Långban gave: 11·06 $MnCO_3$, 2·06 $BaCO_3$, Sjögren, G. För. Förh., **4**, 111, 1878; another 2·80 $MnCO_3$, 1·09 $ZnCO_3$, Lindgren, ib., **5**, 557, 1885. In one from Wester Silfberg, Weibull found 6·98 MnO with G. = 2·804, *rr'* = 75° 29', Min. Mitth., **7**, 110, 1885; other varieties contained much more. A specimen from Negaunee, Lake Superior, gave C. Percy Wilcox (priv. contr.): $\frac{2}{2}$ $CO_2$ 42·37, CaO 39·22, MnO 18·56 = 100·15, G. = 2·84; here Ca : Mn = 3 : 1 approx. See further under rhodochrosite.

6. *Zincocalcite.* Contains some zinc carbonate; one specimen from Olkucz, Poland, gave Gibbs 4·07 ZnO, another from Altenberg 1·06–1·65 ZnO, Monheim (Rg.). Cf. manganocalcite above.

7. *Plumbocalcite* Johnston, Ed. Phil. J., **6**, 79, 1829. White to yellowish and reddish brown; from Wanlockhead and Leadhills, Scotland. Contains variable amounts of lead carbonate. 1·2–5·2 p. c. and G = 2·7–2·8, Collie, J. Ch. Soc., **55**, 95, 1889; 2·7–9·5 p. c. with G. = 2·72–2·74, Lex., Bull. Soc. Min., **8**, 36, 1885. Cf. Traube, Jb. Min., **2**, 278, 1887. Schöffel found in rhombohedral crystals from Bleiberg: 23·75 $PbCO_3$; in a coating with silky luster 14 p. c. $PbCO_3$ and G. = 2·92; also in the underlying limestone 2 to 9 p. c. $PbCO_3$ and G. = 2·88; Höfer, Min. Kärnt., 1870.

**Pyr., etc.**—In the closed tube sometimes decrepitates, and, if containing metallic oxides, may change in color. B.B. infusible, but becomes caustic, glows, and colors the flame reddish yellow; after ignition the assay reacts alkaline; moistened with hydrochloric acid imparts the characteristic lime color to the flame. In borax dissolves with effervescence, and if saturated yields on cooling an opaque, milk-white, crystalline bead. Varieties containing metallic oxides color the borax and salt of phosphorus beads accordingly. With soda on platinum foil fuses to a clear mass; on charcoal at first fuses, but later the soda is absorbed by the coal, leaving an infusible and strongly luminous residue of lime. In the solid mass effervesces when moistened with hydrochloric acid, and fragments dissolve with brisk effervescence even in cold acid.

**Obs.**—Calcite, in its various forms, is one of the most widely distributed of minerals. Beds of sedimentary limestone, formed from organic remains, shells, crinoids, corals, etc., yield on metamorphism crystalline limestone or marble, and in connection with these crystallized calcite and also deposits in caves of stalactites and stalagmites often occur. Common with the zeolites in cavities and veins of igneous rocks as a result of alteration, and similarly though less common with granite, syenite, etc. A frequent mineral in metalliferous deposits, with lead, copper, silver, etc. Deposited from lime-bearing waters as calc sinter, travertine, etc., especially in connection with hot springs as at the Mammoth Hot Springs in the Yellowstone region.

Some of the best known localities for crystallized calcite are the following: Andreasberg in the Harz; the mines of Freiberg, Annaberg, Schneeberg, Bräunsdorf, in Saxony; Auerbach on the Bergstrasse; Oberstein on the Nahe; Altenberg near Aachen; Kapnik in Hungary; Aussig in Bohemia; Bleiberg in Carinthia; Traversella in Piedmont; Elba. In England at Alston Moor and Egremont in Cumberland (Min. Mag., **8**, 149, 1889); Matlock, Derbyshire; Beer Alston in Devonshire; at numerous points in Cornwall; Weardale in Durham; Stank mine, Lancashire; in Northumberland. In twin crystals of great variety and beauty at Guanajuato, Mexico.

The Iceland spar has been obtained from Iceland near Helgustadir on the Eskefiord. It occurs in a large cavity in basalt. The crystals, usually showing the fundamental rhombohedron, are often coated with tufts of stilbite. It also occurs in the north-western part of the island near Djupidalr on the Breitifiord. The quantity is limited and is likely to be exhausted. The locality was early described by Dx., Bull. Soc. G., **4**, 769, 1847 (Min., **2**, 114, 1874); later see Zs. G. Ges., **40**, 191, 1888; Zs. Instrumentenkunde, **8**, 63, 1888. Also Thoroddsen, G. För. Förh., **12**, 247, 1890, who gives sectional figures of the deposit.

In the U. States, crystallized calcite occurs in *N. York*, in St. Lawrence and Jefferson Cos., especially at the Rossie lead mine; crystals highly modified, and often transparent even when large; one nearly transparent, in the cabinet of Yale University, weighs 165 pounds; often covered in part by crystals of galena; at the Natural Dam, 2 m. from Gouverneur, in the same vicinity, good crystals; also at the Wilson vein in Gouverneur, and the Jepson vein in Rossie; at the Parish ore bed in Gouverneur, fine geodes, in specular iron; in Jefferson Co., near Oxbow, on the land of Mr. Benton, from a decomposing limestone, large crystals sometimes as clear as Iceland spar; rose and purple varieties very beautiful; some large crystals weighing 100 lbs. and upward; 4 m. S. of Oxbow, in Antwerp, a vein of calcite and lead, which affords beautiful cleavage masses of white, purple, and brownish shades; also interesting crystals; in Essex Co., town of Moriah, on Mill Brook, near Port Henry, crystals of calcite in white limestone; dog-tooth spar, in Niagara Co., near Lockport, with pearl spar, celestite, selenite, and anhydrite; in Onondaga Co., near Camillus, along the railroad; good crystals in Herkimer Co., 1 m. S. of Little Falls, in the bed of a small stream; in Lewis Co., at Leyden and Lowville, and at the Martinsburg lead mine; on the western bank of Dry Sugar River, near Boonville, Oneida Co.; at Anthony's Nose on the Hudson, formerly groups of large tabular crystals; at Watertown, *agaric mineral*, covering the sides of a cave; at Schoharie, fine *stalactites* in many caverns, of which Ball's cave is the most famous; at Camillus and Schoharie (near the barite locality), *fibrous*, in considerable abundance, and at De Long's Mill, St. Lawrence Co., of a fine satin luster. In *Maine*, at Thomaston, lenticular and prismatic crystals, common. In *N. Hamp.*, at the iron mines, Franconia, *argentine*. In *Mass.*, at Williamsburg and Southampton, *argentine*. In *Conn.*, at the lead mine, Middletown, in crystals. In *N. Jersey*, at Bergen, fine crystallizations of yellow calcite, with datolite, etc.; at Franklin Furnace, a pink variety containing $MnCO_3$, and good cleavage specimens. In *Penn.*, in York Co., Iceland spar. In *Virginia*, at the celebrated Wier's cave, *stalactites* of great beauty; also in the large caves of *Kentucky*. At the Lake Superior copper mines, splendid crystals of wonderful variety and complexity of form often containing scales of native copper. At Warsaw, *Illinois*, in great variety of form, lining geodes and implanted on quartz crystals; at Quincy. At Hazelgreen, *Wisconsin*.

In *Missouri*, with dolomite near St. Louis; also with sphalerite at Joplin and other points in the zinc region in the south-western part of the state, the crystals usually scalenohedral and of a wine-yellow color. Fine transparent cleavage masses at the gadolinite locality in Llano Co., *Texas*. From the Bad Lands, South Dakota. In *Arizona*, at the Copper Queen mine, Bisbee, often green with enclosed malachite.

In Nova Scotia, at Partridge I., a wine-colored calcite, and other interesting varieties.

On the various localities furnishing marbles in the U. S., see Merrill: The Collection of Building and Ornamental Stones in the U. S. National Museum (Report Smithsonian Inst., Pt. II, pp. 277–648, 1885–86); a summary is also given of foreign marbles and their localities.

**Artif.**—On formation by fusion in alkaline chlorides; see Bourgeois, Bull. Soc. Min., **5** 111, 1882.

**Alt.**—Calcite occurs under the forms of dolomite, calamine, siderite, malachite, azurite, gypsum, smithsonite, barite, fluorite, limonite, göthite, hematite, minium, meerschaum, chlorite, quartz, chalcedony, garnet, feldspar, mica, pyrolusite, hausmannite, manganite, marcasite, galena, sphalerite, native copper. Cf. Bischof, Chem. Geol.; Blum, Pseud., 1843, and Nachträge; Roth, Chem. Geol., **1**, 1879. Sandstone in the form of calcite, see Fontainebleau limestone, p. 266.

**Ref.**—[1] Result obtained by Malus, Théorie de la double Réflexion, etc., p. 98, 1810, Paris; by Wollaston, Phil. Trans., p 159, 1812; also by Biot, Mohs, and usually accepted; recently confirmed by Hastings, who gives $rr' = 74^\circ\ 54'{\cdot}93$ for 20° C., Am. J. Sc., **35**, 68, 1888. For other determinations, cf. Kupffer, $rr' = 74^\circ\ 55'{\cdot}5$, Preisschrift, 65, 1825; Breithaupt, 74° 54¼′–74° 55′, Handb., 209. 1841, Schw. J., **24**, 49, 1828; Rath, $rr' = 74^\circ\ 55'{\cdot}2$; Koksharov, $rr' = 74^\circ\ 56'$, Min. Russl., **7**, 59, 1875.

Variation in composition brings a considerable change in angle (cf. Breith.). The cleavage angle also changes remarkably with variation in temperature; an elevation of 100° increases the normal angle $rr'$ by 8′ 34½″, Mitsch., Pogg., **10**, 137, 1827, Abh. Ak. Berlin, 201, 1825.

[2] This list gives the common forms, and some which are rarer; the complete list includes between 150 and 200 forms, with many more that are doubtful. An early and exhaustive monograph on the species was given by Zippe, Uebersicht der Krystallgestalten des rhomb. Kalkhaloides, Denkschr. Ak. Wien, 3, 109, 1852. Sella in 1856 gave a list of forms (Quadro). For later full and in part annotated lists of forms, see Dx., Min., 2, 97, 1874; Irby, Inaug. Diss., Bonn, 1878 (Zs. Kr., 3, 612); Gdt., Index, **1**, 371, 1886; Sansoni (for Andreasberg), Mem. Acc. Linc., **19**, 1884, Zs. Kr., **10**, 545, 1885.

Of the many important memoirs devoted to the subject, in addition to these named, the following may be mentioned (see further the literature given by Irby, Sansoni, Gdt., as well as the Mineralogy of Haüy, of Lévy, Breithaupt, Hausmann, et al.): Count de Bournon, Traité de la chaux carbonatée, etc., London, 1808; Sella, Min. Sarda, 1856; Hochstetter, Denksch. Ak. Wien, **6**, 89, 1854; Hbg., many original observations, Min. Not., **3–12**; Rath, many valuable papers, 1867–1882, Pogg. Ann., **132**, **135**, Erg., **5**, **152**, **155**, **158**, also Zs. Kr., **1**, 604, **6**, 540, et al. Recent memoirs include: Morton, Arendal, etc., Öfv. Ak. Stockh., **41**, No. 8, 65, 1884; Thürling, Andreasberg, Jb. Min., Beil., **4**, 327, 1886; Sansoni, Belgium, Zs. Kr., **11**, 352, 1886; Id., Monte Catini, Att. Acc. Torino, **23**, 1888; Id., Sweden and Norway, Giorn. Min., **1**, 129, 1890; Cesàro, Rhisnes, Ann. Soc. G. Belg. Mem., **16**, 1889. Some new forms are noted on twins by Pirsson, Am. J. Sc., **41**, 61, 1891.

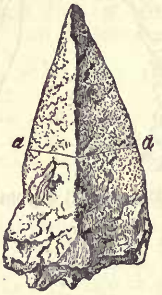
[3] On *twins*, see Sella, Min. Sarda, 1856; Rath, Pogg., **132**, 534, 1867, et al. E. S. D., Min Mitth., 180, 1874, Groth, Min.-Samml., 120, 1878, but cf. Mgg., Jb. Min., **1**, 84, 1883. On the structural phenomena connected with twinning, cf. Brewster, Optics; Pfaff, Pogg., **107**, 336, 1859; Rose, "Die hohlen Canäle," Abh. Ak. Berlin, 1868; Reusch, "Gleitflächen," Pogg., **132**, 441, 1867; Baumh., Zs. Kr., **3**, 588, 1879. Also Mügge, Jb. Min., **1**, 32, 81, 1883, who gives full literature, and ib., **1**, 247, 1889.

On *elasticity*, Baumgarten, Pogg., **152**, 369, 1874; Vater, Zs. Kr., **11**, 577, 1886; Voigt, Wied., **39**, 412, 432, 1890. *Hardness*, Exner, Härte Kryst., 45, 1873. On *etching* and the asterism so produced, Kbl., Ber. Ak. München, 1862; Baumh., Pogg., **138**, 563, 1869, **139**, 349, **140**, 271, 1870. On etching in general, Meyer, Jb. Min., **1**, 74, 1883; Ebner, Ber. Ak. Wien, **89** (2), 368, 1884, and **91** (2), 760, 1885. Velocity of attack by acids in planes ⊥ and ∥ $\dot{c}$ nearly in ratio of $\omega : \epsilon$, Spring, Zs. Phys. Ch., **2**, 13, 1888; cf. also Cesàro, Ann. Soc. G. Belg. Mem., **15**, 219, 253, 1888 *Sp. gravity*, Beudant, Ann. Ch. Phys., **33**, 398, 1828. *Refractive indices*, Rudberg, Pogg., 1828; also Mascart, 1864; Van de Willigen, Arch. Mus. Teyler, **2**, 153, 1869, **3**, 34, 1874; in the ultra violet, Sarasin, Bibl. Univ., **8**, 392, 1882. Double refraction, Schrauf, Zs. Kr., **11**, 5, 1885; Hastings, l. c. *Fluorescence*, Lommel, Wied. Ann., **21**, 422, 1884.

On *optical anomalies* (biaxial, etc.), Zs. Kr., **7**, 73, 1882. *Thermo-electricity*, Hankel, Pogg., **157**, 156, 1876. *Magnetic rotatory power*, Chauvin, C.R., **102**, 972, 1886, J. Phys., **9**, 5, 1890; also Wied., **31**, 273, 1887. In magnetic field, Stenger, Wied., **20**, 304, 1883.

THINOLITE *King*, Rep. Geol. 40th Parallel, **1**, 508, 1878. A tufa deposit of calcium carbonate occurring on an enormous scale in north-western Nevada, covering an area of several miles and 20 to 60 feet thick; named from θίς, *shore*, as being a shore deposit of the Quaternary lake, L. Lahontan. It also occurs about Mono Lake, California. It forms layers of interlaced crystals of a pale yellow or light brown color and often skeleton structure except when covered by subsequent deposit of calcium carbonate.

1.



2.

The crystals are prismatic or acute pyramidal in form (f. 1), sometimes solid, again open skeleton forms with layers converging in one direction, and affording a rectangular rib-work on the cross-section (f. 2, section at *a a*, f. 1). The original mineral is shown to have had an acute pyramidal form approximating at least to the tetragonal type. Occasional forms resembling the Sangerhausen barley-corn pseudomorphs (after celestite, see p. 907) occur.

The original mineral from which the thinolite has resulted is in doubt; gay-lussite has been suggested, but does not agree with the observed form. A possible derivation from a calcium chlorocarbonate ($CaCO_3.CaCl_2$ or $CaCO_3.2NaCl$) has suggested itself on the ground of a similarity in form of the thinolite to the pseudomorphs of cerussite after phosgenite (f. 3, p. 292). See further King, l. c.; E. S. D., U. S. G. Surv., Bull. **12**, 1884; Russell, 3d Ann. Rep. U. S. G. Surv., 1883, Monograph, **11**, 1885.

PREDAZZITE *Petzholdt* pt., Beitr. Geogn. Tyrol, 194, 1843. PENCATITE *Roth*, Zs. G. Ges., **3**, 140, 143, 1851. Massive granular rocks from the neighborhood of Predazzo in southern Tyrol, described at first as mineral species (See 5th Ed., p. 708), but later shown to be mixtures essentially of calcite and brucite. See Damour, Bull. Soc. G. France, **4**, 1050, 1847; Hauenschild, Ber. Ak. Wien, **60**, 795, 1869; Lemberg, Zs. G. Ges., **24**, 229, 1872; cf. also Roth, Ch. Geol., **1**, 234, 1879.

Pencatite was named after Count Marzari Pencati.

**271. DOLOMITE.** Pierres calcaires très-peu effervescentes avec les acides *D. Dolomieu*, J. de Phys., **39**, 1, 1791. Dolomie *Saussure*, Voy. Alpes, § 1929, 1796. Dolomite *Kirwan*, Min., **1**, 111, 1794. Bitterspath, Rhomboidalspath, Kohlensauerter Kalkerde, Bittersalzerde (with anal.), *Klapr.*, Schrift. Nat. Fr. Berl., **5**, 51, 1784, Beitr., **1**, 300, 1795; also Beitr., **3**, 297, **4**, 204, 236, **5**, 103, **6**, 323. Spath magnésien *Delameth*, Sciagr., **1**, 207, 1792. Miemit *Klapr.*, Beitr., **3**, 292, 1802 (discov. at Miemo by D. Thomson in 1791, and sent by him to Kl. labelled Magnesian spar). Rautenspath pt. *Wern.*, 1800, Ludwig's Werner, **1**, 51, 154, 1803. Chaux carbonatée, magnesifère pt., C. c. aluminifère (fr. Saussure's anal.), *H.*, Tr., 1801. Bitterkalk pt. *Hausm.*, Handb., 960, 1813; Perlspath pt., Rauhkalk, Kalktalkspath, *Germ.* Pearl Spar pt., Brown Spar pt., Rhomb Spar pt., Magnesian Limestone. Spath perlé *Fr.*

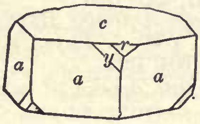
Conites, Flintkalk, *Retzius*, Min., 1795. Conite *Schumacher*, Verzeichniss, etc., 20, 1801. Konit *Germ.* Gurhofian *Karst.*, Mag. Nat. Fr. Berl., **1**, 4, 257, 1807, and Tabell., 50, 1808. Tharandit *Freiesleben*, Geogn. Arbeit, **5**, 212, 1820. Brossit *Hirzel*, Zs. Pharm., 24, 1850.

Rhombohedral; tetartohedral. Axis $\dot{c} = 0{\cdot}83224$; $0001 \wedge 10\bar{1}1 = 43° 51' 37''$ Wollaston[1].

**Forms**[3]:
$c\ (0001,\ O)$
$m\ (10\bar{1}0,\ I)^{12}$
$a\ (11\bar{2}0,\ i\text{-}2)$
$\Theta\ (21\bar{3}0,\ i\text{-}\frac{3}{2}\ r)^{13}$
$\Theta_{,}\ (31\bar{2}0,\ i\text{-}\frac{3}{2}\ l)^{13}$
$u\ (10\bar{1}4,\ \frac{1}{4})^{7}$
$D\ (20\bar{2}5,\ \frac{2}{5})^{5,6}$
$G\ (40\bar{4}7,\ \frac{4}{7})^{5}$
$z\ (30\bar{3}4,\ \frac{3}{4})^{11}$
$\rho\ (40\bar{4}5,\ \frac{4}{5})^{11}$
$\beta\ (14\cdot0\cdot\overline{14}\ 17,\ \frac{14}{17})^{8}$
$r\ (10\bar{1}1,\ 1)$
$\vartheta\ (30\bar{3}1,\ 3)^{4}$
$M\ (40\bar{4}1,\ 4)$
$Q\ (16\cdot0\cdot\overline{16}\cdot1,\ 16)^{12}$
$A\ (0\cdot1\cdot\bar{1}\cdot10,\ -\frac{1}{10})^{5}$
$e\ (01\bar{1}2,\ -\frac{1}{2})$
$\varDelta\ (03\bar{3}5,\ -\frac{3}{5})^{7}$
$l\ (04\bar{4}5,\ -\frac{4}{5})^{5,6}$
$h\ (03\bar{3}2,\ -\frac{3}{2})^{4}$
$f\ (02\bar{2}1,\ -2)$
$d\ (08\bar{8}1,\ -8)^{5}$
$H\ (44\bar{8}9,\ \frac{8}{9}\text{-}2\ r)^{9}$
$\alpha\ (44\bar{8}3,\ \frac{8}{3}\text{-}2)^{12}$
$\alpha_{,}\ (8\bar{4}\bar{4}3,\ \frac{8}{3}\text{-}2\ l)^{13}$
$\delta\ (16\cdot\bar{8}\cdot\bar{8}\cdot3,\ \frac{16}{3}\text{-}2\ l)^{8}$
$\omega\ (6\bar{3}\bar{3}1,\ 6\text{-}2\ l)^{8,12}$
$E\ (42\bar{6}5,\ \frac{2}{5}^{3}\ r)^{10}$
$v\ (21\bar{3}1,\ 1^{3}\ r)$
$k\ (8\cdot4\cdot\overline{12}\cdot1,\ 4^{3}\ r)^{13}$
$s\ (6\bar{1}\bar{5}1,\ 4^{\frac{3}{2}}\ l)^{10}$
$F\ (5\bar{1}\bar{4}3,\ 1^{\frac{5}{3}}\ l)$
$w\ (12\cdot\bar{4}\cdot\bar{8}\cdot1,\ 4^{3}\ l)^{12}$
$g\ (45\bar{9}2,\ -\frac{1}{2}^{9}\ l)$
$i\ (5\cdot8\cdot\overline{13}\cdot3,\ -1^{\frac{13}{3}}\ l)?^{13}$
$\phi\ (8\cdot12\cdot\overline{20}\cdot5,\ -\frac{4}{5}^{5}\ l)^{12}$
$q\ (24\bar{6}1,\ -2^{3}\ l)?^{13}$
$t\ (8\cdot16\cdot\overline{24}\cdot1,\ -8^{3}\ l)^{12}$
$\Gamma\ (\overline{12}\cdot16\cdot\bar{4}\cdot1,\ -8^{2}\ r)$

Of doubtful position $\Omega\ (9\cdot1\cdot\overline{10}\cdot2,\ 4^{\frac{5}{4}})^{8}$, $y\ (3251,\ 1^{5})^{3}$, $x\ (53\bar{8}2,\ 1^{4})^{4}$.

1.



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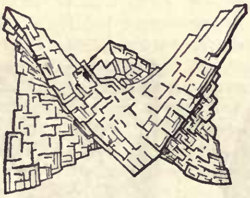

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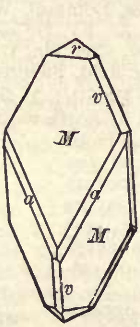

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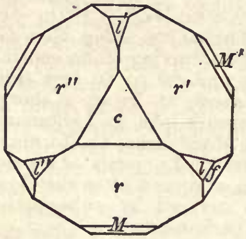


Figs. 1, Hoboken. 2, Saddle-shaped crystal, Tschermak. 3, Rezbánya, Becke. 4, Bex, Kk

$cu = 13°\ 30\frac{1}{2}'$
$cG = 28°\ 46'$
$cz = 35°\ 47'$
$c\rho = 37°\ 33'$
$c\vartheta = 70°\ 52'$
$cM = 75°\ 25'$
$ce = 25°\ 40'$
$cl = 37°\ 33'$
$ch = 55°\ 15'$
$cf = 62°\ 31'$
$cd = 82°\ 35'$
$cH = 36°\ 29\frac{1}{2}'$
$uu' = 23°\ 20\frac{1}{2}'$
$GG' = 49°\ 16'$
$zz' = 60°\ 51'$
$\rho\rho' = 63°\ 43'$
$rr' = {}^{*}73°\ 45'$
$\vartheta\vartheta' = 109°\ 49'$
$MM' = 113°\ 53'$
$ee' = 44°\ 3\frac{1}{2}'$
$ll' = 63°\ 43'$
$hh' = 90°\ 43\frac{1}{2}'$
$ff' = 100°\ 24'$
$dd' = 118°\ 22'$

Twins[14]: tw. pl. (1) *c*, the vertical axes in common; (2) *m*, which is also a plane of symmetry for the twin; (3) *a*, complementary twins, with rhombohedral symmetry; also double twins by the combination of two of these laws; (4) *r*, analogous to calcite.

Habit rhombohedral, usually *r* or *M;* the presence of tetartohedral forms, rhombohedrons of the second or third series, very characteristic. The *r* faces often striated horizontally, also commonly curved (cf. f. 2, p. 276) or made up of subindividuals, and thus passing into saddle-shaped forms (f. 2). Also in imitative shapes; amorphous, granular, coarse or fine, and grains often slightly coherent.

Cleavage: *r* perfect. Fracture subconchoidal. Brittle. H.=3·5–4. G.=2·8–2·9; 2·883 Dmr.; 2·83 A. Sella. Luster vitreous, inclining to pearly in some varieties. Color white, reddish, or greenish white; also rose-red, green, brown, gray, and black. Transparent to translucent. Etching figures[14] correspond in shape to the tetartohedral form. Optically −. Refractive indices:

$$\omega_y = 1{\cdot}68174\ \text{Na} \qquad \epsilon_y = 1{\cdot}50256\ \text{Na, Fizeau (Dx.)}$$

**Comp.**—Carbonate of calcium and magnesium $(Ca,Mg)CO_3$; for normal dolomite $CaMgC_2O_6$ or $CaCO_3.MgCO_3$ = Carbon dioxide 47·8, lime 30·4, magnesia 21·7 = 100, or Calcium carbonate 54·35, magnesium carbonate 45·65 = 100. Varieties occur in which the ratio of the two carbonates varies from 1 : 1. The carbonates of iron and manganese also sometimes enter; rarely cobalt and zinc carbonates.

**Var.**—1. *Structural,* including:

(*a*) *Crystallized. Pearl spar* includes rhombohedral crystallizations with curved faces having a pearly luster.

(*b*) *Columnar;* also fibrous or pisolitic.

*Miemite*, from Miemo, Tuscany, is either in crystals, columnar, or granular, and pale asparagus-green in color.

(*c*) *Granular*, or *saccharoidal*, constitutes many of the kinds of white statuary marble, and white and colored architectural marbles, names of some of which have been mentioned under calcite.

(*d*) *Compact massive*, like ordinary limestone. Many of the limestone strata of the globe are here included, and much *hydraulic limestone*, noticed under calcite.

(*e*) *Compact porcellanous*, *Gurhofian* or *gurhofite;* snow-white and subtranslucent, with a conchoidal fracture, sometimes a little opal-like; from Gurhof, in lower Austria.

*Also depending on Composition.*

2. *Normal dolomite* is Ca : Mg = 1 : 1; most common especially in crystals. Cf. anals. 1–20, 5th Ed., p. 683, also Haushofer, Ber. Ak. München, 220, 1881. The dolomite from the Gebroulaz glacier gave A. Sella (l. c.): $CO_2$ 47·67, CaO 31·37, MgO 21·23 = 100·27; G. = 2·83.

The ratio may also be 3 : 2, 2 : 1 (includes *gurhofian*), 3 : 1, etc., but in some cases the variation is due to mechanical admixture, and much so-called dolomite is merely a magnesian calcite; this is especially true of the massive forms. Cf. 5th Ed., p. 683. In *conite* the ratio is 1 : 3.

3. *Ferriferous; Brown spar*, in part. Contains ferrous carbonate, and as the proportion increases it graduates into ankerite (q.v.). The color is white to brown, and becomes brownish on exposure through the oxidation of the iron. A columnar kind, from Traversella, containing 10 p. c. of $FeCO_3$, has been called *Brossite;* G. = 2·915. *Tharandite*, from Tharand, near Dresden, is crystallized, and contains 4 p. c. of $FeCO_3$.

4. *Manganiferous.* Colorless to flesh-red. A variety from Freiberg, with 5·2 p. c. $MnCO_3$, had $rr' = 73° 37'$, G. = 2·83 Ettling, Lieb. Ann., **99**, 204, 1856. One from Kapnik with 5·4 p. c. $MnCO_3$ had $rr' = 73° 44'$, G. = 2·89 Ott, Haid. Ber., **2**, 403, 1847.

5. *Cobaltiferous.* Colored reddish. A kind from Přibram gave 7·4 p. c. $CoCO_3$, G. = 2·921 Gibbs, Pogg., **71**, 564, 1847.

6. *Zinciferous.* Altenberg, with 1·4 $ZnCO_3$, Monheim. Also Bleiberg, with 2·4 $ZnCO_3$, G. = 2·87, $rr' = 73° 32'$, Gintl, Zeph., Lotos, 1877.

**Pyr., etc.**—B.B. acts like calcite, but does not give a clear mass when fused with soda on platinum foil. Fragments thrown into cold acid, unlike calcite, are only very slowly acted upon, if at all, while in powder in warm acid the mineral is readily dissolved with effervescence. The ferriferous dolomites become brown on exposure.

**Obs.**—Massive dolomite constitutes extensive strata, called limestone strata, in various regions, as in the dolomite region of the southern Tyrol. Crystalline and compact varieties are often associated with serpentine and other magnesian rocks, and with ordinary limestones. Some of the prominent localities are: Leogang in Salzburg; Schemnitz and Kapnik in Hungary; Freiberg in Saxony. In Switzerland, at Bex, in crystals; also in the Binnenthal massive and in colorless crystals; Traversella in Piedmont; Campolongo; Gebroulaz glacier in Savoy with sellaite (see p. 164); the lead mines at Alston in Cumberland, etc. Guanajuato, Mexico.

In the U. States, in *Vermont*, at Roxbury, large, yellow, transparent crystals of the rhomb-spar variety, in talc. In *Rhode Island*, at Smithfield, a coarse cleavable variety, occasionally presenting perfect crystals, with white talc in calcite. In *N. Jersey*, at Hoboken, white hexagonal crystals, and in rhombohedrons. In *N. York*, at Lockport, Niagara Falls, and Rochester, with calcite, celestite, and gypsum; also at Glenn's Falls; in Richmond Co., at the quarantine, crystallized dolomite, in rhombohedrons, and at the Parish ore bed, St. Lawrence Co.; on Hustis's farm in Phillipstown, a variety resembling *gurhofite*, with a semi-opaline appearance and a fracture nearly like porcelain; at the Tilly Foster iron mine, Brewster, Putnam Co., with magnetite, chondrodite. In saddle-shaped crystals with the sphalerite of Joplin, *Missouri*. In *N. Car.*, at Stony Point, Alexander Co., in fine rhombohedral crystals (*r* with *c*) having nearly plane faces.

Named after Dolomieu (1750–1801), who announced some of the marked characteristics of the rock in 1791—its not effervescing with acids, while burning like limestone, and solubility after heating in acids. He observes in his paper that, as early as 1786, he had found the white marble of many of the ancient statues and monuments of Italy to consist of this peculiar rock; and eighteen months before the date of his paper he discovered "immense quantities of similar limestones" in the Tyrol.

**Alt.**—Dolomite occurs altered to siderite, calamine, steatite, limonite, hematite, göthite, pyrolusite, and quartz.

**Ref.**—[1] Wollaston, Mohs, Fizeau, Biot, Dx.; this angle is somewhat variable. The tetartohedral character was first established by Tschermak, Min. Mitth., **4**, 102, 1881. [2] Mlr., Min., 581, 1852. Cf. also Dx., Min., **2**, 127, 1874; Kk., Min. Russl., **7**, 5, 1875; Gdt., Index, **1**, 513, 1886; Becke, who identifies the ± r, ± l forms, Min. Mitth., **10**, 142, 1888, **11**, 224, 1890. The list here given is essentially that of Becke (1890); he discusses several other doubtful forms (Dx., etc.), but overlooks A. Sella. Kk. calculates angles for several forms but not as observed planes, viz.: $50\bar{5}1$, $60\bar{6}1$, and $70\bar{7}1$, etc., breunnerite, ib., p. 181; these are included by Gdt.

[3] J. D. D., Hoboken, Min., 441, 1854. [4] Q. Sella, Traversella, Min. Sarda, 13 et seq., 1856. [5] Hbg., Binnenthal, Min. Not., **3**, 13, 1860; also ib., **7**, 41, where $\frac{10}{13}$ (= $\frac{4}{5}$, cf. Hintze[11]) is misprinted $\frac{10}{3}$, and thence taken by Kk. [6] Rath, Binnenthal, Pogg., **122**, 399, 1864. [7] Kenng., Binnenthal, Min. Schweiz, 301, 1866. [8] Dx., l. c. [9] Groth, Min.-Samml. Strassb., 127, 1878. [10] Tsch., l. c. [11] Hintze, Binnenthal, Zs. Kr., **7**, 438, 1883. [12] A. Sella, Gebroulaz, Mem. Acc. Linc., **4**, Nov. 13, 1887. [13] Becke, l. c. [14] Cf. Tsch., Becke, l. c. Experiments on Elasticity, Voigt, Wied. Ann., **40**, 642, 1890.

**271A. Ankerite.** Dolomite pt. Brown Spar and Pearl Spar pt. Paratomes Kalk-Haloid *Mohs*, Grundr., **1**, 536, 1822, **2**, 116, 1824. Rohwand, Wandstein, *Styrian Miners*. Ankerit *Haid.*, Min. Mohs, **1**, 100, 1825. Tautoklin *Breith.*, Char., 70, 1832, Uib., 20, 1830. Parankerit *Boricky*, Min. Mitth., 47, 1876.

Rhombohedral; $rr' = 73° 48'$ Styria, Mohs. In rhombohedral crystals; also crystalline massive, coarse or fine granular, and compact.

Cleavage: $r$ perfect. H. = 3·5–4. G. = 2·95–3·1. Luster vitreous to pearly. Color white, gray, reddish. Translucent to subtranslucent.

**Comp.**—A sub-species intermediate between calcite, magnesite, and siderite; that is, containing the carbonates of calcium, magnesium, iron, and in small quantities manganese. Formula $CaCO_3.(Mg,Fe,Mn)CO_3$.

Normal ankerite is $2CaCO_3.MgCO_3.FeCO_3$ = Calcium carbonate 50·0, magnesium carbonate 21·0, iron carbonate 29·0 = 100.

Boricky writes the formula $CaFeC_2O_6 + n(CaMgC_2O_6)$ with $n$ varying from $\frac{1}{2}$ to 10; those varieties with $n = 2$ or more, he calls *parankerite*. Normal ankerite would then be $CaFeC_2O_6 + CaMgC_2O_6$, and normal parankerite $CaFeC_2O_6 + 2CaMgC_2O_6$ (or $3CaCO_3.2MgCO_3.FeCO_3$).

For analyses see 5th Ed., p. 685, also Rg., Min. Ch., 229, 1875. Boricky, l. c.

The ankerite from Antwerp, Jefferson Co., N. Y., gave D. N. Harper, priv. contr.:

$CaCO_3$ 55·98 $MgCO_3$ 28·57 $FeCO_3$ 14·66 $MuCO_3$ 1·66 = 100·87

Others from Nova Scotia gave Louis, Proc. N. S. Inst., **5**, 47, 1878–79:

| | | | | |
|---|---|---|---|---|
| G. = 2·998 | $CaCO_3$ 53·75 | $MgCO_3$ 22·75 | $FeCO_3$ 22·70 | $MnCO_3$ 0·80 = 100 |
| | 71·23 | 9·34 | 16·41 | 2·65 insol. 0·53 = 100·16 |

*Tautoclin* Breith. is a grayish white variety, containing about 15 p. c. $FeCO_3$, and having $rr' = 73° 44'$; also G. = 2·961, Ettling; from Beschertglück, near Freiberg in Saxony.

**Pyr., etc.**—B.B. like dolomite, but darkens in color, and on charcoal becomes black and magnetic; with the fluxes reacts for iron and manganese. Soluble with effervescence in the acids.

**Obs.**—Occurs with siderite at the Styrian mines; also at Lobenstein, Freiberg, Schneeberg, Siegen, etc. With the hematite of northern New York (sometimes called siderite). In Nova Scotia near Londonderry, Colchester Co.

Named after Prof. Anker of Styria.

**272. MAGNESITE.** Kohlensaurer Talkerde *Mitchell & Lampadius* (first anal.), Samml. pr. Ch. Abh., 3, 241. Reine Talkerde, Talcum carbonatum, *Wern.*, Ludwig, **2**, 154, 1803. Magnesite pt. *Brongn.*, Min., **1**, 489, 1807. Magnesit *Karst.*, Tabell., 48, 92, 1808. Carbonate of Magnesia. Magnésie carbouatée *Fr.* Kohlénsaure Talkerde, Talkspath, *Germ.* Baudisserite *Delameth*, Min., **2**, 1812. Giobertite *Beud.*, Tr., 410, 1824. Breunnerite *Haid.*, Min. Mohs, **1**, 411, 1825. Breunerite. Walmstedtite *Leonh.*, Handb., 297, 1826. Brown Spar pt.

Rhombohedral; tetartohedral[4](?). Axis: $\dot{c} = 0·81123$; $0001 \wedge 10\bar{1}1 = 43° 7\frac{3}{4}'$, $rr' = {*}72° 36\frac{1}{3}'$ Koksharov[1].

**Forms**[2]: $c$ (0001, $O$), $m$ ($10\bar{1}0$, $I$), $a$ ($11\bar{2}0$, $i$-2), $r$ ($10\bar{1}1$, $R$), $f$ ($02\bar{2}1$, $-$ 2)[8], $v$ ($21\bar{3}1$, $1^3$)[3]; also an undetermined negative scalenohedron[4].

Crystals rare, usually rhombohedral, also prismatic. Commonly massive; granular cleavable to very compact; earthy.

Cleavage: $r$ perfect. Fracture flat conchoidal. Brittle. H. = 3·5–4·5. G. = 3·0–3·12, cryst.; 3·083, Scaleglia, Becke; 3–3·2, ferriferous. Luster vitreous; fibrous varieties sometimes silky. Color white, yellowish, or grayish white, brown. Transparent to opaque. Optically −. Double refraction strong.

**Comp.**—Magnesium carbonate, $MgCO_3$ = Carbon dioxide 52·4, magnesia 47·6 = 100. Iron carbonate is often present.

**Var.**—1. *Ordinary.* (*a*) *Crystallized*, rare. (*b*) *Lamellar*, cleavable. (*c*) *Compact*, fine granular. (*d*) *Compact*, and like unglazed porcelain in fracture. (*e*) *Earthy;* being mixed with hydrated silicate of magnesia or sepiolite (meerschaum); including the *Baudisserite*, from Baudissero, near Turin, which has some resemblance to chalk, and adheres to the tongue. Even the purer varieties of compact magnesite usually contain more or less of the silicate.

*Pinolite* Rumpf (Min. Mitth., 265, 1873) is a rock consisting largely of milk-white magnesite crystals with clay slate filling the spaces between them, from Wald in Styria, from the Semmering, etc.

2. *Ferriferous, Breunnerite;* containing several p. c. of FeO; G. = 3–3·2; white, yellowish, brownish, rarely black and bituminous; often becoming brown on exposure, and hence called *Brown Spar*.

The name *Breunnerite* was originally given by Haidinger (after M. Breunner) to the variety analyzed by Stromeyer containing 5 to 10 p. c. iron protoxide (or 8 to 17 p. c. of carbonate); and *Walmstedite* to an included kind from the Harz, differing only in containing a little more manganese protoxide than usual (2 p c.). The breunnerite from Hall, Tyrol, gave Foullon: $MgCO_3$ 79·13, $FeCO_3$ 19·14, $MnCO_3$ 2·04 = 100·31, Jb. G. Reichs., **38**, 2, 1888.

For analyses see 5th Ed., pp. 686, 687.

**Pyr., etc.**—B.B. resembles calcite and dolomite, and like the latter is but slightly acted upon by cold acids; in powder is readily dissolved with effervescence in warm hydrochloric acid.

**Obs.**—Found in talcose schist, serpentine and other magnesian rocks, also gypsum; as veins in serpentine, or mixed with it so as to form a variety of verd-antique marble (*magnesitic ophiolite* of Hunt); also, in Canada, as a rock, more or less pure, associated with steatite, serpentine, and dolomite. The breunnerite variety has been found in a meteorite from Orgueil, Dx.

Occurs at Hrubschütz in Moravia, where it was first discovered by Mitchell; at Kraubat and Tragössthal, Styria; Maria-Zell in Styria; Flachau in Salzburg; Greiner in the Zillerthal, Tyrol; Gross-Reifling in the Ennsthal in prismatic crystals in gypsum; at Frankenstein in Silesia; Snarum, Norway; Baudissero and Castellamonte in Piedmont; at other localities mentioned above.

In America, at Bolton, Mass., in indistinctly fibrous masses, traversing white limestone; at Lynnfield, Cavendish, and Roxbury, Mass., mixed with or veining serpentine; at Barehills, near Baltimore, Md.; in Penn., in crystals at West Goshen, Chester Co.; near Texas, Lancaster Co.; in Tulare, Alameda, Mariposa, and Tuolumne Cos., California. A white saccharoidal magnesite resembling statuary marble has been found as loose blocks on an island in the St. Lawrence River, near the Thousand Island Park. Also occurs with serpentine, dolomite, steatite, in Brome Co., Quebec.

In Canton Upata, Venezuela, near Mission Pastora, looking like porcelain in the fracture, as observed by N. S. Manross.

Delametherie, in his Théorie de la Terre, **2**, 93, 1795, uses the name magnesite for the carbonate of magnesia, sulphate, nitrate, and muriate, and the carbonate is placed first in the series. Brongniart, in his Mineralogy, **3**, 489, 1807, applies the name to a group, including (1) the carbonate called *Mitchell's magnesite*, (2) meerschaum, (3) the Piedmont magnesite, and (4) other siliceous varieties. As both Brongniart and Delametherie gave the *first* place to the carbonate, the name magnesite would rightly fall to it in case of the division of the group. Karsten, in his Tabellen, 1808, recognized this division of the species, and formally gave to the carbonate the name *magnesite*. The German mineralogists have followed Karsten, as should have been done by all. But in France, Beudant, in 1824, gave the name *giobertite* to the *carbonate*, leaving *magnesite* for the silicate, and most of the French mineralogists have followed Beudant. Giobert analyzed only the siliceous variety from Baudissero, the true composition of the mineral having been ascertained by Lampadius, somewhat earlier, from specimens brought by Mitchell from Moravia.

The name *Breunnerite* is spelled also Breunerite. Haidinger gives the former.

**Ref.**—[1] Tyrol, G. = 3·118, Min. Russl., **7**, 181, 1875. This angle varies for different localities, *e.g.*, Pfitsch, 72° 37½′ Mitsch.; Snarum 72° 32′ Breith.; Greiner, Tyrol, 72° 37½′, G. = 3·17, Zeph.; Maria-Zell, 72° 31′ Rumpf; Gross-Reifling, Ennsthal, 72° 44½′ Foullon, Vh. G. Reichs., 334, 1884; Scaleglia, 72° 33·6′ Becke, Min. Mitth., **11**, 250, 1890. [2] Rumpf, Maria-Zell, Min. Mitth., 263, 1873. [3] A. Sella, Gebroulaz, the crystals, hexagonal prisms (*a*) in anhydrite, were identified as magnesite by angles ($cr$ = 43° 16′), not analyzed, Mem. Acc. Linc., 4, Nov. 13, 1887. [4] Becke, Scaleglia, l. c.

**272A. Mesitite.** Mesitinspath pt. *Breith.*, Pogg., **11**, 170, 1827. Mesitin *Breith.*, Pogg., **70**, 148, 1847.

PISTOMESITE. Mesitin pt. *Breith.*, Pogg., **11**, 170, 1827. Pistomesit *Breith.*, Pogg., **70**, 146, 1847.

Rhombohedral; $rr'$ = 72° 42′ to 72° 46′ Breith. In rhombohedral crystals; also coarse granular.

Cleavage: $r$ perfect. H. = 3·5–4. G. = 3·33–3·42. Luster vitreous, inclining to pearly. Color yellowish white, yellowish gray, yellowish brown. Streak nearly white or colorless. Transparent to subtranslucent.

**Comp., Var.**—A sub-species intermediate between the ferruginous variety of magnesite, breunnerite, and siderite.

1. MESITITE $2MgCO_3,FeCO_3$ = Magnesium carbonate 59·2, iron carbonate 40·8 = 100. $rr'$ = 72° 46′. G. = 3·35–3·36 Br. Usually in flat rhombohedrons ($e$, $01\bar{1}2$) with rounded faces.

2. PISTOMESITE $MgCO_3.FeCO_3$ = Magnesium carbonate 42·0, iron carbonate 58·0 = 100. $rr'$ = 72° 42′. G. = 3·42 Br.

**Anal.**—1, W. Gibbs, Pogg., **71**, 566, 1847. 2, Fritsche, ib., **70**, 147, 1847. 3, Patera, Haid. Ber., **2**, 296, 1847. 4, Fritsche, l. c. 5, Ettling, Lieb. Ann., **99**, 203, 1853.

| MESITITE. | | G. | $CO_2$ | FeO | MgO | CaO | |
|---|---|---|---|---|---|---|---|
| 1. Traversella | | | 46·05 | 26·61 | 27·12 | 0·22 | = 100 |
| 2. " | | 3·35 | 45·76 | 24·18 | 28·12 | 1·30 | = 99·36 |
| 3. Werfen | $rr' = 72° 40'$ | 3·33 | 45·84 | 27·37 | 26·76 | — | = 99·97 |
| PISTOMESITE. | | | | | | | |
| 4. Thurnberg | | 3·42 | 43·62 | 33·92 | 21·72 | — | = 99·26 |
| 5. " | | 3·437 | $\frac{2}{2}$ 44·57 | 33·15 | 22·29 | — | = 100·01 |

**Pyr., etc.**—B.B. blackens and becomes magnetic. But slightly acted upon in mass by acids; readily dissolved with effervescence when in powder by hot hydrochloric acid.

**Obs.**—*Mesitite* is from Traversella, Piedmont; Werfen, with lazulite.

*Pistomesite* is from Thurnberg, near Flachau, in Salzburg; also at Traversella in Piedmont.

Mesitite is named from μεσίτης, *a go-between*. it being intermediate between magnesite and siderite; pistomesite is from πιστός and μεσίτης, named by Breithaupt after he had already used mesitine, and because pistomesite is nearer the middle between siderite and magnesite.

**273. SIDERITE.** ? Vena ferri jecoris colore optima, *Germ.* Stahelreich Eisen, *Gesner*, Foss., 90, 1565. Spatformig Jernmalm, Minera ferri alba spathiformis, *Wall.*, 256, 1747. Järn med Kalkjord förenadt, *Germ.* Stahlstein, *Cronst.*, 29, 1758 Ferrum cum magnesio et terra calcarea acido aereo mineralisatum *Bergm.*, Opusc., **2**, 184, 1780. Spathiger Eisen, Spatheisenstein, *Germ.* Fer spatique *de Lisle*, **3**, 281, 1783. Calcareous or Sparry Iron Ore *Kirwan.* Spathic Iron, Spathose Iron. Brown Spar pt. Steel Ore. Carbonate of Iron. Fer carbonaté, Mine d'acier, *Fr.* Kohlensaures Eisen, Eisenkalk, *Germ.* Eisenspath *Hausm.*, Handb., 951, 952, 1813. Spherosiderit *Hausm.*, ib., 1070, 1813. 1847, 1353. Siderose *Beud.*, **2**, 346, 1832. Junckérite *Dufr.*, Ann. Ch. Phys., **56**, 198, 1834; Breith., Pogg., **58**, 278, 1843. Siderit *Haid.*, Handb., 499. 1845. Chalybit *Glock.*, Syn., 241, 1847.

Oligonspath *Breith.*, Handb., **2**, 235, 1841 = Oligonit *Hausm.*, Handb., 1362, 1847. Thomäit *Meyer*, Jb. Min., 200, 1845. Siderodot *Breith.*, Haid. Ber., **1**, 6, 1847. Sideroplesit *Breith.*, B. H. Ztg., **17**, 54, 1858. Pelosiderit N.-Z., Min., 457, 1885. Thoneisenstein = Clay Iron Ore pt.

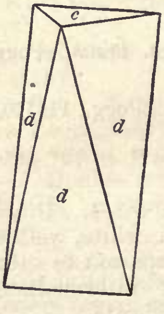
Rhombohedral. Axis $\dot{c} = 0·81841$; $0001 \wedge 10\bar{1}1 = 43° 22' 51''$ Wollaston[1].

| | | | | |
|---|---|---|---|---|
| **Forms**[1]: | $a$ $(11\bar{2}0, i\text{-}2)$ | $e$ $(01\bar{1}2, -\frac{1}{2})$ | $s$ $(05\bar{5}1, -5)$ | $\alpha$ $(44\bar{8}3, \frac{8}{3}\text{-}2)$? |
| $c$ $(0001, O)$ | $r$ $(10\bar{1}1, R)$ | $f$ $(02\bar{2}1, -2)$ | $d$ $(08\bar{8}1, -8)^3$ | $v$ $(21\bar{3}1, 1^3)$ |
| $m$ $(10\bar{1}0, I)$ | $M$ $(40\bar{4}1, 4)$ | $\omega$ $(07\bar{7}3, -\frac{7}{3})^3$ | $\vartheta$ $(44\bar{8}6, \frac{4}{3}\text{-}2)$ | $\beta$ $(24\bar{6}1, -2^3)^4$ |

| | | | |
|---|---|---|---|
| $cM = 75° 11'$ | $c\vartheta = 47° 30'$ | $\omega\omega' = 104° 8'$ | $vv' = 74° 52'$ |
| $ce = 25° 17\frac{1}{2}'$ | $c\alpha = 65° 23'$ | $dd' = 118° 18\frac{1}{2}'$ | $vv^{v} = 35° 23'$ |
| $cf = 62° 7'$ | $rr' = *73° 0'$ | $ss' = 115° 50'$ | $vv^{vi} = 48° 30'$ |
| $c\omega = 65° 36'$ | $MM' = 113° 42'$ | $\vartheta\vartheta' = 43° 16'$ | $\beta\beta' = 37° 26\frac{1}{2}'$ |
| $cd = 82° 28'$ | $ee' = 43° 26'$ | $\alpha\alpha' = 54° 4'$ | $\beta\beta^{v} = 79° 52\frac{1}{2}'$ |
| $cs = 78° 3'$ | $ff' = 99° 54'$ | | |

1.

2.



3.

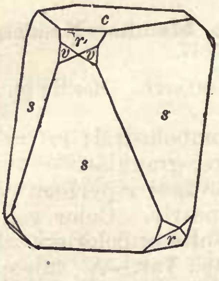


Fig. 1, Curved form, Haid. 2, 3, Cornwall.

Twins: tw. pl. $e$; often with inclosed twinning lamellæ. Crystals commonly rhombohedral $r$ or $e$, the faces often curved and built up of sub-individuals. Often cleavable massive to coarse or fine granular. Also in botryoidal and globular forms, subfibrous within, occasionally silky fibrous; compact and earthy.

Cleavage: *r* perfect. Fracture uneven or subconchoidal. Brittle. H. = 3·5–4. G. = 3·83–3·88 Dmr. Luster vitreous, inclining to pearly. Color ash-gray, yellowish gray, greenish gray, also brown and brownish red, rarely green; and sometimes white. Streak white. Translucent to subtranslucent. Optically —. Double refraction strong. Etching-figures in part symmetric, in part asymmetric, Tschermak.

**Comp.**—Iron protocarbonate, $FeCO_3$ = Carbon dioxide 37·9, iron protoxide 62·1 = 100 (Fe = 48·2 p. c.). Manganese may be present, also magnesium and calcium.

**Var.**—1. *Ordinary.* (*a*) *Crystallized.* (*b*) *Concretionary* = *Spherosiderite;* in globular concretions, either solid or concentric scaly, with usually a fibrous structure. (*c*) *Granular* to *compact massive.* (*d*) *Oolitic,* like oolitic limestone in structure. (*e*) *Earthy,* or stony, impure from mixture with clay or sand, constituting a large part of the clay iron-stone of the Coal formation and other stratified deposits; H. = 3–7, the last from the silica present; G. = 3·0–3·8, or mostly 3·15–3·65.

The varieties based on composition include, besides the nearly pure iron carbonate, also

2. *Manganiferous.* Containing several per cent of manganese carbonate. The *oligonspar* of Breithaupt, or *oligonite,* has 25 p. c. MnO, *rr'* = 72° 56'; G. = 3·714–3·745; color yellowish to between flesh- and iron-red; streak yellowish white; remarkably phosphorescent when heated.

3. *Magnesian.* Containing magnesium carbonate, and but little manganese. The *sideroplesite,* Breith., from Pöhl, has 12 p. c. $MgCO_3$, with *rr'* = 72° 54' Breith.; G. = 3·616–3·660. Here belong some varieties from Londonderry, Nova Scotia, analyzed by Louis, Trans. N. S. Inst., **5**, 50, 1878–79. Zepharovich obtained from a cleavage rhombohedron from Salzburg 10·5 p. c. MgO, *rr'* = 72° 54¾', and G. = 3·699.

4. *Calciferous.* Containing 20 p. c of calcium carbonate and looking like some calamine, the color green; from Altenberg. The *siderodot* of Breithaupt is a calciferous siderite from Radstadt in Salzburg, having G. = 3·41.

For analyses, see 5th Ed., p. 690.

**Pyr., etc.**—In the closed tube decrepitates, gives off $CO_2$, blackens and becomes magnetic. B.B. blackens and fuses at 4·5. With the fluxes reacts for iron, and with soda and niter on platinum foil generally gives a manganese reaction. Only slowly acted upon by cold acid, but dissolves with brisk effervescence in hot hydrochloric acid. Exposure to the atmosphere darkens its color, rendering it often of a blackish brown or brownish red color.

**Obs.**—Occurs in many of the rock strata, in gneiss, mica slate, clay slate, and as clay ironstone in connection with the Coal formation and many other stratified deposits. It is often associated with metallic ores. At Freiberg it occurs in silver mines. In Cornwall it accompanies tin. It is also found accompanying copper and iron pyrites, galena, chalcocite, tetrahedrite. Occasionally it is to be met with in trap rocks as *spherosiderite.*

In the region in and about Styria and Carinthia this ore forms extensive tracts in gneiss, which extend along the chain of the Alps, on one side into Austria, and on the other into Salzburg. At Harzgerode in the Harz, it occurs in fine crystals in gray-wacke; also in Cornwall of varied habit at many localities; at Alston-Moor, and Tavistock, Devonshire. Fine cleavage masses occur with cryolite in Greenland.

The *Spherosiderite* occurs in dolerite at Steinheim near Hanau and Dransfeld near Göttingen and Dransberg, and many other places. Clay iron-stone, which is a siliceous or argillaceous carbonate of iron, occurs in coal beds near Glasgow; also at Mouillar, Magescote, etc., in France, etc.

In the United States, in *Vermont,* at Plymouth. In *Mass.,* at Sterling. In *Conn.,* at Roxbury, an extensive vein in quartz, traversing gneiss; at Monroe, Lane's mine, in small quantities. In *N. York,* a series of important basins occur in Columbia Co., near Burden, they belong to the Hudson River Epoch of the Lower Silurian; at the Rossie iron mines, St. Lawrence Co. In *N. Carolina,* at Fentress and Harlem mines. The argillaceous carbonate, in nodules and beds (clay iron-stone), is abundant in the coal regions of Penn., Ohio, and many parts of the country. In a clay-bed under the Tertiary along the west side of Chesapeake Bay for 50 m. A magnesian variety (like sideroplesite) occurs at Londonderry, Colchester Co., Nova Scotia.

Named *Spherosiderite* by Hausmann in 1813, from the concretionary variety, and retained by him for the whole. Haidinger reduced the name to *Siderite,* the prefix *sphero* being applicable only to an unimportant variety. Beudant's name *Siderose* has an unallowable termination. *Chalybite,* Glocker, should yield to Haidinger's earlier name siderite, as recognized by v. Kobell and Kenngott.

**Alt.**—Siderite becomes brown or brownish black on exposure, owing to the oxidation of the iron and its passing to *limonite;* and by a subsequent loss of water, it may pass to *hematite* or to *magnetite,* the last at times a result of deoxidation of the $Fe_2O_3$ by organic substances. It also changes by substitution, or through the action of alkaline silicates, to *quartz.*

**Ref.**—[1] Phil. Trans., 159, 1812. [2] See Lévy, Heuland, **3**, 162, 1837; Breith., Lobenstein, Pogg., **58**, 279, 1843; Mlr., Min., 586, 1852. Kenng. describes crystals from Tavistock with a negative scalenohedron ($-4^2$) but gives no measurements, Pogg., **97**, 99, 1856. Gdt., Index, **1**, 539, 1886. [3] Dx., Min., **2**, 142, 1872. [4] Klein, Jb. Min., **1**, 256, 1884.

THOMÄITE *Mayer*, Jb. Min., 200, 1845. An iron carbonate, occurring in pyramidal crystallizations which are said to be orthorhombic; also massive. G. = 3·10. Luster pearly. From the Bleis-Bach, in the Siebengebirge. Named after Prof. Thomä of Wiesbaden.

*Junckerite* of Dufrénoy (l. c.) was described as having the same characters, but proved to be only common siderite; and the same fate may befall thomäite. Named after M. Juncker, director of mines at Poullaouen.

274. **RHODOCHROSITE.** Magnesium acido aëreo mineralisatum *Bergm.*, Sciagr., 1782 (without descr. or loc.). Rother Braunsteinerz [= Red Manganese Ore], Rothspath, Magnesium ochraceum rubrum, Oxide de manganèse couleur de rose, pt., *of later part of* 18*th cent.* (it being confounded with the silicate analyzed by Ruprecht in 1782, and Bergmann's announcement being doubted). Luftsaures Braunsteinerz (or Carbonate, after Bergm.) pt. *Lenz*, Min., **2**, 1794 (with mention of druses of small crystals in "Rhomben," others in "Pyramiden," but with cit. of Ruprecht's anal.). Manganèse oxydé carbonaté (after Bergm.) *H.*, Tabl. comp., 111, 1809. Dichter Rothstein pt. *Hausm.*, Handb., 302, 1813. Rhodochrosit, ?Kohlensaures Magnesium oxydul (fr. Lampadius's anal. of a Kapnik sp'n. in his Pr. Ch. Abh., **3**, 239, 1800), *Hausm.*, ib., 1081, 1813. Carbonate of Manganese. Manganspath *Wern.* Dialogite *Jasche*, Germar, Schw. J., **26**, 119 = Blättrige Rothmanganerz *Jasche*, Kl. Min. Schrift., 4, 1817. Diallogite (wrong orthogr.). Rosenspath, Himbeerspath, *Breith.*, Handb., 228, 229, 1841 (Char., 67, 68, 1832). Manganosiderit Bayer, Vh. Ver. Brünn, **12**, May 10, 1873. Manganocalcit *Breith.*, Pogg., **69**, 429, 1846. Rodocrosite *Ital.*

Rhombohedral. Axis $\dot{c} = 0{\cdot}81840$; $0001 \wedge 10\bar{1}1 = 43° 22' 50''$ Sansoni[1].

**Forms**[2]: $a$ $(11\bar{2}0, i\text{-}2)$  $e$ $(01\bar{1}2, -\frac{1}{2})$  $\chi$ $(07\bar{7}2, -\frac{7}{2})$[4]?  $v$ $(21\bar{3}1, 1^3)$[3]
$c$ $(0001, O)$  $r$ $(10\bar{1}1, R)$  $f$ $(02\bar{2}1, -2)$[3]  $t$ $(21\bar{3}4, \frac{1}{4}{}^3)$[3]?  $y$ $(32\bar{5}1, 1^5)$[4]

$cr = 43° 23'$  $rr' = 73° 0'$  $vv' = {}^*74° 52'$  $yy' = 70° 47\frac{1}{2}'$
$ce = 25° 17\frac{1}{2}'$  $ee' = 43° 26'$  $vv^{v} = 35° 23'$  $yy^{v} = 45° 26'$
$cf = 62° 7'$  $ff' = 99° 54'$  $vv^{vi} = 48° 30'$  $yy^{vi} = 30° 15'$

Distinct crystals not common; usually the rhombohedron *r*; also *e*, with rounded striated faces. Cleavable, massive to granular massive and compact. Also globular and botryoidal, with columnar structure, sometimes indistinct; incrusting.

Cleavage: *r* perfect. Fracture uneven. Brittle. H. = 3·5–4·5. G. = 3·45–3·60 and higher. Luster vitreous inclining to pearly. Color shades of rose-red; yellowish gray, fawn-colored, dark red, brown. Streak white. Translucent to subtranslucent. Optically −. Double refraction strong.

**Comp.**—Manganese protocarbonate, $MnCO_3$ = Carbon dioxide 38·3, manganese protoxide 61·7 = 100. Iron carbonate is usually present, and sometimes the carbonates of calcium, magnesium, zinc and rarely cobalt.

**Var.**—1. *Ordinary.* Pure $MnCO_3$ or nearly so, in crystals, but more commonly cleavable massive to indistinctly crystalline. Cf. remarks below, Ref. [1].

2. *Ferriferous.* Containing several per cent up to nearly 40 p. c. of $FeCO_3$. A cleavable variety from Branchville, Ct., gave Penfield 16·8 p. c. $FeCO_3$, $rr' = 73° 11'$, G. = 3·76, Am. J. Sc., **18**, 50, 1879. *Manganosiderite* is a Hungarian variety, resembling sphærosiderite, with 38·8 $FeCO_3$.

3 *Calciferous. Manganocalcite.* Contains calcium carbonate. The original from Schemnitz was flesh-red columnar. G. = 3·037 Br.; an early analysis gave: $MnCO_3$ 67·48, $FeCO_3$ 3·22, $CaCO_3$ 18·81, $MgCO_3$ 9·97 = 99·48, Rg., Pogg., **68**, 511, 1846; a later examination, however, showed it to be a mixture of a carbonate and silicate, Rg., Min. Ch. Erg., 157, 1886; and this is confirmed by Dx., Bull. Soc. Min., **7**, 72, 1884. It was supposed to be isomorphous with aragonite, but Krenner proves it to be rhombohedral, cf. Nat. Ber. aus Ungarn, **1**, 201, **2**, 355, 1884, and Zs. Kr., **8**, 242, 1883, **9**, 288, 1884. A variety from Wester Silfberg belongs here, G. = 3·09; analysis: $CO_2$ 40·59, MnO 24·60, FeO 6·95, CaO 26·71, insol. 1·15 = 100, Weibull, Min. Mitth., **7**, 110, 1885. See also p. 269.

A cleavable kind from Franklin Furnace, N. J., gave Roepper $MnCO_3$ 43·54, $FeCO_3$ 0·76, $CaCO_3$ 50·40, $MgCO_3$ 5·69 = 100·39. G. = 3·052. Am. J. Sc., **50**, 37, 1870; it was called *roepperite* by Kenngott, Jb. Min., 188, 1872.

4. *Zinciferous.* Contains zinc carbonate. A specimen from the Trotter mine, Mine Hill, Franklin Furnace, N. J., gave P. E. Browning: $MnCO_3$ 73·78, $ZnCO_3$ 2·28, $CaCO_3$ 20·37, $MgCO_3$ 3·74, $FeCO_3$ 0·35, $Fe_2O_3$ 0·16 = 100·68. G. = 3·47, Am. J. Sc., **40**, 375, 1890.

**Pyr., etc.**—B.B. changes to gray, brown, and black, and decrepitates strongly, but is infusible. With salt of phosphorus and borax in O.F. gives an amethystine-colored bead, in R.F. becomes colorless. With soda on platinum foil a bluish green manganate. Dissolves with effervescence in warm hydrochloric acid. On exposure to the air changes to brown, and some bright rose-red varieties become paler.

**Obs.**—Occurs commonly in veins along with ores of silver, lead, and copper, and with other ores of manganese.

Found at Schemnitz and Kapnik in Hungary; Nagyág in Transylvania; near Elbingerode in the Harz; at Freiberg in Saxony; at Diez near Oberneisen in Nassau; at Daaden, Rheinprovinz; at Moet-Fontaine in the Ardennes, Belgium; at Glendree in the County of Clare, Ireland, where it forms a layer 2 inches thick below a bog, and has a yellowish gray color; botryoidal at Hartshill in Warwickshire.

It has been observed in a pulverulent form, coating triplite, at Washington, Conn., on the land of Joel Camp; at Branchville with manganesian phosphates in a vein of albitic granite; in New Jersey, with franklinite at Mine Hill, Franklin Furnace. In Colorado, at the John Reed mine, Alicante, Lake Co., in beautiful clear rhombohedrons (*r*) up to ½ inch across; also at the Oulay mine, near Lake City, in flat rhombohedrons (*e*). In Montana, at Butte City, in rhombohedrons. Abundant at the silver mines of Austin, Nevada. At Placentia Bay, Newfoundland, in slates, fawn-colored and brown.

Named *rhodochrosite* from *ῥόδον*, *a rose*, and *χρῶσις*, *color;* and *dialogite*, from *διαλογή* *doubt.* The latter name is attributed to Jasche by Germar (l. c.).

**Alt.**—Quartz pseudomorphs occur near Klein-Voigtsberg.

**Ref.**—[1] Horhausen, nearly pure $MnCO_3$, with 1·14 FeO; another variety gave 72° 44′, Zs. Kr., **5**, 250,1880. The Lake Co., Colorado, variety in transparent rose-red rhombohedrons with faultless surface gave *rr′* = 73° 4′ 30″, E. S. D.; Mackintosh found in it 3·62 p. c. FeO, G. = 3·69. cf. Kunz, Am. J. Sc., **34**, 477, 1887. [2] See Mlr., Min., 588, 1852. [3] Peters, Kapnik, Jb. Min., 458, 1861, no angles. [4] Sandb., Oberneisen, Pogg., **88**, 491, 1853. [5] Weiss, Daaden, Zs. G. Ges., **31**, 801, 1879, also Sansoni, l. c.

**275. SMITHSONITE.** Calamine pt. Galmei pt. Zincum acido aëro mineralisatum *Bergm.*, Sciagr., 144, 1782, Opusc., **2**, 209, 1780 (from his own anal.). Zinkspath, Kohlengalmei, *Germ.* Carbonate of Zinc. Smithsonite *Beud.*, Tr., **2**, 354, 1832. Zinkspath, Kapnit (or Capnit), *Breith.*, Handb., 241, 236, 1841. Dry-bone *Miners.* Smitsonite *Ital.*

Rhombohedral. Axis $\dot{c}$ = 0·80633; $0001 \wedge 10\bar{1}1$ = 42° 57′ 20″ Wollaston[1].

**Forms**[2]: $a\ (11\bar{2}0, i\text{-}2)$ $M\ (40\bar{4}1, 4)$ $f\ (02\bar{2}1, -2)$ $s\ (05\bar{5}1, -5)$
$c\ (0001, O)$ $r\ (10\bar{1}1, R)$ $e\ (01\bar{1}2, -\frac{1}{2})$ $\chi\ (07\bar{7}2, -\frac{7}{2})$ $v\ (21\bar{3}1, 1^3)$

$cM$ = 74° 58′ $cs$ = 77° 52½ $ff'$ = 99° 27′ $ae$ = 68° 34′
$ce$ = 24° 58′ $rr'$ = *72° 20′ $\chi\chi'$ = 111° 46′ $vv'$ = 74° 41′
$cf$ = 61° 46′ $MM'$ = 113° 31½′ $ss'$ = 115° 42½′ $vv^{v}$ = 35° 19′
$c\chi$ = 72° 56½′ $ee'$ = 42° 53′ $ar$ = 53° 50′ $vv^{vi}$ = 49° 1½′

Rarely well crystallized; faces *r* generally curved and rough. Also reniform, botryoidal, or stalactitic, and in crystalline incrustations; also granular, and sometimes impalpable, occasionally earthy and friable.

Cleavable: *r* perfect. Fracture uneven to imperfectly conchoidal. Brittle. H. = 5. G. = 4·30–4·45; 4·45 Lévy; 4·42 Haid. Luster vitreous, inclining to pearly. Streak white. Color white, often grayish, greenish, brownish white, sometimes green, blue and brown. Subtransparent to translucent. Optically —.

**Comp.**—Zinc carbonate, $ZnCO_3$ = Carbon dioxide 35·2, zinc protoxide 64·8 = 100. Iron and manganese carbonates are often present, also calcium and magnesium carbonates in traces; rarely cadmium.

Indium has also been detected (Tennessee), by Tanner, Ch. News., **30**, 141, 1874. For analyses see 5th Ed., pp. 692, 693.

A bright yellow variety from Marion Co., Arkansas, gave H. N. Stokes (priv. contr.):

$CO_2$ 34·68 ZnO 64·12 CdO 0·63 FeO 0·14 CaO 0·38 Cu *tr* CdS 0·25 $SiO_2$ 0·06 = 100·26.

**Var.**—1. *Ordinary.* (*a*) *Crystallized;* (*b*) *botryoidal* and *stalactitic*, common, closely resembling similar forms of the silicate, calamine; (*c*) *granular* to *compact massive;* (*d*) *earthy*, impure, in nodular and cavernous masses, varying from grayish white to dark gray, brown, brownish red, brownish black, and often with drusy surfaces in the cavities; "dry-bone" of American miners, which also includes some calamine.

2. *Ferriferous.* Monheimite, Zinkeisenspath, Eisenzinkspath, *Germ.* Contains over 20 p. c. of iron carbonate; *Capnite* Breith., having *rr′* = 72° 53′, G. = 4·17 Breith.

3. *Manganiferous.* Contains over 5 p. c. of manganese carbonate; G. = 3·95–4·2.

4 *Cupriferous. Herrerite* of Del Rio. Apple-green, with rhombohedral cleavage; it was shown by Genth to belong here, Proc. Ac. Philad., **7**, 232.

**Pyr.**, etc.—In the closed tube loses carbon dioxide, and, if pure, is yellow while hot and white on cooling. B.B. infusible, moistened with cobalt solution and heated in O.F. gives a green color on cooling. With soda on charcoal gives zinc vapors, and coats the coal with the oxide, which is yellow while hot and white on cooling; this coating, moistened with cobalt solution, gives a green color after heating in O.F. Cadmiferous varieties, when treated with soda, give at first a deep yellow or brown coating before the zinc coating appears. With the fluxes some varieties react for iron, copper, and manganese. Soluble in hydrochloric acid with effervescence.

**Obs.**—Found both in veins and beds, especially in company with galena and sphalerite, also with copper and iron ores. It usually occurs in calcareous rocks, and is generally associated with calamine, and sometimes with limonite. It is often produced by the action upon zinc sulphide of carbonated waters.

Found at Nerchinsk in Siberia, one variety of a dark brown color, containing cadmium, another of a beautiful bright green; at Dognaczka in Hungary; Bleiberg and Raibel in Carinthia; Wiesloch in Baden, in Triassic limestone; Moresnet in Belgium; Altenberg, near Aix la Chapelle (Aachen), in concentric botryoidal groups. In the province of Santander, Spain, between the Bay of Biscay and the continuation of the Pyrenees range, at Puente Viesgo, the mountains being only four leagues from the coast; the smithsonite here occurs in Mountain limestone; in other places it is found in dolomite, probably Muschelkalk; it is in vertical lodes, found frequently in scalenohedrons as a pseudomorph after calcite. At Ciguenza, 5 miles E. of Santander, the lode varies in width from 1 to 2 meters to 1 inch; the mineral is drusy, cavernous; sphalerite is abundant, and changes into pure white smithsonite; the latter also occurs like chalcedony, in reniform and botryoidal masses; it sometimes contains galena and cerussite. In England, at Roughten Gill, Alston Moor, near Matlock, in the Mendip Hills, and elsewhere; in Scotland, at Leadhills; in Ireland, at Donegal. At Laurion, Greece, in great variety.

In the U. States, in *Conn.*, at Brookfield in very small quantities. In *N. Jersey*, at Mine Hill, near the Franklin Furnace, only pulverulent from decomposition of zincite. In *Penn.*, at Lancaster abundant, and often in fine druses of crystals, also sometimes pseudomorphous after dolomite; at the Perkiomen lead mine; at the Ueberroth mine, near Bethlehem, in scalenohedrons, also an earthy variety abundant as an ore. In *Wisconsin*, at Mineral Point, Shullsburg, etc., constituting pseudomorphs after sphalerite and calcite. In *Minnesota*, at Ewing's diggings, N.W. of Dubuque, etc. In south-western *Missouri* associated with sphalerite and calamine in St. François, Jefferson, Newton, Jasper counties; also with the lead ores in the central part of the state. In *Arkansas*, at Calamine, Lawrence Co.; in Marion Co., sometimes colored bright orange-yellow by greenockite (CdS) and then locally known as "turkey-fat ore."

Named after James Smithson (1754–1829), who founded the Smithsonian Institution in Washington. The name calamine is frequently used in England, cf. calamine, p. 549.

**Alt.**—Smithsonite changes through the action of alkaline silicates to the silicate calamine, or becomes incrusted with silica and forms quartz pseudomorphs. It is also sometimes replaced by limonite or göthite. The concretionary variety from Spain has a nucleus of calamine.

**Ref.**—[1] Cf. Breith., 72° 21½′, Handb., **1**, 241, 1841; Lévy also gives 72° 20′, Ann. Mines, **4**, 507, 1843. [2] See Lévy and Breith.; also Dx., Min., **2**, 150, 1874.

ORTHORHOMBIC ZINC CARBONATE(?) *Griffiths & Dreyfus*, Ch. News, **54**, 67, Aug. 6, 1886. From southwestern Siberia, associated with galena and barite in limestone. Described as occurring in right rhombic prisms, often showing twinning. H. = 5–6. G. = 4·629. Analysis of crystals:

$CO_2$ 35·21 ZnO 50·03 FeO 2·77 CdO 0·92 MnO 0·12 $SiO_2$ 5·62 $H_2O$ 5·33 = 100

It is called by the author isodimorphous with calcite and aragonite, but needs confirmation. (Pseudomorphous?)

**276. SPHÆROCOBALTITE.** *Weisbach*, Jb. Berg.-Hütt., 1877. Kobaltspath *Germ.*

Rhombohedral. In small spherical masses, with crystalline surface and concentric and radiated structure.

H. = 4. G. = 4·02–4·13. Luster vitreous. Color rose-red, altering superficially to velvet-black. Streak peachblossom-red.

**Comp.**—Cobalt protocarbonate, $CoCO_3$ = Carbon dioxide 37·1, cobalt protoxide 62·9 = 100.

**Anal.**—Winkler, l. c.

$CO_2$ 34·65 CoO 58·86 CaO 1·80 $Fe_2O_3$ 3·41 $H_2O$ 1·22 = 99·94

**Pyr., etc.**—B.B. in closed tube becomes black. Attacked slowly by cold acid; rapidly with effervescence when warmed. Reacts for cobalt with the fluxes.

**Obs.**—Occurs sparingly with roselite at Schneeberg, Saxony.

**Artif.**—An artificial rhombohedral cobalt carbonate is mentioned by Senarmont, Ann. Ch. Phys., **30**, 137, 1850.

## 2. Aragonite Group. $RCO_3$. Orthorhombic.

**277. ARAGONITE.** Spath calcaire crist. en prismes hexagones dont les deux bouts sont striés du centre à la circonference, id. dont les deux bouts sont lisses (fr. Spain), *Davila*, Cat. Cab., 2, 50, 52, 1767. Arragonischer Apatit *Wern.*, Bergm. J., 1, 95, 1788; *Klapr.*, ib., 1, 299, Crell's Ann., 1, 387, 1788 (making it carbonate of lime). Arragonischer Kalkspath *Wern.*, Bergm. J., 2, 74, 1790 (after Klapr. anal.). Arragon Spar (var. of Calc Spar) *Kirwan*, Min., 1, 87, 1794. Arragonit *Wern.*, Estner's Min., 2, 1039, 1796. Excentrischer Kalkstein *Karsten*, Tabell., 34, 74, 1800. Arragonite (first made distinct from Calc Spar through cryst.) *Haüy*, Tr., 2, 1801, and Broch. Min., 1, 576, 1800. Iglit (fr. Iglo, Transylvania) *Esmark*, Bergm. J., 3, 99, 1798; Igloit. Nadelstein *Lenz*. Erbsenstein pt., Faserkalk pt., Schallenkalk pt., Sprudelstein, *Germ.* Chimborazite *E. D. Clarke*, Ann. Phil., 2, 57, 147, 1821. Tarnovizit *Breith.*, Handb., 252, 1841; Tarnovicit *Haid.*, Handb., 1845. Mossottite *Luca*, N. Cimento, 7, 453, 1858. Oserskit *Breith.*, B. H. Ztg., 17, 54, 1858.

Stalactites Flos Ferri, Marmoreus ramulosus, *Linn.*, Syst., 183, 1768. Stalagmites coralloides *Wall.*, 2, 388, 1778. Coralloidal Aragonite. Chaux carbonaté coralloides *H.*, Tr., 2, 1801. Eisenblüthe pt. *Wern.*

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}622444 : 1 : 0{\cdot}720560$ Koksharov[1].

$100 \wedge 110 = 31^\circ\ 54'$, $001 \wedge 101 = 49^\circ\ 10'\ 42''$, $001 \wedge 011 = 35^\circ\ 46'\ 30''$.

**Forms**[2]:
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)
*c* (001, *O*)

*m* (110, *I*)

*d* (102, $\frac{1}{2}$-ī)
*g* (304, $\frac{3}{4}$-ī)
*u* (101, 1-ī)
*f* (201, 2-ī)

*α* (013, $\frac{1}{3}$-ĭ)
*x* (012, $\frac{1}{2}$-ĭ)

*k* (011, 1-ĭ)
*κ* (043, $\frac{4}{3}$-ĭ)
*l* (032, $\frac{3}{2}$-ĭ)
*i* (021, 2-ĭ)
*v* (031, 3-ĭ)
*e* (051, 5-ĭ)
*q* (061, 6-ĭ)
*β* (0·13·2, $\frac{13}{2}$-ĭ)
*χ* (071, 7-ĭ)
*ν* (081, 8-ĭ)
*λ* (091, 9-ĭ)
*j* (0·12·1, 12-ĭ)

*ϵ* (0·13·1, 13-ĭ)
*ϑ* (0·14·1, 14-ĭ)
*μ* (0·16·1, 16-ĭ)
*ρ* (0·20·1, 20-ĭ)
*η* (0·24·1, 24-ĭ)

*o* (112, $\frac{1}{2}$)
*p* (111, 1)
*ζ* (441, 4)
*ι* (661, 6)
*ω* (13·13·2, $\frac{13}{2}$)
*ψ* (771, 7)
*γ* (881, 8)

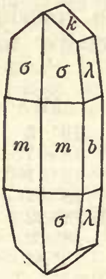
*σ* (991, 9)
*θ* (10·10·1, 10)
*δ* (14·14·1, 14)
*Ψ* (20·20·1, 20)[3]
*π* (24·24·1, 24)

*y* (215, $\frac{2}{5}$-$\bar{2}$)
*ϕ* (425, $\frac{4}{5}$-$\bar{2}$)

*w* (25·27·24, $\frac{9}{8}$-$\overset{\smile}{\tfrac{27}{25}}$)
*z* (25·27·2, $\frac{27}{2}$-$\overset{\smile}{\tfrac{27}{25}}$)
*Φ* (561, 6-$\breve{\tfrac{6}{5}}$)[4]
*v* (9·12·2, 6-$\breve{\tfrac{4}{3}}$)

*Λ* (12·17·5, $\frac{17}{5}$-$\overset{\smile}{\tfrac{17}{12}}$)
*ξ* (126, $\frac{1}{3}$-$\breve{2}$)
*H* (125, $\frac{2}{5}$-$\breve{2}$)
*τ* (124, $\frac{1}{2}$-$\breve{2}$)
*r* (123, $\frac{2}{3}$-$\breve{2}$)
*n* (122, 1-$\breve{2}$)
*t* (243, $\frac{4}{3}$-$\breve{2}$)
*s* (121, 2-$\breve{2}$)
*Σ* (362, 3-$\breve{2}$)
*E* (132, $\frac{3}{2}$-$\breve{3}$)
*Γ* (158, $\frac{5}{8}$-$\breve{5}$)
*Δ* (151, 5-$\breve{5}$)

1.



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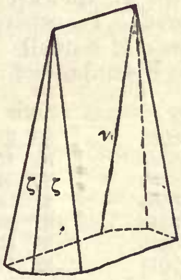

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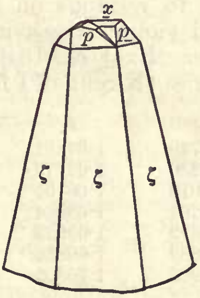

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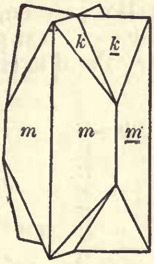

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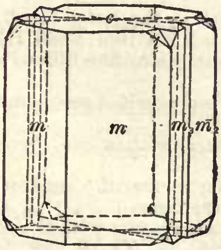

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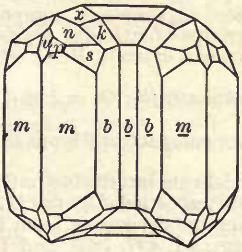

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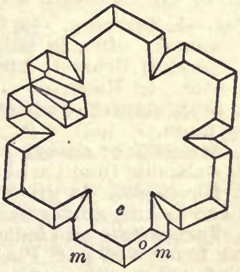


Fig. 1, Kamsdorf, Schmidt-Schrauf. 2, 3, Hüttenberg, Zeph. 4, Molina, Schrauf. 5, Herrengrund, Id. 6, Horschenz, Id. 7, Oberstein, Lasp.

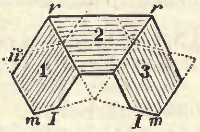
mm''' = *63° 48'
dd' = 60° 7½'
gg' = 81° 56'
uu' = 98° 21'
ff' = 133° 17'
αα' = 27° 1'
xx' = 39° 38'
ll' = 94° 27'
kk' = 71°·33'

bk = *54° 13½'
ii' = 110° 29'
vv' = 130° 21'
ee' = 148° 58½'
qq' = 153° 57'
νν' = 160° 19'
jj' = 166° 48'
μμ' = 170° 5'
ρρ' = 172° 4'

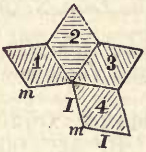
co = 34° 17'
cp = 53° 45'
cζ = 79° 37'
cγ = 84° 46'
cθ = 85° 48'
cδ = 87° 0'
cn = 42° 45'
cs = 61° 35'

oo' = 57° 8½'
pp' = 86° 24½'
nn' = 50° 19'
ss' = 66° 51'
oo''' = 34° 38'
pp''' = 50° 27'
nn''' = 63° 54'
ss''' = 86° 35'

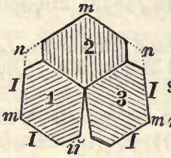
8.



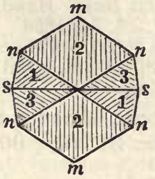
9.



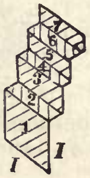
10.



11.

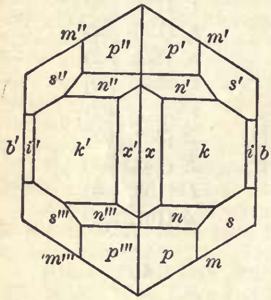


12.



Twins[5]: tw. pl. *m*, commonly contact-twins, also penetration-twins, and as thin twinning lamellæ producing fine striations; twinning commonly repeated, thus producing pseudohexagonal forms, often of complex structure as revealed by etching or optical examination (cf. f. 8–12); a six-fold feather-like striation on *c* (resembling the markings on f. 6, p. 284) common with twins from Sicily. Crystals often acicular, and characterized by the presence of acute domes or pyramids. Also globular, reniform, and coralloidal shapes; sometimes columnar, composed of straight or divergent fibers; also stalactitic; incrusting.

13.



Cleavage: *b* distinct; also *m*; *k* (011) imperfect. Fracture subconchoidal. Brittle. H. = 3·5–4. G. = 2·93–2·95; 2·99 tarnowitzite. Luster vitreous, inclining to resinous on surfaces of fracture. Color white; also gray, yellow, green, and violet; streak uncolored. Transparent to translucent. Optically –. Ax. pl. ∥ *a*. Bx ⊥ *c*. Dispersion $\rho < \upsilon$ small. Refractive indices (Rudberg[6]) and axial angles (Kirchhoff[7]) for the Fraunhofer lines:

| | α | β. | γ | 2E | 2V |
|---|---|---|---|---|---|
| Line B | 1·52749 | 1·67631 | 1·68061 | 30° 38' | 18° 5' |
| " C | 1·52820 | 1·67779 | 1·68203 | 30° 42½' | 18° 7' |
| " D | 1·53013 | 1·68157 | 1·68589 | 30° 54' | 18° 11' |
| " E | 1·53264 | 1·68634 | 1·69084 | 31° 9½' | 18° 17' |
| " F | 1·53479 | 1·69053 | 1·69515 | 31° 23' | 18° 22' |
| " G | 1·53882 | 1·69836 | 1·70318 | 31° 49' | 18° 32' |
| " H | 1·54226 | 1·70509 | 1·71011 | 32° 14' | 18° 42' |

**Comp.**—Calcium carbonate, $CaCO_3$ = Carbon dioxide 44·0, lime 56·0 = 100. Some varieties contain a little strontium, others lead, and rarely zinc.

**Var.**—1. *Ordinary.* (*a*) Crystallized in simple or compound crystals, the latter much the most common; often in radiating groups of acicular crystals. G. = 2·927 Biot; 2·931 Haid.; 2·932 Kamsdorf, Schmid: 2·945–2·947 small crystals, Beud. (*b*) Columnar; also fine fibrous with silky luster. (*c*) Massive.

2. *Scaly massive.* Snow-white (*Schaumkalk*); G. = 2·984; from Wiederstadt, a pseudomorph after gypsum.

3. *Stalactitic* or *stalagmitic.* Either compact or fibrous in structure, as with calcite; *Sprudelstein* is stalactitic from Carlsbad.

4. *Coralloidal.* In groupings of delicate interlacing and coalescing stems, of a snow-white color, and looking a little like coral; often called *Flos ferri* (Eisenblüthe *Germ.*).

5. *Tarnowitzite.* A kind containing lead carbonate, from Tarnowitz in Silesia; with G. = 2·99. Böttger found 3·89 p. c. $PbCO_3$, Pogg., **47**, 497, 1839, and Herde 8·56, Zs. Kr. **9**, 199, 1884. Traube found in an aragonite from Tarnowitz 0·80, 0·46 p. c. $PbCO_3$ and 1·38, 1·06 $ZnCO_3$; the true tarnowitzite, however, gave him 6·64 $PbCO_3$ and only a trace of zinc, Zs. Kr., **15**, 410, 1889.

A variety from Wythe Co., Va., gave Dunnington, 7·29 $PbCO_3$, Proc. Am. Ch. Soc., **2**, 14, 1878. Collie found in a "plumbo-aragonite" from Leadhills, 0·8–1·3 p. c. $PbCO_3$, G. = 2·9, J. Ch. Soc., **55**, 95, 1889.

*Mossottite* is a light green, columnar, radiated variety, from the Lias of Gerfalco, in Tuscany, containing nearly 7 p. c. of strontium carbonate and a trace of copper; G. = 2·884. *Oserskite* is columnar aragonite from Nerchinsk, Siberia; G. = 2·854–2·855.

**Pyr., etc.**—B.B. whitens and falls to pieces, and sometimes, when containing strontia, imparts a more intensely red color to the flame than lime; otherwise reacts like calcite.

**Obs.**—The most common repositories of aragonite are beds of gypsum, beds of iron ore (where it occurs in coralloidal forms, and is denominated *flos-ferri*, "*flower of iron*"), basalt, and trap rock; occasionally it occurs in lavas. It is often associated with copper and iron pyrites, galena, and malachite. It is forming at an old mine in Monte Vasa, Italy, at a temperature below the boiling point of water; also at a temperature of 30° C. in the Eureka mine, Nevada, the formation going on rapidly, a rate of $\frac{5}{16}$ inch in three weeks being noted (J. S. Curtis, U. S. G. Surv., Mon., **7**, 57, 1884). It constitutes the pearly layer of shells. Minute pointed crystals occur in drusy cavities in the sinter of the thermal springs of Baden.

First discovered in Aragon, Spain, at Molina and Valencia, near Migranilla, in six-sided prisms, with gypsum, embedded in a ferruginous clay. Since found at Bilin in Bohemia, in a vein traversing basalt in fine prisms; at Sasbach, Kaiserstuhl, Baden; at Baumgarten and Tarnowitz in Silesia; at Leogang in Salzburg, Austria; in Waltsch, Bohemia; Herrengrund, Hungary; Dognaczka; with sulphur in Sicily in fine prisms. The *flos-ferri* variety is found in great perfection in the Styrian mines, coating cavities and even caves of considerable extent, and associated with siderite. At Dufton, a silky, fibrous variety, called *satin spar*, occurs traversing shale in thin veins, generally associated with pyrite. In Buckinghamshire, Devonshire, etc., it occurs in stalactitic forms in caverns, and of snowy whiteness at Leadhills in Lanarkshire. At Alston Moor, fine tapering crystals. A banded and fibrous form ("alabaster") of a delicate blue at Caterno, Chili.

Aragonite in fibrous crusts and other forms occurs in serpentine at Hoboken, N. J. (it has been called magnesite). Coralloidal aragonite occurs sparingly at Lockport, N. Y., coating gypsum in geodes; at Edenville, N. Y., lining cavities of arsenopyrite and pharmacosiderite; at the Parish ore bed, Rossie, N. Y.; at Haddam, Conn., in thin seams between layers of gneiss; at New Garden, in Chester Co., Penn.; at Wood's Mine, Lancaster Co., Penn.; at Warsaw, Ill., lining geodes; Mine-la-Motte, Mo., in crystals; on the north boundary of the Creek nation, 16 m. from the crossing of the Arkansas, in hexagonal crystals nearly $\frac{1}{2}$ in. through. *Flos-ferri* in the Organ Mts., New Mexico.

**Alt.**—Aragonite may undergo similar changes with calcite. Pseudomorphs of copper after aragonite occur at Corocoro, Bolivia (see p. 22).

A change by paramorphism to calcite is not uncommon; the reverse change, yielding pseudomorphs of aragonite after calcite, is rare (cf. Bauer, Jb. Min., **1**, 12, 1890). The change into calcite can be caused by elevation of temperature, as shown by the loss in specific gravity (Rose), and in the change to uniaxial character (Klein); cf. also Mgg. Jb., **1**, 62, 1886.

**Ref.**—[1] Bilin, Min. Russl., **6**, 261, 1875. The prismatic angle *mm'''* increases with rise of temperature, 2′ 46″ for 100° and *kk'* diminishes 5′ 29″, Mitsch., Pogg., **10**, 144, 1827. Beckenkamp makes the crystals hemimorphic both in the direction of the $\bar{b}$ and $\dot{c}$ axes, and hence apparent simple crystals would become twins with *b* or *c* as twinning planes, Zs. Kr., **14**, 375, 1888

[2] See Mlr., Min., 567, 1852; Schrauf, Atlas XXI–XXIII, 1872, also Ber. Ak. Wien, **62** (2), 734, 1870, **65** (1), 250, 1872; Dx., Min., **2**, 86, 1874; Zeph., Ber. Ak. Wien, **71** (1), 253, 1875, new planes, list, authorities, etc., he adds several vicinal prismatic planes; Gdt., Index, **1**, 239, 1886. On the tapering forms with high indices, see Websky, tarnowitzite, Zs. G Ges., **9**, 737, 1857; Schmid, Pogg., **126**, 147, 1865; Zeph., Langer, Zs. Kr., **9**, 196, 1885. [3] Langer, l. c. [4] Traube, Tarnowitz, l. c.

[5] Cf. Schrauf, l. c., also Sen., Ann. Ch. Phys., **41**, 60, 1854; Leydolt, Ber. Ak. Wien, **19**, 10, 1856. [6] Rudberg, Pogg., **17**, 7, 1829; cf. also Wilde, ib., **80**, 225, 1850; Heusser, ib., **89**, 532, 1853; Müttrich, ib., **121**, 398, 1864; Lang, Ber. Ak. Wien, **83** (2), 671, 1881. [7] Kirchhoff, ib., **108**, 567, 1859; also Dx., N. R., 34, 1867, Min., **2**, 90, 1874. On *pyro-electricity* cf. Hankel, Abh. Sächs. Ges., **10**, 1874; Beckenkamp, Zs. Kr., **14**, 375, 1888. On *etching*, Beckenkamp, l.c.

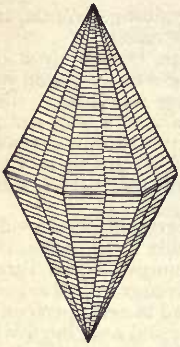
**278. BROMLITE.** Barytocalcite *J. F. W. Johnston*, Phil. Mag., **6**, 1, 1835, **10**, 373, 1837. Bicalcareo-carbonate of Barytes (from a wrong anal.) *Thomson*. Rec. Gen. Sc., **1**, 373, 1835. Bromlite *Thomson*, Phil. Mag., **11**, 45, 48, 1837. Alstonite *Breith.*, Handb., **2**, 255, 1841.

Orthorhombic; form near witherite. The crystals are dihexahedral pyramids formed by complex twinning[1]; the faces are horizontally striated, and also divided vertically by a medial twinning line (f. 1, 2). Pyramidal angles 57° 30′ adjacent, 38° basal, Dx.

Cleavage: *m* imperfect. Fracture uneven. H. = 4–4·5. G. = 3·718, Th.; 3·706, J. Luster vitreous. Colorless, snow-white, grayish, pale cream-color, pink.

Translucent. Optically −. Ax. pl. ‖ *a*. Bx ⊥ *c*. Dispersion nearly zero. Axial angles[1]:

1.



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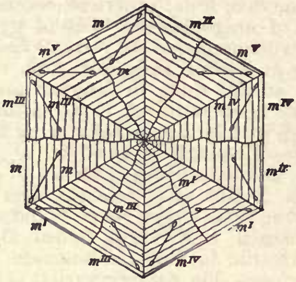


Des Cloizeaux.

$2E_r = 9° 50'$ at 17° C.,
$= 11° 10'$ at 141·5° C., Dx.

**Comp.**—An isomorphous compound of the carbonates of barium and calcium, $(Ba,Ca)CO_3$; ratio of Ba : Ca = 1 : 1 (anal. 1, 2), also 3 : 4 (anal. 3), 1 : 2 (anal. 4). $BaCO_3.CaCO_3$ = Barium carbonate 66·3, calcium carbonate 37·7, or Carbon dioxide 29·6, baryta 51·5, lime 18·9 = 100. Strontium carbonate is given in some analyses.

**Anal.**—1–4, Becker, Zs. Kr., **12**, 222, 1886. Cf. also 5th Ed., p. 698.

| | | $CO_2$ | BaO | CaO | | |
|---|---|---|---|---|---|---|
| 1. Alston Moor | $\frac{3}{3}$ | 29·65 | 50·97 | 19·83 | insol. 0·25 | = 100·70 |
| 2. " " | $\frac{3}{3}$ | 29·52 | 51·45 | 19·89 | MnO 0·20 | = 101·06 |
| 3. " " | $\frac{3}{3}$ | 31·71 | 44·69 | 23·40 | MnO 0·29 | = 100·09 |
| 4. " " | $\frac{2}{2}$ | 32·21 | 37·41 | 29·06 | MnO 0·30 | = 98·98 |

**Pyr., etc.**—Same as for barytocalcite, p. 289.

**Obs.**—Found at the lead mine of Fallowfield, near Hexham in Northumberland, with witherite, and at Bromley Hill near Alston in Cumberland, in veins with galena, whence the name *Bromlite*, given by Thomson. Most English mineralogical authors have set aside Thomson's name, although the earliest and of British origin, for Breithaupt's. There appears to be no sufficient reason for this.

**Ref.**—[1] Min., **2**, 79, 1874.

**279. WITHERITE.** Terra ponderosa aerata *Withering*, Trl. Bergm. Sciagr., 29, 1783, Phil. Trans., 293, 1784. Witherit *Wern.*, Bergm. J., **2**, 225, 1790. Aerated Barytes *Watt*, Mem. Manchester Soc., **3**, 599, 1790. Barolite *Kirwan*, Min., **1**, 134, 1794. Kohlensaurer Baryt *Germ.* Baryte carbonatée *Fr.*

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·6032 : 1 : 0·7302$ Des Cloizeaux.
$100 \wedge 110 = 31° 6'$, $001 \wedge 101 = 50° 26\frac{1}{2}'$, $001 \wedge 011 = 36° 8\frac{1}{4}'$.

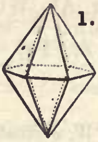
**Forms:** *c* (001, *O*) *g* (130, *i*-$\breve{3}$) *x* (012, $\frac{1}{2}$-$\breve{i}$) *i* (021, 2-$\breve{i}$) *n* (041, 4-$\breve{i}$)
*b* (010, *i*-$\breve{i}$) *m* (110, *I*) *z* (014, $\frac{1}{4}$-$\breve{i}$) *k* (011, 1-$\breve{i}$) *l* (031, 3-$\breve{i}$)

*bm* = *58° 54′ *zz′* = 20° 41½′ *ii′* = 111° 12′ *ll′* = 130° 56′
*mm‴* = 62° 12′ *xx′* = 40° 7′ *bi* = *34° 24′ *nn′* = 142° 12′
*gg′* = 57° 51′ *kk′* = 72° 16½′

Crystals always repeated twins, with tw. pl. *m*, closely simulating hexagonal pyramids, (f. 1–5); structure often highly complex (f. 6). Faces usually rough and horizontally striated. Also in globular, tuberose, and botryoidal forms; structure columnar or granular; amorphous.

Cleavage: *b* distinct; *m*, *x* imperfect. Fracture uneven. Brittle. H. = 3–3·75. G. = 4·29–4·35; 4·277 Dmr. Luster vitreous, inclining to resinous on

1.



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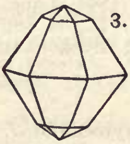
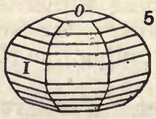
3.



4.

5.



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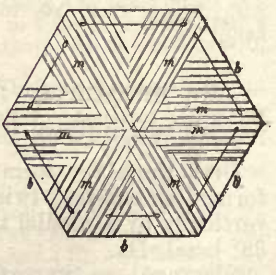


Section ‖ *c*, Dx.

surfaces of fracture. Color white, often yellowish, or grayish. Streak white. Subtransparent to translucent. Optically −. Ax. pl. ∥ *b*. Bx ⊥ *c*.

$$2E_r = 26° 30' \text{ at } 17° \text{ C.}, \quad = 26° 24' \text{ at } 121° \text{ C., Dx.}$$

**Comp.**—Barium carbonate, $BaCO_3$ = Carbon dioxide 22·3, baryta 77·7 = 100.

Thomson's *Sulphato-carbonate of Baryta* is witherite incrusted by barite, as shown by Heddle.

**Pyr., etc.**—B.B. fuses at 2 to a bead, coloring the flame yellowish green; after fusion reacts alkaline. B.B. on charcoal with soda fuses easily, and is absorbed by the coal. Soluble in dilute hydrochloric acid; this solution, even when very much diluted, gives with sulphuric acid a white precipitate which is insoluble in acids.

**Obs.**—Occurs at Alston Moor in Cumberland, associated with galena, in veins traversing the coal formation; at Fallowfield near Hexham in Northumberland, in large quantities, also in splendid crystals, sometimes transparent, and occasionally 6 in. long; at Anglezarke in Lancashire, a fibrous variety; at Arkendale in Yorkshire; near St. Asaph in Flintshire; Tarnowitz in Silesia; Szlana, Hungary; Leogang in Salzburg; Peggau in Styria; Zméov in the Altai; some places in Sicily; the mine of Arqueros, near Coquimbo, Chili; L. Etang Island. Near Lexington, Kentucky, with barite. In a silver-bearing vein near Rabbit Mt., Thunder Bay, L. Superior.

**Alt.**—Witherite is altered to barite through the action of calcium sulphate in solution at the ordinary temperature, or by the action of other sulphates in solution, or of water containing sulphuric acid.

**Artif.**—Formed from fusion of alkaline chlorides by Bourgeois, Bull. Soc. Min., **5**, 111, 1882.

**280. STRONTIANITE.** Strontianit *Sulzer*, Lichtenberg's Mag., **7**, 3, 68, Bergm. J., **1**, 5, 433, 1791. Strontian *Wern.* Strontianit. Kohlensaure Strontianerde, *Klapr.*, Crell's Ann., **2**, 189, 1793; **1**, 99, 1794; Beitr., **1**, 268. Mineral from Strontian, Strontian Spar (*not* Strontites = Strontia), *Hope*, Edinb. Trans., **4**, 3, 1798 (read Nov., 1793). Strontiane carbonatée *Fr.*

Emmonite, Calcareo-carbonate of Strontian *Thomson*, Rec. Gen. Sc., 3, 415, 1836. Calciostrontianit Cathrein, Zs. Kr., **14**, 366, 1888. Barystrontianite, Stromnite, *S. Traill*, Ed. Phil. J., **1**, 380, 1819.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·60901 : 1 : 0·72388 Naumann[1].

100 ∧ 110 = 31° 20⅓′, 001 ∧ 101 = 49° 55½′, 001 ∧ 011 = 35° 54′.

**Forms**[2]:
*b* (010, *i*-ĭ)
*c* (001, *O*)
*m* (110, *I*)
*t* (102, ½-ī)

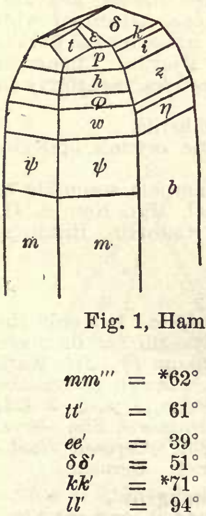
*e* (012, ½-ĭ)[3]
*δ* (023, ⅔-ĭ)[4]
*k* (011, 1-ĭ)
*l* (032, 3/2-ĭ)
*i* (021, 2-ĭ)
*v* (031, 3-ĭ)

*z* (041, 4-ĭ)
*q* (061, 6-ĭ)
*ζ* (081, 8-ĭ)
*χ* (0·12·1, 12-ĭ)
*η* (0·24·1, 24-ĭ)[4]
*n* (115, ⅕)[5]

*ϵ* (113, ⅓)[4]
*o* (112, ½)
*ρ* (445, ⅘)
*p* (111, 1)
*θ* (332, 3/2)
*h* (221, 2)

*ϕ* (331, 3)
*λ* (441, 4)
*d* (661, 6)[5]
*ξ* (881, 8)
*ω* (12·12·1, 12)[4]
*ψ* (40·40·1, 40)[4]

1.



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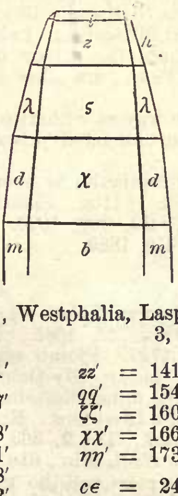

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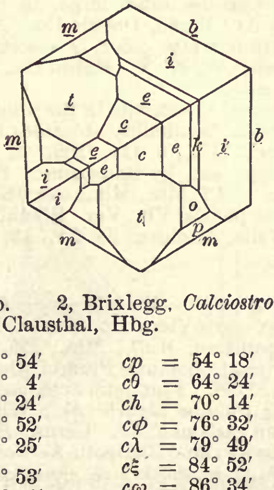

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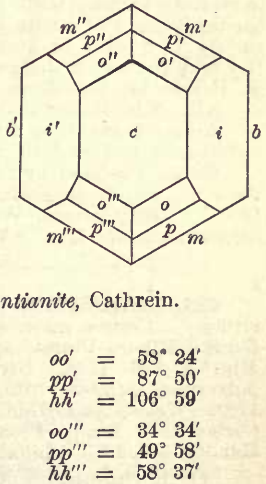


Fig. 1, Hamm, Westphalia, Lasp. 2, Brixlegg, *Calciostrontianite*, Cathrein. 3, Clausthal, Hbg.

*mm‴* = *62° 41′
*tt′* = 61° 27′
*ee′* = 39° 48′
*δδ′* = 51° 31′
*kk′* = *71° 48′
*ll′* = 94° 43′
*ii′* = 110° 44′

*zz′* = 141° 54′
*qq′* = 154° 4′
*ζζ′* = 160° 24′
*χχ′* = 166° 52′
*ηη′* = 173° 25′
*cϵ* = 24° 53′
*co* = 34° 50′

*cp* = 54° 18′
*cθ* = 64° 24′
*ch* = 70° 14′
*cϕ* = 76° 32′
*cλ* = 79° 49′
*cξ* = 84° 52′
*cω* = 86° 34′
*cψ* = 88° 58′

*oo′* = 58° 24′
*pp′* = 87° 50′
*hh′* = 106° 59′
*oo‴* = 34° 34′
*pp‴* = 49° 58′
*hh‴* = 58° 37′

Twins: tw. pl. *m* very common, usually contact-, rarely penetration-twins, also repeated, trillings, fourlings, and again polysynthetic giving inclosed tw. lamellæ. Crystals often acicular or acute spear-shaped, like aragonite, from the presence of acute pyramids and brachydomes; forms *hhl* and 0·2*h*·*l* often present together (f. 2) giving a pseudohexagonal aspect. Also in columnar globular forms; fibrous and granular.

Cleavage: *m* nearly perfect; *b* in traces. Fracture uneven. Brittle. H. = 3·5–4. G. = 3·680–3·714 Dmr. Luster vitreous; inclining to resinous on uneven faces of fracture. Color pale asparagus-green, apple-green; also white, gray, yellow, and yellowish brown. Streak white. Transparent to translucent. Optically −. Ax. pl. ∥ *b*. Bx ⊥ *c*. Dispersion $\rho < v$ small.

$$2E_r = 12^\circ\, 17' \qquad 2E_{bl} = 12^\circ\, 24'.$$

**Comp.**—Strontium carbonate, $SrCO_3$ = Carbon dioxide 29·9, strontia 70·1 = 100. A little calcium is sometimes present.

Cf. analyses, 5th Ed., p. 699, Macadam obtained for selected strontianite from Strontian: $SrCO_3$ 94·50, $BaCO_3$ 0·21, $CaCO_3$ 4·82 = 99·53. The white massive form gave, with 56·60 $SrCO_3$ and 6·81 $CaCO_3$, etc., also 21·25 $SrSO_4$, 10·01 $BaSO_4$ and 3·64 $CaSO_4$. Min. Mag., **6**, 173, 1885.

Heddle describes a variety from Sutherland with 8·53 CaO, G. = 3·447, Min. Mag., **5**, 175, 1883. Vrba (l. c.) gives (anal. by Kovář) 6·37 $CaCO_3$ and G. = 3·69, for the strontianite from Altahlen.

Thomson obtained in his *emmonite* "from Massachusetts": $SrCO_3$ 82·69, $CaCO_3$ 12·50, $Fe_2O_3$ 1·00, zeolite 3·79 = 99·98. G. = 2·946. Named for Prof. Emmons. Cathrein gives for a similar mineral (*calciostrontianite*) from Brixlegg, Tyrol: $SrCO_3$ 86·89, $CaCO_3$ 13·14 = 100·03. It occurs in highly modified crystals, f. 2, Zs. Kr., **14**, 366, 1888.

Traill's *stromnite* is pronounced a mixture by Greg and Lettsom. It is from near Stromness, on Pomona, one of the Orkneys.

**Pyr., etc.**—B.B. swells up, throws out minute sprouts, fuses only on the thin edges, and colors the flame strontia-red; the assay reacts alkaline after ignition. Moistened with hydrochloric acid and treated either B.B. or in the naked lamp gives an intense red color. With soda on charcoal the pure mineral fuses to a clear glass, and is entirely absorbed by the coal; if lime or iron be present they are separated and remain on the surface of the coal. Soluble in hydrochloric acid; the dilute solution when treated with sulphuric acid gives a white precipitate.

**Obs.**—Occurs at Strontian in Argyllshire, in veins traversing gneiss, along with galena and barite, in acicular diverging and fibrous groups, rarely in perfect crystals; in Yorkshire, England; Giant's Causeway, Ireland; Clausthal in the Harz; Bräunsdorf, near Freiberg, Saxony. Leogang in Salzburg; on the Grosskogel, near Brixlegg, Tyrol (*calciostrontianite*); massive and in fine crystals in the neighborhood of Hamm, Westphalia; at the Wilhelmine mine near Altahlen, Münster, Westphalia, in large crystals up to 20 mm. in height and 16 mm. in breadth.

In the U. States it occurs at Schoharie, N. Y., in granular and columnar masses, and also in crystals, forming nests or geodes, often large, in the hydraulic limestone, associated with barite, pyrite, and calcite. At Clinton, Oneida Co. At Muscalonge Lake a massive and fibrous variety, of a white or greenish white color, is sometimes the matrix of fluorite. Chaumont Bay and Theresa, in Jefferson Co., N. Y., Mifflin Co., Penn., are other localities. Sparingly on St. Helen's Is., near Montreal.

**Alt.**—Strontianite is altered to celestite in the same way as witherite to barite.

**Artif.**—Formed by fusion in alkaline chlorides in elongated prismatic crystals, optically negative, Bourgeois Bull. Soc. Min., **5**, 111, 1882.

**Ref.**—[1] Credited by Zippe and by Hausmann. Strontianite is hemimorphic according to Beckenkamp, cf. aragonite. [2] Cf. Mlr., Min., 569, 1852. [3] Hbg., Clausthal, Min. Not., **9**, 41, 1870. [4] Lasp., Hamm, Westphalia, Vh. Ver. Rheinl., **23**, 308, 1876. [5] Cathrein, Brixlegg, *calciostrontianite*, l. c. [6] Vrba, Altahlen, Zs. Kr., **15**, 449, 1889.

**281. CERUSSITE.** *Ψιρύθιον Theophr.*, etc., Cerussa *Plin.*, etc., *Agric.*, but only the artificial. Cerussa nativa ex agro Vicentino *Gesner*, Foss., 85, 1565. Blyspath (= Bleispath *Germ.*), Minera Plumbi spathacea, *Wall.*, Min., 295, 1747. Plomb spathique *Fr. Trl.* Wall. Min., **1**, 536, 1753. Bly-Spat, Spatum Plumbi (the hard); Bly-Ochra, Cerussa nativa (the pulverulent), *Cronst.*, Min., 1758. Plumbum acido aereo mineralisatum *Bergm.*, Opusc., **2**, 426, 1780. Weissbleierz *Wern.*; Plombe blanche *Fr.*; White Lead Ore. Kohlensaures Blei *Germ.* Carbonate of Lead. Plomb carbonaté *Fr.* Céruse *Beud.*, Tr., **2**, 363, 1832. Cerussit *Haid.*, Handb., 503, 1845. Iglésiasite (Zinc-Bleispath *Kersten*) *Huot*, Min., 618, 1841. Cerusite.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·609968 : 1 : 0·723002 Koksharov[1].

$100 \wedge 110 = 31^\circ\, 22'\, 55''$, $001 \wedge 101 = 49^\circ\, 50'\, 49''$, $001 \wedge 011 = 35^\circ\, 52'\, 1''$,

**Forms**[2]:
*a* (100, $i$-$\bar{\imath}$)
*b* (010, $i$-$\breve{\imath}$)
*c* (001, $O$)
*f* (530, $i$-$\bar{\frac{5}{3}}$)
*m* (110, $I$)
$\nabla$ (350, $i$-$\breve{\frac{5}{3}}$)
$\chi$ (120, $i$-$\breve{2}$)[3]
*r* (130, $i$-$\breve{3}$)
$\Gamma$ (180, $i$-$\breve{8}$)[5]
$\mathfrak{a}$ (105, $\frac{1}{5}$-$\bar{\imath}$)[4]
*E* (104, $\frac{1}{4}$-$\breve{\imath}$)[8]
*d* (103, $\frac{1}{3}$-$\bar{\imath}$)

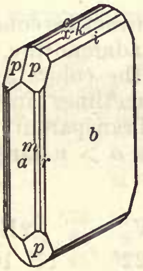
*y* (102, $\frac{1}{2}$-$\bar{\imath}$)
*e* (101, 1-$\bar{\imath}$)
$\pi$ (302, $\frac{3}{2}$-$\bar{\imath}$)
*l* (201, 2-$\bar{\imath}$)
$\mathfrak{c}$ (016, $\frac{1}{6}$-$\breve{\imath}$)[4]
$\gamma$ (013, $\frac{1}{3}$-$\breve{\imath}$)
*x* (012, $\frac{1}{2}$-$\breve{\imath}$)
*q* (023, $\frac{2}{3}$-$\breve{\imath}$)
*k* (011, 1-$\breve{\imath}$)
$\mathfrak{e}$ (087, $\frac{8}{7}$-$\breve{\imath}$)[4]
$\mathfrak{f}$ (076, $\frac{7}{6}$-$\breve{\imath}$)[4]
*S* (032, $\frac{3}{2}$-$\breve{\imath}$)[8]
*i* (021, 2-$\breve{\imath}$)

*R* (052, $\frac{5}{2}$-$\breve{\imath}$)[8]
*v* (031, 3-$\breve{\imath}$)
*z* (041, 4-$\breve{\imath}$)
*n* (051, 5-$\breve{\imath}$)
*t* (061, 6-$\breve{\imath}$)
*u* (071, 7-$\breve{\imath}$)
$\zeta$ (081, 8-$\breve{\imath}$)
$\mathfrak{n}$ (091, 9-$\breve{\imath}$)[4]
$\mathfrak{g}$ (0·10·1, 10-$\breve{\imath}$)[4]
$\mathfrak{h}$ (0·14·1, 14-$\breve{\imath}$)[4]
*h* (114, $\frac{1}{4}$)
*g* (113, $\frac{1}{3}$)
*o* (112, $\frac{1}{2}$)

*p* (111, 1)
$\tau$ (221, 2)
$\epsilon$ (331, 3)
$\mathfrak{b}$ (14·14·1, 14)[4]
$\vartheta$ (313, 1-$\bar{3}$)
$\Delta$ (311, 3-$\bar{3}$)
*w* (211, 2-$\bar{2}$)
$\mu$ (324, $\frac{3}{4}$-$\bar{\frac{3}{2}}$)
$\mathfrak{u}$ (323, 1-$\bar{\frac{3}{2}}$)
$\nu$ (322, $\frac{3}{2}$-$\bar{\frac{3}{2}}$)
*N* (11·13·1, 13-$\breve{\frac{13}{11}}$)[7]
$\delta$ (562, 3-$\breve{\frac{6}{5}}$)
$\rho$ (342, 2-$\breve{\frac{4}{3}}$)

*K* (354, $\frac{5}{4}$-$\breve{\frac{5}{3}}$)[7]
$\eta$ (352, $\frac{5}{2}$-$\breve{\frac{5}{3}}$)
$\kappa$ (351, 5-$\breve{\frac{5}{3}}$)[8]
$\alpha$ (122, 1-$\breve{2}$)
*s* (121, 2-$\breve{2}$)
$\lambda$ (377, 1-$\breve{\frac{7}{3}}$)
$\psi$ (134, $\frac{3}{4}$-$\breve{3}$)
$\beta$ (133, 1-$\breve{3}$)
$\xi$ (394, $\frac{9}{4}$-$\breve{3}$)
$\phi$ (131, 3-$\breve{3}$)
$\omega$ (154, $\frac{5}{4}$-$\breve{5}$)[5]
*H* (161, 6-$\breve{6}$)[8]
$\sigma$ (173, $\frac{7}{3}$-$\breve{7}$)

1.



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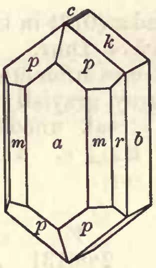

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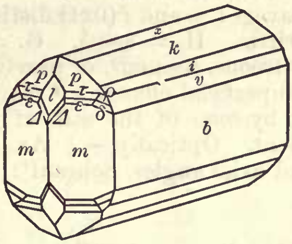

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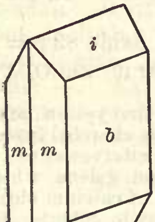

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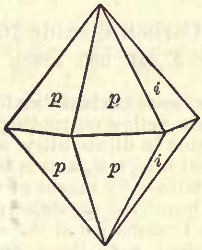

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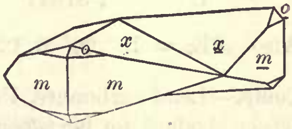

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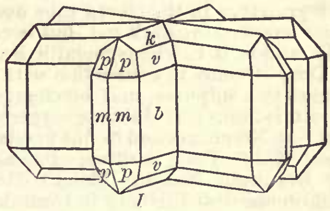

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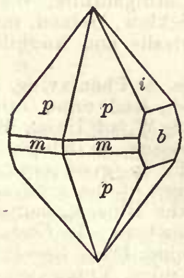

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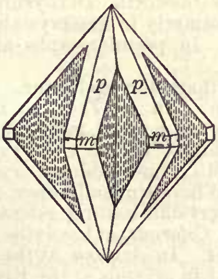

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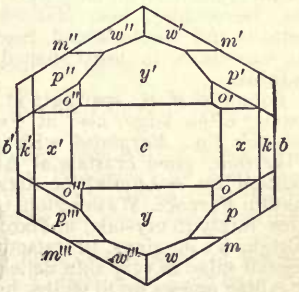

Figs. 1, 2, Phenixville. 3, Rezbanya, Schrauf. 4, Pelsöcz-Ardó, Schmidt. 5, 8, Berezov, Kk. 6, Central City, Col., Brown. 7, Schrauf. 9, 10, Transbaikal, Kk.

$ff''' = 40^\circ\ 12'$
$mm''' = {*}62^\circ\ 45'\ 50''$
$rr' = 57^\circ\ 19'$

$dd' = 43^\circ\ 7'$
$yy' = 61^\circ\ 18'$
$ee' = 99^\circ\ 42'$
$ll' = 134^\circ\ 15'$

$\gamma\gamma' = 27^\circ\ 6'$
$xx' = {*}39^\circ\ 45'$
$qq' = 51^\circ\ 28'$
$kk' = 71^\circ\ 44'$

$ii' = 110^\circ\ 40'$
$vv' = 130^\circ\ 30'$
$zz' = 141^\circ\ 51'$
$nn' = 149^\circ\ 4\tfrac{1}{2}'$
$tt' = 154^\circ\ 2'$
$uu' = 157^\circ\ 39'$
$\zeta\zeta' = 160^\circ\ 23'$

$ch = 19^\circ\ 8\tfrac{1}{2}'$
$cg = 24^\circ\ 50'$
$co = 34^\circ\ 46'$
$cp = 54^\circ\ 14'$

$c\tau = 70^\circ\ 11\tfrac{1}{2}'$
$c\epsilon = 76^\circ\ 30'$
$cw = 68^\circ\ 2'$
$c\alpha = 43^\circ\ 4'$
$cs = 61^\circ\ 52'$
$c\beta = 39^\circ\ 29'$
$c\phi = 67^\circ\ 58\tfrac{1}{2}'$

$oo' = 58^\circ\ 16'$
$pp' = 87^\circ\ 42'$
$ss' = 67^\circ\ 58\tfrac{1}{2}'$
$\alpha\alpha' = 51^\circ\ 18\tfrac{1}{2}'$

$\beta\beta' = 35^\circ\ 30\tfrac{1}{2}'$
$\phi\phi' = 52^\circ\ 47'$

$gg''' = 25^\circ\ 16'$
$oo''' = 34^\circ\ 33'$
$pp''' = 49^\circ\ 59\tfrac{1}{2}'$
$ww''' = 31^\circ\ 23\tfrac{1}{2}'$
$\alpha\alpha''' = 63^\circ\ 46'$
$\beta\beta''' = 67^\circ\ 50'$
$ss''' = 85^\circ\ 59'$
$\phi\phi''' = 108^\circ\ 53'$

Twins[6]: tw. pl. *m*, very common, contact- and penetration-twins, often repeated yielding six-rayed stellate groups; also less common tw. pl. *r* (130). Simple crystals often tabular ∥ *b*, prismatic ∥ *ă*; also pyramidal. Brachydome faces and *b* usually horizontally striated, also *p* often striated ∥ edge *m*/*p* or *i*/*p*. Crystals grouped in clusters, and aggregates. Rarely fibrous, often granular massive and compact; earthy. Sometimes stalactitic.

Cleavage: *m* and *i* (021) distinct; *b* and *x* (012) in traces. Fracture conchoidal. Very brittle. H. = 3–3·5. G. = 6·46–6·574 Dmr. Luster adamantine, inclining to vitreous, resinous, or pearly; sometimes submetallic, if the colors are dark, from a superficial change. Color white, gray, grayish black, sometimes tinged blue or green by some of the salts of copper; streak uncolored. Transparent to subtranslucent. Optically −. Ax. pl. ∥ *b*. Bx ⊥ *c*. Dispersion $\rho > v$ large. Indices and axial angles, Schrauf[9]:

| | $\alpha$ | $\beta$ | $\gamma$ | | 2V | 2E |
|---|---|---|---|---|---|---|
| Line B | 1·79148 | 2·05954 | 2·06131 | ∴ | 8° 22′ | 17° 16½′ |
| " D | 1·80368 | 2·07628 | 2·07803 | ∴ | 8° 14′ | 17° 8′ |
| " E | 1·81641 | 2·09194 | 2·09344 | ∴ | 7° 35′ | 15° 55′ |

Also $2E_r = 18^\circ\ 22'$ at 12° C., 20° 20′ at 71·5° C., 22° 2′ at 95·5° C., Dx[9].

**Comp.**—Lead carbonate, $PbCO_3$ = Carbon dioxide 16·5, lead oxide 83·5 = 100.

Kersten obtained for the *iglesiasite* (Schw. J., **65**, 365, 1832): $PbCO_3$ 92·10, $ZnCO_3$ 7·02 = 99·12. G. = 5·9.

**Pyr., etc.**—In the closed tube decrepitates, loses carbon dioxide, turns first yellow, and at a higher temperature dark red, but becomes again yellow on cooling. B.B. on charcoal fuses very easily, and in R.F. yields metallic lead. Soluble in dilute nitric acid with effervescence.

**Obs.**—Occurs in connection with other lead minerals, and is formed from galena, which, as it passes to a sulphate, may be changed to carbonate by means of solutions of calcium bicarbonate. It is found at Johanngeorgenstadt in beautiful crystals; at Berezov in Siberia; in the Altai; at Nerchinsk and in fine crystals in the Transbaikal at the Kadainsk, Taininsk, and other mines; Monte Poni, Sardinia; Pajsberg, Sweden; near Bonn on the Rhine; Friedrichssegen near Braubach, Nassau; Badenweiler, Baden; at Clausthal in the Harz, and at Andreasberg (Bleiglimmer); at Bleiberg in Carinthia; at Mies and Příbram in Bohemia; at Rezbanya and Telekes, Hungary; Laurion, Greece; in England, in Cornwall, in the mine of St. Minvers; delicate crystals 10 in. long were formerly found near St. Austell and elsewhere; at E. Tamar mine, Devonshire; near Matlock and Wirksworth, Derbyshire; in Cardiganshire, Wales; at Leadhills and Wanlockhead, Scotland, formerly in fine crystals; in Wicklow, Ireland, magnificent, sometimes in heart-shaped twins. In pseudomorphs after anglesite and leadhillite, at Leadhills.

Found in *Mass.*, sparingly at the Southampton lead mine. In *Penn.*, at Phenixville, in fine crystals, often large; also at Perkiomen. In *N. York*, at the Rossie lead mine, rare. In Frederick Co., *Maryland*, with anglesite at a lead mine, 2½ miles S. W. of Union Bridge. In *Virginia*, good crystals at Austin's mines, Wythe Co. In *N. Carolina*, in King's mine, Davidson Co. At Valle's diggings, Mo., but seldom crystallized; in good crystals at Franklin Furnace, Washington Co; in Wisconsin and other lead mines of the northwestern States, rarely in crystals; at Hazelgreen, crystals coating galena; near the Blue Mounds, Wis., at Brigham's diggings, in stalactites. In *Colorado*, at Leadville, and elsewhere. In *Utah*, at the Flagstaff mine in very thin delicate tables. In *Arizona*, at the Flux mine, Pima Co., in large crystalline masses up to 60 lbs. in weight; in crystals at the Red Cloud mine, Yuma Co.

*Bleierde* occurs in opaque earthy nodules at Tarnowitz, Kall in the Eifel, and elsewhere. *Bleischwärze*, a black carbonaceous lead carbonate, occurs at Tarnowitz, Mies, Badenweiler, etc.

**Alt.**—Cerussite occurs altered to pyromorphite, galena, minium.

Pseudomorphs after galena, phosgenite, anglesite, leadhillite, linarite, etc., have been noted.

**Artif.**—Cf. Riban, C. R., **93**, 1026, 1881.

Observed as a recent formation at Pompeii; also similarly at Laurium, Greece.

**Ref.**—[1] Min. Russl., **6**, 100, 1870. [2] For lists of planes, authorities, etc., cf. Mlr., Min., 565, 1852; Lang, Vh. Min. Ges., **9**, 152, 1874; Dx., Min., **2**, 153, 1874; Schrauf, Atlas, XLI–XLII, 1877; Schmidt, Zs. Kr., **6**, 546, 1881; Gdt., Index, **1**, 401, 1886. Cf. also Zeph., Ber. Ak. Wien, **62** (1), 439, 1870, Lotos, 1874, 1878; Kk., l. c.; Schrauf, Min. Mitth., 203, 1873; Slg., Vh. Ver. Rheinl., **33**, 244, 1876, Jb. Min., **1**, 137, 1880; Miers, La Croix, Zs. Kr., **6**, 598, 1882; Artini, Sardinia, Mem. Acc. Linc., **5**, read Dec. 2, 1888. Dannenberg gives a pyramid (4·86·45), Zs. Kr., **18**, 64, 1890.

[3] Schmidt, l. c. [4] Mügge, Spain, Jb. Min., **2**, 39, 1882. [5] Liweh, Badenweiler, Zs. Kr., **9**, 512, 1884. [6] Cf. Kk. and Schrauf, Slg., l. c. [7] Negri, Auronza, Riv. Min. Ital., **4**, 41, 1889. [8] Artini, Sardinia, l. c. [9] Ber. Ak. Wien, **42**, 120, 1860. N. R., 49, 1867.

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## 3. Barytocalcite Group. Monoclinic.

### 282. BARYTOCALCITE. *Brooke*, Ann. Phil., 8, 114, 1824.

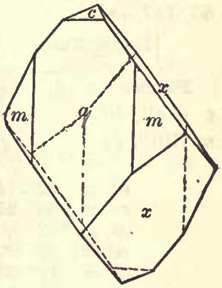
Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 0·77171 : 1 : 0·62545$; $\beta = 73° 52' = 001 \wedge 100$ Brooke[1].

$100 \wedge 110 = 36° 33'$, $001 \wedge 101 = {}^*32° 26'$, $001 \wedge 011 = 30° 59\frac{5}{6}'$.

**Forms**[1]:
*a* (100, *i*-*ī*)
*c* (001, *O*)
*m* (110, *I*)
*g* (120, *i*-2)
*o* (101, = 1-*ī*)
*x* ($\bar{1}$21, 2-$\grave{2}$)
*y* ($\bar{1}$51, 5-$\grave{5}$)
*ρ* ($\bar{1}$61, 6-$\grave{6}$)

$mm''' = {}^*73° 6'$ $a'x = 70° 54'$ $cm = {}^*77° 6'$ $yy' = 139° 50'$
$gg' = 68° 0'$ $cx = 61° 35'$ $xx' = 95° 8\frac{1}{2}'$ $\rho\rho' = 146° 7'$
$ao = 41° 26'$

Crystals prismatic by extension of *x*, *y*. Faces *a* vertically striated; also *x*, *y*, *ρ* ‖ each other. Also massive.



Cleavage: *m* perfect; *c* less so. Fracture uneven to subconchoidal. Brittle. H. = 4. G. = 3·64–3·66. Luster vitreous, inclining to resinous. Color white, grayish, greenish, or yellowish. Streak white. Transparent to translucent. Optically −. Ax. pl. and $Bx_o \perp b$. $Bx_a \wedge \grave{c} = +64° 22'$. Dispersion $\rho > v$, small; horizontal nearly zero. Axial angles for two sections Dx.:

$$2E_{.} = 23° 15', \quad 3E_{bl} = 22° 47';$$

also $2E_r = 24° 53'$ at 17° and 25° 38′ at 170·8° C.

**Comp.**—Carbonate of barium and calcium, $BaCO_3.CaCO_3$ = Barium carbonate 66·3, calcium carbonate 33·7 = 100, or Carbon dioxide 29·6, baryta 51·5, lime 18·9 = 100. Cf. bromlite, p. 283.

**Anal.**—1–3 Becker, Zs. Kr., **12**, 222, 1886. Also 5th Ed., p. 702.

| | $CO_2$ | BaO | CaO | MnO | |
|---|---|---|---|---|---|
| 1. | $\frac{3}{3}$ 29·52 | 50·09 | 19·77 | 0·35 | = 99·73 |
| 2. | $\frac{4}{4}$ 29·44 | 50·36 | 19·22 | 0·25 | insol. 0·30 = 99·57 |
| 3. | $\frac{3}{3}$ 29·39 | 51·59 | 18·61 | 0·35 | insol. 0·28 = 100·22 |

**Pyr., etc.**—B.B. colors the flame yellowish green, and at a high temperature fuses on the thin edges and assumes a pale green color (barium manganate, Plattner); the assay reacts alkaline after ignition. With the fluxes reacts for manganese. With soda on charcoal the lime is separated as an infusible mass, while the remainder is absorbed by the coal. Soluble in dilute hydrochloric acid.

**Obs.**—Occurs at Alston-Moor in Cumberland, in attached crystals and massive, in the Subcarboniferous or Mountain limestone with barite and fluorite. Crystals 2 in. long have been obtained.

**Ref.**—[1] L. c. Cf. also Haid., Pogg., **5**, 160, 1825. Dx., Ann. Ch. Phys., **13**, 425, 1845; also Min., **2**, 80, 1874. With Mlr. (Min., 574, 1852), $x = 110$, $m = 111$ (*s*), $o = 001$.

**283. BISMUTOSPHÄRITE.** Arsenikwismuth *Werner*, Min. Syst., 56, 1817. Luftsaures Wismuth *Beyer*, 1805. Bismutosphärit *Weisbach*, Jb. Berg.-Hütt., 1877.

In spherical forms with concentric and fine fibrous, radiated structure; also pseudomorphous after stibnite.

H. = 3–3·5. G. = 7·30 Weisb.; 7·42 Wells. Color bright yellow to dark gray or blackish brown.

**Comp.**—$Bi_2CO_5$ or $Bi_2(CO_3)_3.2Bi_2O_3$ = Carbon dioxide 8·7, bismuth trioxide 91·3 = 100.

**Anal.**—1, Winkler (quoted by Weisb.) l. c. 2, Id., Jb. Min., **2**, 254, 1882 (cf. Frenzel, ib., 801 1873). 3, H. L. Wells, Am. J. Sc., **34**, 271, 1887. 4, 5, E. S. Sperry, ibid. 6, Wells, l. c.

| | | | $CO_2$ | $Bi_2O_3$ | |
|---|---|---|---|---|---|
| 1. | Schneeberg | G. = 7·30 | 8·97 | 88·58 | quartz 0·28, loss 2·17 = 100 |
| 2. | Guanajuato | G. = 7·64 | 8·29 | 91·68 | $SiO_2$,$Fe_2O_3$ *tr.* = 99·97 |
| 3. | Willimantic | G. = 7·42 | 8·03 | 91·64 | $H_2O$ 0·47, $SO_3$ 0·34, insol. 0·08, $Fe_2O_3$ *tr.* = 100·56 |
| 4. | " | | 8·01 | 92·07 | $H_2O$ 0·90 = 100·98 |
| 5. | " | | 7·92 | 92·05 | $H_2O$ 0·54 = 100·51 |
| 6. | Portland | | 7·54 | 89·03 | $H_2O$ 0·94, $Fe_2O_3$, CuO, insol. 2·79 = 100·30 |

**Pyr.**—Gives no water, or only a minute amount, in the closed tube, fusing easily. Bismuth coating on charcoal. Dissolves entirely with effervescence in nitric acid.

**Obs.**—At Schneeberg, Saxony (Werner's *arsenikwismuth*, Weisb.) with quartz on brown spar, which last carries native bismuth and smaltite. At Guanajuato, Mexico, pseudomorphous. Also sparingly at Willimantic and Portland, Conn., as a result of the alteration of bismuthinite in a feldspar vein in gneiss. It retains the structure of the origiual mineral, but in cavities minute crystals in scales are noted which are probably the same mineral.

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## 4. Parisite Group. Hexagonal.

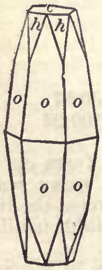
**284. PARISITE.** Musite *Medici-Spada*, 1835. Parisit *Medici-Spada*, Bunsen, Lieb. Ann., **53**, 147, 1845.

Hexagonal. Axis $\dot{c}$ = 3·2891; 0001 ∧ 10$\bar{1}$1 = 75° 15′ Des Cloizeaux[1].

| **Forms**[1]: | | | | |
|---|---|---|---|---|
| | *q* (10$\bar{1}$2, $\frac{1}{2}$) | *o* (20$\bar{2}$1, 2) | *f* (11$\bar{2}$4, $\frac{1}{2}$-2) | *k* (22$\bar{4}$3, $\frac{4}{3}$-2) |
| *c* (0001, *O*) | *r* (20$\bar{2}$3, $\frac{2}{3}$) | *d* (11$\bar{2}$8, $\frac{1}{4}$-2) | *g* (11$\bar{2}$3, $\frac{2}{3}$-2) | *s* (11$\bar{2}$1, 2-2) |
| *m* (10$\bar{1}$0, *I*) | *p* (10$\bar{1}$1, 1) | *e* (11$\bar{2}$6, $\frac{1}{3}$-2) | *h* (11$\bar{2}$2, 1-2) | *x* (63$\bar{9}$5, $\frac{9}{5}$-$\frac{3}{2}$) |

| | | | |
|---|---|---|---|
| *cq* = 62° 14′ | *cg* = 65° 29′ | *pp′* = 57° 50′ | *kk′* = 58° 21′ |
| *cr* = 68° 27′ | *ch* = 73° 5′ | *oo′* = 59° 26′ | *ss′* = 59° 15′ |
| *co* = *82° 30′ | *ck* = 77° 9′ | *dd′* = 37° 2′ | *xx′* = 21° 29′ |
| *cd* = 39° 26′ | *cs* = 81° 21′ | *ff′* = 50° 35′ | *xx*$^{x1}$ = 37° 41′ |
| *ce* = 47° 38′ | *qq′* = 52° 31′ | *hh′* = 57° 9½′ | *cx* = 80° 35′ |
| *cf* = 58° 42′ | *rr′* = 55° 25½′ | | |

Crystals usually acute double hexagonal pyramids terminated by *c*; *m* rare. Faces *c* slightly uneven; planes in zone *cs* horizontally striated, of zone *cp* horizontally channeled.



Muso, Vrba[1].

Cleavage: *c* very perfect. Fracture small conchoidal. Brittle. H. = 4·5. G. = 4·358 Dmr.; 4·364 Vrba. Luster vitreous; on *c* pearly or resinous. Color brownish yellow; streak yellowish white. Translucent; transparent in thin sections. Optically +. Double refraction strong. Indices: $\omega$ = 1·569, $\epsilon$ = 1·670, Sen.[2]

**Comp.**—A fluocarbonate of the cerium metals, composition perhaps $(CaF)(CeF)Ce(CO_3)_3$ Groth, with the cerium replaced in part by didymium and lanthanum.

**Anal.**—Damour & Deville, C. R., **59**, 270, 1864 (as given by Rg., Min. Ch., 251, 1875). Also Bunsen, see 5th Ed., p. 703.

| | $CO_2$ | Ce | La | Di | Ca | F | O |
|---|---|---|---|---|---|---|---|
| G. = 4·358 | 23·48 | 37·75 | 6·86 | 8·21 | 7·22 | 5·55 | [10·93] |

**Pyr., etc.**—In the closed tube yields no water, but gives off carbon dioxide and becomes lighter in color. B.B. glows and is infusible. With fused salt of phosphorus in the open tube gives B.B. the reaction for fluorine. With borax and salt of phosphorus in the platinum loop gives a glass, yellow while hot and colorless on cooling. Dissolves slowly in hydrochloric acid with effervescence.

**Obs.**—From the emerald mines of the Muso valley, U. S. Colombia, where it was discovered by J. J. Paris, the proprietor of the mine, after whom it was named, and from which place it was sent in 1835 to Medici-Spada, of Rome, by Col. Acosta. The earlier name *Musite* (sometimes written *Mussite*, the name of the valley being written both Muso and Musso, as well as Muzo) is objectionable, because of the use of the name *Mussite* for a variety of pyroxene.

A mineral is probably to be referred here (Brögger, Zs. Kr., **16**, 650, 1890), which occurs very sparingly in hexagonal tabular crystals, sometimes in rosettes, with weibyeïte at the eudidymite locality on Ober-Arö, Langesundfiord, Norway.

**Ref.**—[1] Min., **2**, 162, 1874. Vrba gives, *ch* = 73° 26′ 50″ and $\dot{c}$ = 3·3646, Ber. Böhm. Ges., 647, 1886, and Zs. Kr., **15**, 210, 1888. [2] Quoted by Dx.

KISCHTIMITE. Kischtim-Parisit *T. Karavayev*, Bull. Ac. St. Pet., **4**, 401, 1861, J. pr. Ch., **85**, 442, 1862. Kk., Min. Russl., **4**, 40, 1862. Kischtimite *G. J. Brush*, Am. J. Sc., **35**, 427, 1863. Kyshtymo-parisite.

Massive. H. = 4·5. G. = 4·784. Luster between greasy and vitreous. Color dark brownish yellow. Streak much lighter than color. In small pieces translucent.

A fluocarbonate of the cerium metals near parisite. Analysis: Karavayev:

| | $CO_2$ | La | Ce | F | O | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| ⅔ | 17·19 | 36·56 | 27·81 | 6·35 | [9 89] | 2·20 | = 100 |

From the gold washings of the Barsovka river, in the district of Kyshtymsk, Ural.

**285. BASTNÄSITE.** Basiskfluorcerium *Hisinger*, Öfv. Ak. Stockh., 189, 1838. Bastnäsite *Huot*, Min., **1**, 296, 1841. Hamartite *A. E. Nordenskiöld*, Öfv. Ak. Stockh., **25**, 399, 1868.

Basisk flussspatssyradt Cerium *Berz.*, Afh., **6**, 64, 1818. Basisches Fluorcerium. Basic fluocerine. Basicerine *Beud.* Fluocerine *Hausm.*, 1847. Hydrofluocerite.

Massive, and in hexagonal prisms[1], pseudomorphous after tysonite.

H. = 4–4·5. G. = 4·93 Nd.; 5·19 Allen. Luster vitreous to greasy. Color wax-yellow to reddish brown. Streak light yellowish gray.

**Comp.**—A fluocarbonate of the cerium metals $(RF)CO_3$ or $(Ce,La,Di)_2C_3O_9.(Ce,La,Di)F_3$.

**Anal.**—1, Nd., l. c.; he also recalculates Hisinger's results and shows that they correspond to his, allowing for the $CO_2$, which was overlooked. 2, Allen and Comstock, Am. J. Sc., **19**, 390, 1880.

| | | $CO_2$ | $Ce_2O_3$ | $(La,Di)_2O_3$ | F | |
|---|---|---|---|---|---|---|
| 1. | G. = 4·93 | 19·50 | 28·49 | 45·77 | [5·23] | $H_2O$ 1·01 = 100 |
| 2*a*. | G. = 5·19 | ⅔ 20·15 | 41·04 | 34·76 | | |
| | | $CO_2$ | $(Ce,La,Di)_2O_3$ | (Ce,La,Di) | | |
| 2*b*[a]. | | 20·15 | 50·13 | 21·82 | [7·90] | = 100 |

[a] Calculated from 2*a*; joint atomic weight 140·2

**Pyr., etc.**—B.B. infusible. Slightly attacked by hydrochloric acid. Dissolves in strong sulphuric acid with effervescence ($CO_2$) and evolution of hydrofluoric acid.

**Obs.**—Found in small masses embedded between allanite crystals at the Bastnäs mine, Riddarhyttan, Sweden. Also as an alteration product of tysonite (p. 166) in the granite of the Pike's Peak region in Colorado. The basic fluocerine was from Finbo, Sweden.

Hamartite is from ἁμαρτειν, *to go astray*, but bastnäsite, from the locality, has the priority.

**Ref.**—[1] The hamartite of Nordenskiöld is described as occurring in hexagonal prisms (cf. also Dx., Min., **2**, 163, 1874), but it seems very probable that, like the mineral from Colorado, they are only pseudomorphs after an original fluoride like tysonite.

WEIBYEÏTE *W. C. Brögger*, Zs. Kr., **16**, 650, 1890. In minute pyramidal orthorhombic crystals with *p* (111), also subordinate *m* (110), a prism (10·9·0) or (540), and a dome (201) or (021). Angles $pp^{iv}$ = 95° 59′, $pp'''$ = 56° 44′ or near zircon. Optically biaxial, negative. Bx ⊥ 100 or 010. 2E = 110° approx. Colorless within but covered with a thin yellow ocher-like crust, and penetrated to some extent by the same substance.

Analysis, G. Forsberg:

| $CO_2$ | $Ce_2O_3$ | $La_2O_3,Di_2O_3$ | CaO | SrO | F | |
|---|---|---|---|---|---|---|
| 19·16 | 35·38 | 31·58[a] | 3·42 | 0·97 | 5·04 | X[b] 0·23 = 95·78 |

[a] $Di_2O_3$ = 9 p. c. approx.; at. weight = 139–140. [b] X = O in excess.

Deducting O (= F) 2·12 the sum is 93·66, leaving $H_2O$ (and loss) 6·34.

The mineral analyzed was mixed with the ocher-like substance mentioned, also with parisite or an allied mineral, and the interpretation of the analysis is otherwise doubtful, but a composition analogous to that of bastnäsite is suggested.

Found as a later formation on eudidymite, also with analcite and natrolite, on the island called Ovre-Arö, in the Langesundfiord, Norway. Named for the Norwegian mineralogist, P. C. Weibye.

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## 5. Phosgenite Group. Chlorocarbonate. Tetragonal.

**286. PHOSGENITE.** Hornblei *Karst.*, Tab., 78, 1800. Salzsaures Bleierze *Klapr.*, Beitr., 3, 141, 1802. Corneous Lead *Jameson.* Bleihornerz, Chlorbleispath, *Germ.* Plomb carbonaté muriatifère, Plomb chloro-carbonaté, Plomb corné, *Fr.* Phosgen-spath *Breith.*, Char., 61, 1832. Kerasine *Beud.*, Tr., 2, 502, 1832. Phosgenit *Breith.*, Handb., 2, 183, 1841. Galenoceratite, Bleikerat, *Glocker*, Syn., 248, 1847. Cromfordite *Greg & Lettsom*, Min., 421, 1858.

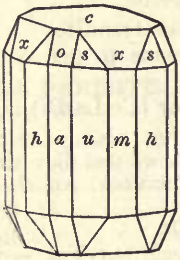
Tetragonal. Axis $\dot{c} = 1{\cdot}08758$; $001 \wedge 101 = 47° 24' 6''$ Koksharov[1].

| | | | | |
|---|---|---|---|---|
| **Forms**[2]: | *m* (110, *I*) | *h* (210, *i*-2) | *o* (201, 2-*i*) | *v* (311, 3-3)[3] |
| *c* (001, *O*) | *l* (310, *i*-3)[3] | *p* (203, ⅔-*i*)[3] | *x* (111, 1) | *s* (211, 2-2) |
| *a* (100, *i*-*i*) | | | | |

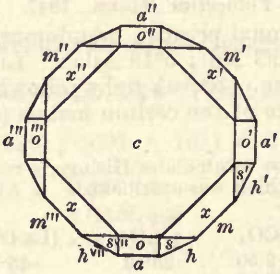
On pseudomorphs, also uncertain acute pyramids (f. 3), an octagonal prism[4], etc.

| | | | |
|---|---|---|---|
| *co* = 65° 19′ | *cs* = 67° 39′ | *xx′* = 72° 43′ | $ss^{vii}$ = 48° 52′ |
| *cx* = 56° 58′ | *oo′* = 79° 57′ | *ss′* = 34° 1′ | *xs* = 19° 27′ |

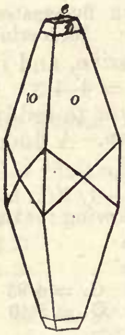
1.



2.



3.



Figs. 1, 2, Monte Poni, Kk. 3, Silesia (pseudomorph), Kr. v. Nidda[4].

Crystals prismatic; sometimes tabular ∥ *c*.

Cleavage: *m*, *a* distinct; also *c*. Rather sectile. H. = 2·75–3. G. = 6·0–6·09, Lovisato; 6·305 Rg. Luster adamantine. Color white, gray, and yellow. Streak white. Transparent to translucent. Optically +. Indices: $\omega = 2{\cdot}114$, $\epsilon = 2{\cdot}140$ orange rays, Sella (Dx.).

**Comp.**—Chlorocarbonate of lead, $(PbCl)_2CO_3$ or $PbCO_3.PbCl_2$ = Carbon dioxide 8·1, chlorine 13·0, lead oxide 81·9 = 103; or Lead carbonate 49·0, lead chloride 51·0 = 100.

Analyses, see 5th Ed., p. 703.

**Pyr., etc.**—B.B. melts readily to a yellow globule, which on cooling becomes white and crystalline. On charcoal in R.F. gives metallic lead, with a white coating of lead chloride. With a salt of phosphorus bead previously saturated with copper oxide gives the chlorine reaction. Dissolves with effervescence in dilute nitric acid.

**Obs.**—At Cromford near Matlock in Derbyshire, in crystals sometimes 2 or 3 inches long; very rare in Cornwall; in minute crystals at a lead mine near Elgin in Scotland; in large crystals at Gibbas, Monte Poni and Montevecchio in Sardinia; near Bobrek in Upper Silesia.

A recent formation at Bourbonne-les-Bains; also at Laurion, Greece, where it is the result of the action of the sea-water upon ancient lead slags, in the cavities of which it occurs with laurionite (wh. see, p. 171).

**Alt.**—Occurs at the Elisabeth zinc mine, Upper Silesia, altered to lead carbonate, the crystals are acute tetragonal pyramids (f. 3), sometimes with a zirconoid or an octagonal prism; they are embedded in clay. Cf. thinolite, p. 271.

**Artif.**—Cf. Friedel & Sarasin, Bull. Soc. Min., **4**, 175, 1881.

**Ref.**—[1] Mte. Poni, Min. Russl., **8**, 118, 1881; cf. Hansel, Zs. Kr., **2**, 291, 1878. [2] Cf. Mlr. Min., 622, 1852. [3] Rath, Laurium, Ber. nied. Ges., 102, 1887. [4] Krug v. Nidda, Zs. G. Ges., **2**, 126, 1850.

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## B. Acid, Basic, and Hydrous Carbonates

**287. Teschemacherite** $HNH_4CO_3$ Orthorhombic

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| | | | $\grave{a} : \overset{\mid}{\bar{b}} : \grave{c}$ | $\beta$ |
|---|---|---|---|---|
| **288. Malachite** | $Cu_2(OH)_2CO_3$ | Monoclinic | 0·8809 : 1 : 0·4012 | 61° 50′ |
| **289. Azurite** | $Cu_3(OH)_2(CO_3)_2$ | " | 0·8501 : 1 : 0·8805 | 87° 36′ |
| **290. Aurichalcite** | $(Zn,Cu)_5(OH)_6(CO_3)_2$ | | | |
| **291. Hydrozincite** | $Zn_3(OH)_4CO_3$? | | | |
| **292. Hydrocerussite** | $Pb_3(OH)_2(CO_3)_2$? | Hexagonal | | |
| **293. Dawsonite** | $Na(Al(OH)_2)CO_3$ | Monoclinic? | | |

---

| | | | | |
|---|---|---|---|---|
| | | | $\breve{a}:\bar{b}:\grave{c}$ | |
| **294. Thermonatrite** | $Na_2CO_3+H_2O$ | Orthorhombic | 0·8268 : 1 : 0·8089 | |
| **295. Nesquehonite** | $MgCO_3+3H_2O$ | " | 0·6445 : 1 : 0·4568 | |
| | | | $\grave{a}:\overset{\mid}{\bar{b}}:\grave{c}$ | $\beta$ |
| **296. Natron** | $NaCO_3+10H_2O$ | Monoclinic | 1·4828 : 1 : 1·4001 | 58° 52′ |
| | | | $\grave{a}:\bar{b}:\grave{c}$ | $\beta$ |
| **297. Gay-Lussite** | $Na_2CO_3.CaCO_3+5H_2O$ | Monoclinic | 1·4897 : 1 : 1·4442 | 78° 27′ |
| | | | $\breve{a}:\bar{b}:\grave{c}$ | |
| **298. Lanthanite** | $La_2(CO_3)_3+9H_2O$ | Orthorhombic | 0·9528 : 1 : 0·9023 | |
| | | | $\grave{a}:\overset{\mid}{\bar{b}}:\grave{c}$ | $\beta$ |
| **299. Trona** | $HNaCO_3.Na_2CO_3+2H_2O$ | Monoclinic | 2·8460 : 1 : 2·9697 | 77° 23′ |
| | | | $\grave{a}:\overset{\mid}{\bar{b}}:\grave{c}$ | $\beta$ |
| **300. Hydromagnesite** | $Mg_4(OH)_2(CO_3)_3+3H_2O$ | Monoclinic? | 1·0379 : 1 : 0·4652 | 90° |
| **301. Hydrogiobertite** | $Mg_2(OH)_2CO_3+2H_2O$ | | | |
| | | | $\breve{a}:\bar{b}:\grave{c}$ | |
| **302. Lansfordite** | $Mg_4(OH)_2(CO_3)_3+21H_2O$ | Triclinic | 0·5493 : 1 : 0·5655 | |
| | | | $\alpha=95°\ 22', \beta=100°\ 15', \gamma=92°\ 28'$ | |
| **303. Zaratite** | $Ni_3(OH)_4CO_3+4H_2O$ | | | |

| | |
|---|---|
| **304. Remingtonite** | Hydrous cobalt carbonate |
| **305. Tengerite** | Hydrous yttrium carbonate |
| **306. Bismutite** | Hydrous bismuth carbonate |
| | |
| **307. Uranothallite** | $Ca_2U(CO_3)_4+10H_2O$ |
| **308. Liebigite** | Hydrous carbonate of uranium and calcium |
| **309. Voglite** | Hydrous carbonate of uranium, calcium, and copper |

**287. TESCHEMACHERITE.** Bicarbonate of Ammonia *E. F. Teschemacher*, Phil. Mag., **28**, 548, 1846. Teschemacherite *Dana*, Min., 705, 1868.

Orthorhombic. In crystals with prismatic cleavages at 68°. H. = 1·5. G. = 1·45. Yellowish to white.

**Comp.**—Acid ammonium carbonate, $HNH_4CO_3$ or $(NH_4)_2CO_3.H_2CO_3$ = Carbon dioxide 55·7, ammonia 32·9, water 11·4 = 100.

Analysis.—Phipson, J. Ch. Soc., **16**, 74, 1863.

| | $CO_2$ | $(NH_4)_2O$ | $H_2O$ | CaO | |
|---|---|---|---|---|---|
| Chincha Islands | 51·53 | 29·76 | 11·00 | 6·02 | $P_2O_5$ 0·60, MgO, $SO_3$, Cl *tr.*, alk. and uric [acid 1·09 = 100 |

The material analyzed by Phipson was white, compact, crystalline, and fragile, and had a strong odor of ammonia, from which he infers the presence either of free ammonia or of sesquicarbonate.

**Pyr., etc.**—In the closed tube for the most part volatilized, giving the odor of ammonia, a white sublimate of ammonium carbonate, while an abundance of water condenses on the tube. Soluble in water, and heated with a fixed alkali gives a strong odor of ammonia. Effervesces with acids. Reacts alkaline to test paper.

**Obs.**—From guano deposits on the coast of Africa and Patagonia, and the Chincha Islands. Forms a bed several inches thick in the lowest parts of the guano deposits of Patagonia, as announced by Teschemacher; similarly at the Chincha Islands, according to Phipson.

On the form, etc., of the artificial ammonium carbonate, see Rose, Pogg., **46**, 400, 1839; also Rg., Kr. Ch., **1**, 545, 1881.

KALICINE *Pisani*, C. R., **60**, 918, 1865. Potassium bicarbonate. Announced as found under a dead tree at Chypis in Valais, as a result of recent decomposition. Pisani obtained for its composition: $CO_2$ 42·20, $K_2O$ 42·60, $H_2O$ 7·76, $CaCO_3$ 2·50, $MgCO_3$ 1·34, sand, etc. 3·60 = 100.

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**288. MALACHITE.** *Χρυσοκόλλα* pt. *Theophr.*, *Dioscor.*, etc. *Ψευδὴς Σμάραγδος* [False Emerald of Copper Mines] pt., *Theophr.* Chrysocolla, Molochites, pt., *Plin.*, *Agric.* Berggrün. *Germ.* Molochit, *Agric.*, Interpr., 1546. Ærugo nativa. Viride montanum pt., Koppargrön, Bärggrönt pt., Malachit, *Wall.*, Min., 278, 279, 1747. Cuivre carbonaté vert *L'Abbé Fontana*, J. de Phys., **2**, 509, 1778, proving the existence of a green carbonate. Green Carbonate of Copper; Green Malachite; Mountain Green pt Berggrün pt. *Germ.* Atlaserz [fib. var.] *Germ.* Rame carbonato verde, Verde di monte *Ital.* Malaquita *Span.*

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c}$ = 0·88093 : 1 : 0·40118; $\beta$ = *61° 50′ = 001 ∧ 100 Hbg.-Lang.[1]

100 ∧ 110 = 37° 50′, 001 ∧ $\bar{1}01$ = 27° $5\frac{1}{6}$′, 001 ∧ 011 = 19° $28\frac{2}{3}$′.

**Forms:**
$a$ (100, $i$-$\bar{i}$)
$b$ (010, $i$-$\grave{i}$)
$c$ (001, $O$)

$m$ (110, $I$)
$u$ ($\bar{3}04$, $\frac{3}{4}$-$\bar{i}$)
$x$ ($\bar{1}01$, 1-$\bar{i}$)
$v$ ($\bar{5}04$, $\frac{5}{4}$-$\bar{i}$)

$w$ (403, $\frac{4}{3}$-$\bar{i}$)
$y$ ($\bar{3}02$, $\frac{3}{2}$-$\bar{i}$)
$z$ ($\bar{2}01$, 2-$\bar{i}$)?
$\eta$ ($\bar{3}12$, $\frac{3}{2}$-$\bar{3}$)

$\epsilon$ ($\bar{6}23$, 2-$\bar{3}$)
$\alpha$ ($\bar{5}24$, $\frac{5}{4}$-$\frac{\bar{5}}{2}$)
$\gamma$ ($\bar{4}23$, $\frac{4}{3}$-$\bar{2}$)
$e$ ($\bar{2}11$, 2-$\bar{2}$)?

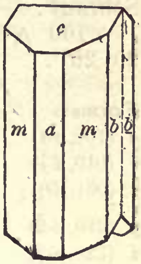
$\beta$ ($\bar{5}34$, $\frac{5}{4}$-$\frac{\bar{5}}{3}$)
$d$ ($\bar{3}23$, 1-$\frac{\bar{3}}{2}$)
$\zeta$ ($\bar{3}21$, 3-$\frac{\bar{3}}{2}$)

$mm'''$ = *75° 40′
$a'x$ = 91° 5′
$cv$ = 34° 28′
$cw$ = 36° 53′

$a'w$ = *81° 17′
$cy$ = 41° 38′
$cz$ = 54° $37\frac{1}{2}$′
$cm$ = 68° 7′

$c\eta$ = 42° 49′
$\eta\eta'$ = 22° $4\frac{1}{2}$′
$\alpha\alpha'$ = 22° 33′

$\beta\beta'$ = 33° 18′
$\gamma\gamma'$ = 29° 37′
$dd'$ = 29° 56′



Twins: tw. pl. *a* very common; often as penetration-twins. Crystals, usually slender, acicular prisms, grouped in tufts and rosettes. Form seldom distinct; faces uneven; *a, m, b* vertically striated; *v, α, β* striated ‖ edge *v*/*α*. Commonly massive or incrusting, with surface tuberose, botryoidal, or stalactitic, and structure divergent; often delicately compact fibrous, and banded in color; frequently granular or earthy.

Cleavage: *c* perfect; *b* less so. Fracture subconchoidal, uneven. Brittle. H. = 3·5–4. G. = 3·9–4·03. Luster of crystals adamantine, inclining to vitreous; of fibrous varieties more or less silky; often dull and earthy. Color bright green. Streak paler green. Translucent to subtranslucent to opaque.

Optically —. Ax. pl. ‖ *b*. $\text{Bx}_\text{a} \wedge \acute{c} = 23° \ 29'$ red, 23° 31′ yellow. Dispersion $\rho < v$ in the air, $\rho > v$ within, rather large; inclined feeble. Axial angles, Dx.:

$$2\text{E}_\text{r} = 89° \, 14', 2\text{E}_\text{y} = 89° \, 18'; \ \beta_\text{r} = 1{\cdot}87, \ \beta_\text{y} = 1{\cdot}88 \ \therefore \ 2\text{V}_\text{r} = 44° \, 7', 2\text{V}_\text{y} = 43° \, 54'$$

**Comp.** = Basic cupric carbonate, $CuCO_3.Cu(OH)_2$ or $2CuO.CO_2.H_2O$ = Carbon dioxide 19·9, cupric oxide 71·9, water 8·2 = 100.

**Pyr., etc.**—In the closed tube blackens and yields water. B.B. fuses at 2, coloring the flame emerald-green; on charcoal is reduced to metallic copper; with the fluxes reacts like cuprite, p. 206. Soluble in acids with effervescence.

**Obs.**—Common with other ores of copper and as a product of their alteration; thus as a pseudomorph after cuprite and azurite. Occurs abundantly in the Ural; at Chessy in France; massive at Schwatz in Tyrol; in Cornwall and in Cumberland, England; Sandlodge copper mine, Shetland, Scotland; Limerick, Waterford, and elsewhere, Ireland; at Saalfeld; Rheinbreitbach; Dillenburg, Nassau; Betzdorf near Siegen. At the copper mines of Nizhni Tagilsk a bed of malachite was opened which yielded many tons of malachite; one mass measured at top 9 by 18 ft.; and the portion uncovered contained at least half a million pounds of pure malachite. Also in handsome masses at Bembe, on the west coast of Africa; with the copper ores of Cuba; Chili; at the Cobar mines and elsewhere in New South Wales; South Australia.

Occurs in *Conn.*, sparingly at Cheshire. In *N. Jersey*, at Schuyler's mines, and still better at New Brunswick. In *Pennsylvania*, in the Blue Ridge, near Nicholson's Gap; near Morgantown, Berks County; at Cornwall, Lebanon Co., in good specimens; at the Perkiomen and Phenixville lead-mines. In *Maryland*, between Taneytown and Newmarket, E. of the Monocacy; in the Catoctin Mts. In *Wisconsin*, at the copper mines of Mineral Point, and elsewhere. In *California*, at Hughes's mine, in Calaveras Co. Abundantly in fine masses and acicular crystals, with calcite at the Copper Queen mine, Bisbee, Cochise Co., *Arizona*; also in Graham Co., especially at the Humming Bird mine, Morenci (6 m. from Clifton), where beautiful stalactitic forms of malachite and azurite in concentric bands are obtained. At the Santa Rita mines, Grant Co., and elsewhere in *New Mexico*. Tintic district, *Utah*.

Named from *μαλαχή*, *mallows*, in allusion to the green color.

**Artif.**—Obtained by de Schulten in acicular crystals, C. R., **110**, 202, 1890.

**Ref.**—[1] The fundamental angles taken by Dx. (Min., **2**, p. 185) are accepted here, viz.: *ac*, *mm‴* Hbg., Rheinbreitbach (Min. Not., **6**, 9, **7**, 32), *a′w* Lang, Nizhni Tagilsk; with Lang *x* = 001, Phil. Mag., **25**, 432, 1863, **28**, 502, 1864. See also Zeph., Ber. Ak. Wien, **51** (1), 112, 1865.

LIME-MALACHITE. Kalk-malachit *Zincken*, B. H. Ztg., **1**, 1842. Calco-malachite. Massive, reniform, botryoidal; structure fibrous and foliated. H. 2·5. Luster silky. Color verdigris-green. From Zincken's trials it is a hydrous carbonate of copper, with some carbonate and sulphate of calcium and iron. The original from Lauterberg in the Harz; a similar substance elsewhere, as in Arizona. Probably simply malachite impure with gypsum or calcite, or in some cases both.

MYSORIN *Thomson*, Min., **1**, 601, 1836. An impure malachite according to F. R. Mallet, Rec. Geol. Survey India, **12**, 166, 1879, and Min. India, 156, 1887. From Mysore, India.

**289. AZURITE.** Cæruleum, Lapis armenius pt., *Plin.*, **33**, 57. Cæruleum, *Germ.* Lasur, Berglasur pt., *Agric.*, 217, etc. Koppar-Lazur, Cuprum lazureum, Cæruleum montanum, *Wall.*, Min., 280, 1747. Bleu de montagne, Cuivre azuré, *Fr. Trl.*, Wall., **1**, 506, 1753. Kupferlasur *Wern.* Bergblau *Germ.* *Abbé Fontana*, J. de Phys., **2**, 1778 (with anal. making it a carbonate). Blue Carbonate of Copper, Blue malachite. Chessy Copper. Azure Copper Ore. Cuivre carbonaté bleu *Fr.* Azurite *Beud.*, Tr., 417, 1824. Lasur *Haid.*, Handb., 508, 1845. Chessylite *B. & M.*, Min., 594, 1852. Lasurit *v. Kobell*, Tafeln, 32, 1853. Azzurrite, Rame carbonato azzurro, Bleu di Monte *Ital.* Azurita, Cobre azul *Span.*

Monoclinic. Axes: $\grave{a} : \bar{b} : \grave{c} = 0{\cdot}85012 : 1 : 0{\cdot}88054$; $\beta = 87^\circ\ 36' = 001 \wedge 100$ Schrauf[1].

$100 \wedge 110 = 40^\circ\ 20'\ 37''$, $001 \wedge 101 = 44^\circ\ 45'\ 56''$, $001 \wedge 011 = 41^\circ\ 20'\ 25''$.

**Forms**[2]:
$a\ (100,\ i\text{-}\bar{i})$
$b\ (010,\ i\text{-}\grave{i})$
$c\ (001,\ O)$

$g\ (210,\ i\text{-}\bar{2})$
$i\ (320,\ i\text{-}\bar{\tfrac{3}{2}})$
$m\ (110,\ I)$
$w\ (120,\ i\text{-}\grave{2})$

$M\ (104,\ -\tfrac{1}{4}\text{-}\bar{i})$
$\zeta\ (102,\ -\tfrac{1}{3}\text{-}\bar{i})$
$\sigma\ (101,\ -1\text{-}\bar{i})$
$\phi\ (201,\ -2\text{-}\bar{i})$

$r\ (\bar{1}08,\ \tfrac{1}{8}\text{-}\bar{i})$
$\mu\ (\bar{1}05,\ \tfrac{1}{5}\text{-}\bar{i})$
$D\ (\bar{1}04,\ \tfrac{1}{4}\text{-}\bar{i})$
$F\ (\bar{2}07,\ \tfrac{2}{7}\text{-}\bar{i})$
$A\ (\bar{1}03,\ \tfrac{1}{3}\text{-}\bar{i})$
$n\ (\bar{1}02,\ \tfrac{1}{2}\text{-}\bar{i})$
$\theta\ (\bar{1}01,\ 1\text{-}\bar{i})$
$B\ (\bar{5}04,\ \tfrac{5}{4}\text{-}\bar{i})$
$\eta\ (\bar{3}02,\ \tfrac{8}{2}\text{-}\bar{i})$
$v\ (\bar{2}01,\ 2\text{-}\bar{i})$
$\psi\ (\bar{3}01,\ 3\text{-}\bar{i})$

$S\ (014,\ \tfrac{1}{4}\text{-}\grave{i})$[3]

$q\ (025,\ \tfrac{2}{5}\text{-}\grave{i})$
$l\ (023,\ \tfrac{2}{3}\text{-}\grave{i})$
$f\ (011,\ 1\text{-}\grave{i})$
$p\ (021,\ 2\text{-}\grave{i})$

$Q\ (223,\ -\tfrac{2}{3})$[2,4]
$s\ (111,\ -1)$
$h\ (221,\ -2)$

$t\ (\bar{2}25,\ \tfrac{2}{5})$
$T\ (\bar{1}12,\ \tfrac{1}{2})$
$N\ (\bar{4}47,\ \tfrac{4}{7})$[4]
$u\ (\bar{2}23,\ \tfrac{2}{3})$

$x\ (\bar{1}11,\ 1)$
$k\ (\bar{2}21,\ 2)$
$\pi\ (\bar{4}41,\ 4)$

$\xi\ (321,\ -3\text{-}\bar{\tfrac{3}{2}})$
$z\ (\bar{4}11,\ 4\text{-}\bar{4})$
$y\ (\bar{2}11,\ 2\text{-}\bar{2})$
$G\ (\bar{3}21,\ 3\text{-}\bar{\tfrac{3}{2}})$[4]
$K\ (\bar{1}\bar{2}{\cdot}10{\cdot}5,\ \tfrac{12}{5}\text{-}\bar{\tfrac{6}{5}})$[4]

$\delta\ (243,\ -\tfrac{4}{3}\text{-}\grave{2})$
$\gamma\ (121,\ -2\text{-}\grave{2})$
$\omega\ (241,\ -4\text{-}\grave{2})$
$H\ (4{\cdot}10{\cdot}7,\ -\tfrac{10}{7}\text{-}\grave{\tfrac{5}{2}})$

$J\ (132,\ -\tfrac{3}{2}\text{-}\grave{3})$
$\tau\ (\bar{6}83,\ \tfrac{8}{3}\text{-}\grave{\tfrac{4}{3}})$
$\Sigma\ (\bar{2}32,\ \tfrac{3}{2}\text{-}\grave{\tfrac{3}{2}})$
$\nu\ (\bar{3}53,\ \tfrac{5}{3}\text{-}\grave{\tfrac{5}{3}})$
$e\ (\bar{2}45,\ \tfrac{4}{5}\text{-}\grave{2})$
$d\ (\bar{2}43,\ \tfrac{4}{3}\text{-}\grave{2})$
$\alpha\ (\bar{1}21,\ 2\text{-}\grave{2})$
$\beta\ (\bar{3}62,\ 3\ \grave{2})$
$o\ (\bar{2}41,\ 4\text{-}\grave{2})$
$\rho\ (\bar{1}34,\ \tfrac{3}{4}\text{-}\grave{3})$
$\Delta\ (\bar{2}{\cdot}10{\cdot}3,\ \tfrac{10}{3}\text{-}\grave{5})$
$\lambda\ (\bar{2}{\cdot}18{\cdot}3,\ 6\text{-}\grave{9})$

$gg''' = 46^\circ\ 1'$
$ii''' = 59^\circ\ 2\tfrac{1}{2}'$
$mm''' = 80^\circ\ 41'$
$ww' = 60^\circ\ 58'$

$c\zeta = 26^\circ\ 51\tfrac{1}{3}'$
$a\sigma = 42^\circ\ 50'$
$c\phi = 62^\circ\ 18'$
$cn = 27^\circ\ 52\tfrac{1}{2}'$
$c\theta = 47^\circ\ 15'$
$c\eta = 58^\circ\ 56\tfrac{1}{2}'$
$cv = 66^\circ\ 11\tfrac{1}{2}'$

$qq' = 38^\circ\ 46\tfrac{1}{2}'$
$ll' = 60^\circ\ 47'$
$ff' = 82^\circ\ 41'$
$pp' = 120^\circ\ 47'$

$cs = 52^\circ\ 28'$
$ch = 68^\circ\ 12'$
$cm = 88^\circ\ 10'$
$c\omega = 75^\circ\ 6'$
$cx = 54^\circ\ 51'$
$ck = 71^\circ\ 25'$
$cd = 54^\circ\ 29'$

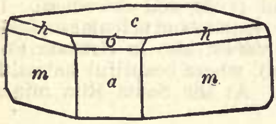
$co = 77^\circ\ 23\tfrac{1}{2}'$

$as = 51^\circ\ 0\tfrac{1}{2}'$
$a\omega = 59^\circ\ 59'$
$a'y = 33^\circ\ 16'$
$a'x = 53^\circ\ 15'$
$a'\alpha = 63^\circ\ 50'$
$a'k = 44^\circ\ 55'$
$a'o = 60^\circ\ 59'$
$hk = 91^\circ\ 20'$

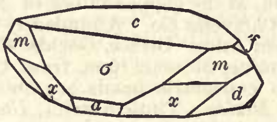
$sx = 75^\circ\ 44'$

$ss' = 61^\circ\ 49'$
$hh' = 73^\circ\ 56'$
$\omega\omega' = 112^\circ\ 48\tfrac{1}{2}'$
$xx' = 63^\circ\ 57'$
$\alpha\alpha' = 102^\circ\ 37'$
$yy' = 42^\circ\ 30'$
$kk' = 75^\circ\ 45'$
$oo' = 114^\circ\ 32'$
$dd' = 89^\circ\ 7'$

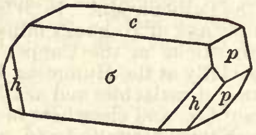
1.



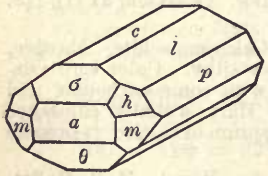
2.



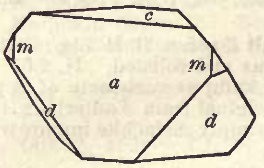
3.



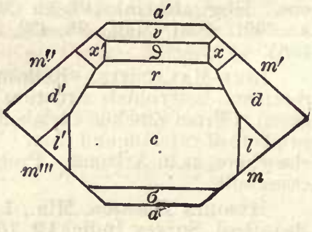
4.



5.



6.



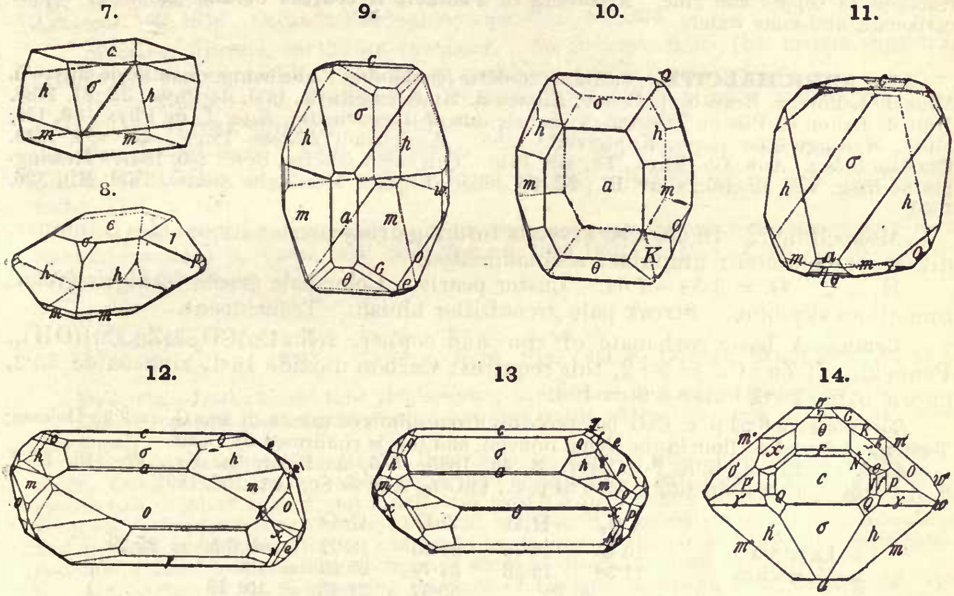
Figs. 1, 2, Chessy. 3, Nizhni Tagilsk. 4, Chessy. 5, Banat. 1–6, after Schrauf (Rose, Zippe).

Twins: tw. pl. (1) $v\ (\bar{2}01)$ Dx.; 2, $\theta\ (\bar{1}01)$ Groth[5]; not common. Crystals varied in habit and highly modified; often tabular ∥ *c*, or $\sigma$ (101) or $\theta$ (101), also prismatic ∥ $\grave{c}$, *m* prominent, and again elongated ∥ axis $\bar{b}$; sometimes rhombohedral in aspect. Faces usually slightly undulating; *c* striated ∥ edge *p*/*f*, and *a* ∥ edge *a*/*c*. Also massive, and presenting imitative shapes, having a columnar composition; also dull and earthy.

Cleavage: $p$ (021) perfect but interrupted; $a$ less perfect; $m$ in traces. Fracture conchoidal. Brittle. H. = 3·5–4. G. = 3·77–3·83. Luster vitreous, almost adamantine. Color various shades of azure-blue, passing into berlin-blue. Streak blue, lighter than the color. Transparent to subtranslucent.

Optically +. Ax. pl. $\perp b$. $Bx_a \wedge \dot{c} = -12° 36'$. Dispersion $\rho > v$ considerable; horizontal distinct. Axial angles for rays between green and blue:

$$2H = 82° 5' \text{ and } 2E = 151°, \text{Dx.}$$



7–14, Arizona, Farrington.

**Comp.**—Basic cupric carbonate, $2CuCO_3.Cu(OH)_2$ or $3CuO.2CO_2H_2O$ = Carbon dioxide 25·6, cupric oxide 69·2, water 5·2 = 100.

For analyses, see 5th Ed., p. 716; they agree closely with the requirements of the formula.

**Pyr., etc.**—Same as in malachite.

**Obs.**—Occurs in splendid crystallizations at Chessy, near Lyons, whence it derived the name *Chessy Copper* or *chessylite*. Also in fine crystals in Siberia; at Moldawa in the Banat; at Wheal Buller, near Redruth in Cornwall; also in Devonshire and Derbyshire, England; in small quantities at Alston-Moor and Wanlockhead, etc.; at Puerto Cabello, S. A.; Cobar mines and elsewhere in New South Wales; South Australia.

Occurs in *Penn.*, at the Perkiomen lead mine, in indifferent specimens, associated with galena, sphalerite, and cerussite; at Phenixville, in crystals; at Cornwall, in crystals on red shale; near Nicholson's Gap, in the Blue Ridge. In *N. York*, near Sing Sing. In *N. Jersey*, near New Brunswick. In *Wisconsin*, at the old copper diggings near Mineral Point, in good crystals; also at the Bracken mine, in small but fine crystals. In *Arizona*, at the Longfellow mine, also other mines in Graham Co.; also with malachite in beautiful crystals at the Copper Queen mine, Bisbee; at the Clifton mines, Graham Co. In Grant Co., *New Mexico*. At the Mammoth mine in the Tintic district, *Utah*, with various copper arsenates. In *California*, Calaveras Co., at Hughes's mine, in crystals.

**Alt.**—Azurite is often altered to malachite through the loss of carbon dioxide and addition of water; also to native copper, as at Grant Co., New Mexico, Yeates, Am. J. Sc., **38**, 405, 1889.

**Artif.**—Formed artificially by Debray, Becquerel, Michel; cf. Bull. Soc. Min., **13**, 139, 1890.

**Ref.**—[1] Ber. Ak. Wien, **64** (1), 123, 1871 and Atlas, XXVI–XXIX, 1872. This is the position of Haidinger (Min. Mohs, **2**, 167, 1825); Zippe, Pogg., **22**, 393, 1831; Miller (Min., p. 594, 1852); with Rose (Reis. Ural, **1**, 315, 541, 1837), Lévy (Heuland, **3**, 64, 1837). With Schrauf (l. c.) the vertical axis has double the length, i.e. $h = 111$, etc. Schrauf points to a similarity of form between azurite and epidote.

[2] See Schrauf for review and correction of earlier authorities, also Dx., Min., **2**, 190, 1874. A note in Zs. Kr., 8, 532, credits Krenner and Franzenau with having observed on crystals from Utah also (507), and (223), no angles given. Cf. also Gdt., Index, **2**, 269, 1888, who gives some planes not included here. [3] H. S. Washington, Arizona, priv. contr. [4] Farrington, Arizona, Am. J. Sc., **41**, 300, 1891. [5] Min.-Samml., Strassb., 139, 1878.

ATLASITE *Breith.*, B. H. Ztg., **24**, 310, 1865. A carbonate of copper containing chlorine from Chañarcillo, Chili. It resembles atacamite, and may be a mixture of this species and azurite. See further 5th Ed., p. 716.

ZINKAZURITE *Breith.*, B. H. Ztg., **11**, 101, 1852. A blue mineral in small crystals, having G. = 3·49, from the Sierra Almagrera in Spain. Heated, it affords a little water, with the reactions of copper and zinc. According to Plattner, it consists of zinc sulphate, copper carbonate, and some water.

**290. AURICHALCITE.** Calamine verdâtre (containing "une bonne quantité de cuivre"), Mine de Laiton [= Brass-ore], *Patrin*, Aperçu d. Mines en Sibèrie, in J. de Phys., **33**, 81, 1788. Mine de Laiton de Pise en Toscane, Aurichalchum of the ancients?, *Sage*, J. de Phys., **38**, 155, 1791. Messingblüthe *Germ.* Kupferzinkblüthe. Aurichalcit *Böttger*, Pogg, **48**, 495, 1839. Buratite *Delesse*, Ann. Ch. Phys., **18**, 478, 1846. Orichalcit *Glocker*, Syn., 230, 1847. Messingblüthe *Risse*, Ver. Rheinl., Corr.-Bl., **22**, 95, 1865. Risséite, Messingite *Adam.*, Tabl. Min., 26, 1869.

Monoclinic[1]?. In acicular crystals forming drusy incrustations; also columnar, divergent; plumose; granular; also laminated.

H. = 2. G. = 3·54–3·64. Luster pearly. Color pale green, verdigris-green; sometimes sky-blue. Streak pale greenish or bluish. Translucent.

**Comp.**—A basic carbonate of zinc and copper, $2(Zn,Cu)CO_3.3(Zn,Cu)(OH)_2$, Penfield. If Zn : Cu = 5 : 2, this requires: Carbon dioxide 16·1, zinc oxide 53·2, cupric oxide 20·8, water 9·9 = 100.

*Buratite* gave 8·62 p. c. CaO but probably from admixed calcite, it has G. = 3·32 Delesse; Tschermak found no lime in the Banat mineral, and this is confirmed by Belar.

**Anal.**—1, Pisani, Bull. Soc. Min., 8, 43, 1885. 2–5, A. Belar, Zs. Kr., **17**, 113, 1889. 6, 7, Penfield, after deducting 1·53, 0·64 p. c., $CaCO_3$, Am. J. Sc., **41**, 106, 1891.

| | | $CO_2$ | $H_2O$ | ZnO | CuO | |
|---|---|---|---|---|---|---|
| 1. Laurium | | 15·45 | 14·75 | 50·45 | 18·07 | insol. 0·50 = 99·22 |
| 2. Morawitza | | 11·38 | 13·53 | 54·70 | 20·39 | = 100 |
| 3. " | | 26·78 | | 53·57 | 21·43 | = 101·78 |
| 4. Campiglia | | 26·50 | | 55·51 | 20·20 | = 102·21 |
| 5. Sardinia | | 22·97 | | 58·72 | 15·58 | $Fe_2O_3$ 2·17 = 100·44 |
| 6. Utah | G. = 3·54 | 16·07 | 10·06 | 52 99 | 21·21 | = 100·33 |
| 7. " | G. = 3·64 | 16·04 | 9·99 | 54·36 | 20·00 | = 100·39 |

**Pyr., etc.**—In the closed tube blackens, and yields water. B.B. infusible; colors the flame deep green. With soda on charcoal gives a coating of zinc oxide; the fused mass removed from the coal and triturated in a mortar affords minute globules of copper. With the fluxes reacts for copper. Soluble in acids with effervescence.

**Obs.**—Aurichalcite occurs at Loktevski, at a copper mine in the Altai, where it is associated with calcite and limonite, sometimes forming a drusy covering upon these minerals; at Morawitza in the Banat; Chessy, near Lyons; Rezbanya, in Hungary; Campiglia in Tuscany; at Matlock in Derbyshire, of a pale green color, laminated structure, and pearly luster; at Roughten-Gill, in Cumberland; Leadhills, Scotland; zinc mines of the province of Santander, Spain; at the zinc mines of Laurium, Greece.

In the U. S., at Lancaster, Pa.; from the Santa Caterina Mts., Arizona, in fine specimens, reported also from the Copper Queen mine, Bisbee. At the Kesler mine, Big Cottonwood, and the Cave mine in Beaver Co., Utah.

The mineral aurichalcite was first described as a greenish variety of calamine by Patrin, in 1788 (l. c.), and called *Brass ore* (Mine de Laiton), "because," as he says, "the compound of copper and zinc is here made by nature." Among the brass or copper ores of the ancients, *aurichalcum* was reputed the best (Pliny, 33, 2); and Sage was thence led to suggest (l. c., 1791) that the *cupriferous calamine* (which afforded, as he showed by experiment, the best of brass, without the addition of either copper or zinc) might be the ancient *aurichalcum*. As the ore is a scarce one, this is not at all probable. But the idea explains the use of the word for the species. In addition, it is to be said that brass (or an alloy related to it) was called *aurichalcum* by Virgil and Horace, and also in the middle ages.

The Latin word *aurichalcum* is regarded by some good authorities as derived from ʼορείχαλκος (= *mountain brass*); and, in fact, the Latin poets just mentioned wrote it *orichalcum*. But others regard it as a hybrid word (from the Latin *aurum*, *gold*, and χαλκὸς, *brass* or *bronze*), and the *o* of the poets as an example of the admissible change in

Latin of *au* to *o*. Glocker, in view of the first of these derivations, changes aurichalcite to *orichalcite;* but, whatever the derivation, as the use of *aurichalcum* dates from before Pliny's time, we moderns may as well let it stand without correction.

*Buratite* is named from M. Burat, who is stated to have discovered the mineral in Italy.

**Artif.**—Cf. Delesse, l. c.; also Belar, who throws doubt upon the observations of Delesse.

**Ref.**—[1] For observations on the form see Belar, l. c.

**291. HYDROZINCITE.** Calamine *Smithson*, Phil. Trans , 12, 1803. Zinkblüthe *Karst.*, Tabell., 70, 99, 1808. Hydro-carbonate of Zinc. Earthy calamine. Zinconise *Beud.*, Tr., 2, 357, 1832. Zinc Bloom. Hydrozinkit *Kenng.*, Min., 1853. Marionite *Elderhorst*, G. Rep. Arkansas, 153, 1858. Cegamit *Weisbach*, Synops. Min., 36, 1875.

Massive, fibrous, earthy or compact. As incrustations, the crusts sometimes concentric and agate-like. At times reniform, pisolitic, stalactitic.

H. = 2–2·5. G. = 3·58–3·8. Luster dull. Color pure white, grayish or yellowish. Streak shining. Usually earthy or chalk-like.

**Comp.**—A basic zinc carbonate, exact composition uncertain, perhaps $ZnCO_3.2Zn(OH)_2$ or $3ZnO.CO_2.2H_2O$ = Carbon dioxide 13·6, zinc oxide 75·3, water 11·1 = 100.

Analyses vary somewhat widely probably, in consequence of want of homogeneity in the material examined: 1, Cossa, Att. Soc. Tor., 6, 189, 1870. 2, V. v. Zotta, Zs. Kr., 13, 143, 1887. Also 5th Ed., p. 711.

| | $CO_2$ | ZnO | $H_2O$ | |
|---|---|---|---|---|
| 1. Auronzo | 14·55 | 73·21 | 11·83 | = 99·59 |
| 2. Bleiberg | 17·05 | 70·76 | 10·30 | PbO 1·26, $Fe_2O_3$ 0·42, $SiO_2$ 0·36 = 100·15 |

**Pyr., etc.**—In the closed tube yields water; in other respects resembles smithsonite.

**Obs.**—Occurs at most mines of zinc, and is a result of the alteration of the other ores of this metal.

Found in great quantities at the Dolores mine, Udias valley, province of Santander, in Spain, along with calamine, smithsonite, and sphalerite, covering the floor of an extensive cavern to a depth of a yard and a half, and hanging in dazzling white branching stalactites from the roof; part is concretionary, pisolitic, nodular; it is intimately mixed with zinc silicate, and is pseudomorphous after it; and opal-like masses of silicate and hydrous carbonate are common, formed by the falling of drops of water holding the silicate in solution.

Also occurs in the neighboring province of Guipuzcoa, Spain, near La Nestosa, at the mines of Las Nieves and La Augustina; at Bleiberg and Raibel in Carinthia; near Reimsbeck, in Westphalia; in Höllenthal, on the Zugspitze in Bavaria; at Taft in the province of Jesd in Persia.

In the U. S., at Friedensville, Pa.; at Linden, in Wisconsin, as a concretionary fibrous white crust on smithsonite; in Marion Co., Arkansas (*marionite*), in concentric and contorted laminæ and botryoidal crusts; with sphalerite, etc., at Joplin, Mo.

Beudant's name *zinconise*, from zinc and κόνις, powder, has priority, but is too badly formed to be retained.

**Artif.**—Deposited when hot solutions of zinc salts in water are decomposed by carbonates of the alkalies. The white substance formed on zinc, when moistened and exposed to the air, is a related compound. Belar (Zs. Kr., 17, 123, 1889) describes an artificial hydrous zinc carbonate, $ZnCO_3 + H_2O$, in crystals resembling hydromagnesite in habit.

**292. HYDROCERUSSITE.** *A. E. Nordenskiöld*, G. För. Förh., 3, 381, 1877. Hydrocerusite. Plumbonacrite *Heddle*, Min. Mag., 8, 201, 1889.

In thin hexagonal planes, optically uniaxial, negative Lcx.[1]

Soft. G. = 6·14, artif. cryst. Colorless. Luster pearly.

**Comp.**—A basic lead carbonate, probably $2PbCO_3.Pb(OH)_2$ or $3PbO.2CO_2.H_2O$ = Carbon dioxide 11·4, lead oxide 86·3. water 2·3 = 100.

**Pyr., etc.**—Yields lead on charcoal. Soluble in acid with evolution of carbon dioxide.

**Obs.**—Occurs sparingly as a coating on native lead, at Långban, Wermland, Sweden. Also in cavities in galena at Wanlockhead, Scotland.

**Artif.**—An artificial basic lead carbonate with the above composition is described by Bourgeois, Bull. Soc. Min., 11, 221, 1888.

**Ref.**—[1] Bull. Soc. Min., 8, 35, 1885.

**293. DAWSONITE.** *B. J. Harrington*, Can. Nat., 7, 305, 1874.

Monoclinic ?. In thin incrustations of radiating bladed crystals.

Cleavage: longitudinal easy. H. = 3. G. = 2·40. Luster vitreous. Color white. Transparent to translucent. Double refraction strong. Ax. pl. transverse to needles and nearly ⊥ to the cleavage; axial angle large, Dx.[1]

**Comp.**—A basic carbonate of aluminium and sodium, $Na_3Al(CO_3)_3.2Al(OH)_3$ or $Na_2O.Al_2O_3.2CO_2.2H_2O$ = Carbon dioxide 30·6, alumina 35·4, soda 21·5, water 12·5 = 100.

**Anal.**—1, 2, Harrington, l. c. 3, *Id.*, ibid., **10**, 84, 1881 after deducting calcite. 4, Friedel, Bull. Soc. Min., **4**, 28, 1881.

| | $CO_2$ | $Al_2O_3$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|
| 1. Montreal | 29·88 | 32·84 | 20·58[a] | 11·91 | MgO *tr.*, CaO 5·95 = 101·16 |
| 2. " | 30·72 | 32·68 | 20·17 | [10·33] | MgO 0·45, CaO 5·65 = 100 |
| 3. " | 27·78 | 36·12 | 22·86 | 13·24 | = 100 |
| 4. Tuscany | 29·09 | 35·89 | 19·13 | 12·00 | MgO 1·39, CaO 0·42 = 97·92 |

[a] Incl. $K_2O$ 0·38.

**Pyr.**—B.B. swells up, colors the flame deep yellow, and after ignition yields an alkaline reaction; gives a fine blue with cobalt nitrate; in the closed tube yields water and carbon dioxide. Soluble in acids with effervescence.

**Obs.**—Found as a crystalline coating, resembling tremolite, on the jointed surfaces of a feldspathic dike cutting the Trenton limestone near McGill College, Montreal; it is associated with calcite, dolomite, pyrite, etc. Also from the province of Siena, Piau Castagnaio, Tuscany, in a quartzose rock, impregnated with dolomite, in part argillaceous; associated with calcite, dolomite, pyrite, fluorite, and cinnabar.

**Ref.**—[1] Bull. Soc. Min., **1**, 8, 1878.

HOVITE. Native Carbonate of Alumina and Lime, *J. H. & G. Gladstone*, Phil. Mag., **23**, 461, 1862.

A soft white earthy substance from fissures in flint at an old quarry in the Upper Chalk, at Hove near Brighton. Analyses show silica, carbon dioxide, alumina, lime and water; it may be a carbonate of alumina and lime, but very impure and of doubtful nature. See 5th Ed., p. 709.

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**294. THERMONATRITE.** *Νιτρον* and Nitrum pt. *Vet.* Natron, Alkali orientale impurum terrestre, Jordblandadt Alkaliskt-salt, *Wall.*, Min., 174, 1747. Natürliches mineralisches Alkali *Wern.* Prismatisches Natronsalz *Mohs.* Thermonatrit *Haid.*, Handb. 487, 1845. Thermonitrit *Hausm.*, Handb., 1411, 1847. Soude carbonatée prismatique *Dufr.*

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c}$ = 0·8268 : 1 : 0·8089 Marignac[1].
100 ∧ 110 = 39° 35′, 001 ∧ 101 = 44° 22½′, 001 ∧ 011 = 38° 58⅙′.

**Forms** (artif. cryst.): *b* (010, *i*-ĭ) *m* (110, *I*) *u* (101, 1-ī) *p* (122, 1-2̆)
*a* (100, *i*-ī) *c* (001, *O*) *g* (102, ½-ī) *e* (021, 2-ĭ)

*mm‴* = *79° 10′ *gg′* = 52° 8′ *ee′* = 116° 33½′ *pp″* = 86° 47′
*ag* = *63° 56′ *uu′* = 88° 45′ *pp′* = 41° 39′ *pp‴* = 72° 0½′

Often in flattened crystals ∥ *c* or *a*, also prismatic *c*. Usually as an efflorescence.

Cleavage: *b* difficult. Somewhat sectile. H. = 1–1·5. G. = 1·5–1·6. Luster vitreous. White, grayish, yellowish. Taste alkaline.

**Comp.**—Hydrous sodium carbonate, $Na_2CO_3 + H_2O$ = Carbon dioxide 35·5, soda 50·0, water 14·5 = 100.

**Obs.**—Occurs in various lakes, and as an efflorescence over the soil in many dry regions of the globe; also about some mines and volcanoes. It results from the efflorescence of natron.

**Ref.**—[1] Ann. Mines, **12**, 55, 1857; cf. the somewhat different results of Haid., Ed. J. Sc., **2**, 327, 1825 or Pogg., **5**, 369, 1825.

**295. NESQUEHONITE.** *F. A. Genth* and *S. L. Penfield*, Am. J. Sc., **39**, 121, 1890.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c}$ = 0·64446 : 1 : 0·45678 Penfield.
100 ∧ 110 = 32° 48′, 001 ∧ 101 = 35° 19⅔′, 001 ∧ 011 = 24° 33′.

**Forms**: *b* (010 *i*-ĭ), *c* (001, *O*), *m* (110, *I*), *d* (011, 1-ĭ). Angles (approx.): *mm‴* = *65° 36′, *dd′* = *49° 6′.

In prismatic crystals, usually united in radiating groups; prismatic faces deeply striated vertically.

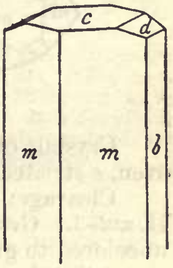
Cleavage: *m* perfect; *c* less so. Fracture splintery ‖ *m*. H.=2·5. G.=1·83–1·85. Luster vitreous or slightly greasy. Colorless to white. Transparent to translucent. Optically —. Ax. pl. ‖ *c*. Bx ⊥ 100. Dispersion small, $\rho < v$. Axial angles, Pfd.:

$2E_r = 83° 55'$ Li  $2E_y = 84° 15'$ Na  $2E_{gr} = 84° 22'$ Tl

Also (artif. cryst.) $\beta_y = 1·501$  $\gamma_y = 1·526$ ∴ $2V_y = 53° 5'$ and $\alpha = 1·495$.

**Comp.**—Hydrous magnesium carbonate, $MgCO_3 + 3H_2O$ = Carbon dioxide 31·4, magnesia 29·0, water 39·1 = 100.

**Anal.**—1, 2, Genth, l.c.: 1, original crystals; 2, material pseudomorphous after lansfordite.



| | $CO_2$ | MgO | $H_2O$ | | |
|---|---|---|---|---|---|
| 1. | 30·22 | 29·22 | 40·32 | = | 99·76 |
| 2. | 28·85 | 28·23 | 42·92 | = | 100 |

**Obs.**—From an anthracite coal mine at Nesquehoning, 4 miles from Lansford, Schuylkill Co., Penn.; when found it formed the base of stalactites and incrustations, the remainder of which consisted of lansfordite, out of which it had been formed; later the entire stalactites became altered into a white chalky substance with fibrous structure which was also nesquehonite (cf. lansfordite, p. 305).

**Artif.**—Deposited in crystals from a solution of $MgCO_3$ in water containing carbon dioxide; they are identical with the natural crystals. Cf. Pfd., l. c., also Mitsch., Mem. Soc. Genève, **14**, 252, 1855.

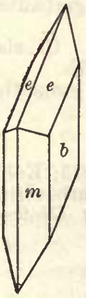
**296. NATRON.** *Νιτρον*, Nitrum, *of the Ancients.* Hemiprismatisches Natronsalz *Mohs.* Natrit *Weisbach,* Synops. Min., p. 7, 1875. Soda. Carbonate of Soda. Sodium Carbonate. Soude carbonatée.

Monoclinic. Axes: $\grave{a} : \bar{b} : \dot{c} = 1·4828 : 1 : 1·4001$; $\beta = *58° 52' = 001 \wedge 100$ Haidinger[1].

$100 \wedge 110 = 51° 46'$, $001 \wedge \bar{1}01 = 57° 39\frac{1}{3}'$, $001 \wedge 011 = 50° 9\frac{1}{2}'$

**Forms** (artif. cryst.)[1]: *a* (100, *i-ī*), *b* (010, *i-ì*), *c* (001, *O*); *m* (110, *I*); *s* ($\bar{1}$01, 1-*ī*); *e* (011, 1-*ì*), *p* ($\bar{1}$12, ½).

Angles: $mm''' = *103° 32'$, $a's = 63° 29'$, $ee' = *100° 19'$, $cm = 71° 20'$, $cp = 43° 43'$, $pp' = 69° 55'$.



Twins: tw. pl. *c*. Crystals tabular ‖ *b*.

Cleavage: *c* distinct; *b* imperfect; *m* in traces. Fracture conchoidal. Brittle. H. = 1–1·5. G. = 1·42–1·46. Vitreous to earthy. White, sometimes gray or yellow, owing to impurities. Taste alkaline. Optically—. Ax. pl. and $Bx_a$ ⊥ *b*. $Bx_o \wedge \dot{c} = +41° 8'$. Dispersion $\rho > v$ small. Axial angles:

$2E_r = 112° 48'$  $2E_y = 112° 42'$ Dx.

**Comp.**—Hydrous sodium carbonate, $Na_2CO_3 + 10H_2O$ = Carbon dioxide = 15·4, soda 21·7, water 62·9 = 100.

**Obs.**—Occurs in nature only in solution, as in the soda lakes of Egypt and elsewhere, or mixed with the other sodium carbonates. See *Trona* and *Thermonatrite.*

**Ref.**—[1] Ed. J. Sc., **2**, 326, 1825, or Pogg., **5**, 369, 1825. Cf. also Dx., Min., **2**, 168, 1874; Rg., Kr. Ch., 549, 1881.

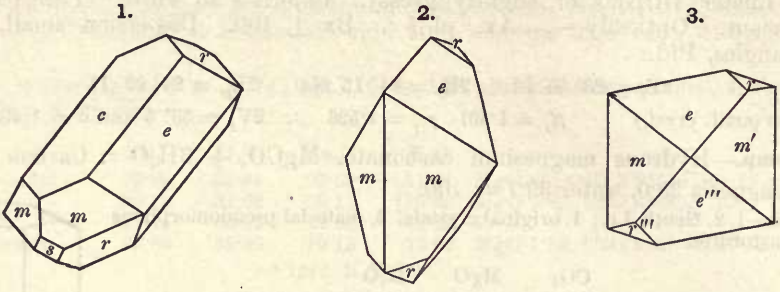
**297. GAY-LUSSITE** *Boussingault,* Ann. Ch. Phys., **31**, 270, 1826. Gaylussite.

Monoclinic. Axes $\grave{a} : \bar{b} : \dot{c} = 1·4897 : 1 : 1·4442$; $\beta = 78° 26\frac{3}{4}' = 001 \wedge 100$ Phillips[1].

$100 \wedge 110 = 55° 35'$, $001 \wedge \bar{1}01 = 49° 41\frac{1}{3}'$, $001 \wedge 011 = 54° 45'$.

**Forms**[1]: *a* (100, *i-ī*), *b* (010, *i-ì*), *c* (001, *O*); *m* (110, *I*); *s* ($\bar{1}01$, 1-*ī*); *e* (011. 1-*ì*); *r* ($\bar{1}12$, ½).

*mm'''* = *111° 10' *ee'* = *109° 30' *cm* = *83° 30' *me* = 42° 21
*a's* = 51° 52' *cr* = 43° 20' *rr'* = 69° 29' *er* = 27° 44'



1, South America. 2, 3, Ragtown, Nevada.

Crystals often elongated ∥ $\breve{a}$; also flattened wedge-shaped: surfaces usually uneven, *e* striated ∥ edge *e/r*.

Cleavage: *m* perfect; *c* rather difficult. Fracture conchoidal. Very brittle. H. = 2–3. G. = 1·93–1·95. Luster vitreous. Color white, yellowish white. Streak uncolored to grayish. Translucent. Optically —. Ax. pl. and $Bx_a \perp b$. $Bx_o \wedge \dot{c}$ = −14° 48′ red, −13° 8′ blue. Dispersion $\rho < v$, and crossed large. Axial angles:

At 17° C. $2E_r$ = 51° 38′ $2E_{bl}$ = 52° 53′ At 71·5° $2E_r$ = 53° 32′ Dx.

**Comp.**—Hydrous carbonate of calcium and sodium, $CaCO_3.Na_2CO_3 + 5H_2O$ = Calcium carbonate 33·8, sodium carbonate 35·8, water 30·4 = 100.

**Pyr., etc.**—Heated in a closed tube decrepitates and becomes opaque. B.B. fuses easily to a white enamel, and colors the flame intensely yellow. Dissolves in acids with a brisk effervescence; partly soluble in water, and reddens turmeric paper.

**Obs.**—Abundant at Lagunilla, near Merida, in Venezuela, where its crystals are disseminated at the bottom of a small lake, in a bed of clay, covering *urao;* the natives call them *clavos* or *nails*, in allusion to their crystalline form.

Also abundant in Little Salt Lake, or Soda Lake, in the Carson desert near Ragtown, Nevada. The lake is in a crater-shaped basin, and its waters are dense and strongly saline; the gay-lussite is deposited upon the evaporation of the water; it also occurs in another smaller Soda lake in the same neighborhood.

Named after Gay Lussac, the French chemist (1778–1850).

**Artif.**—Obtained by various methods, also in connection with soda manufacture. Cf. Arzruni, l. c., and authors quoted by him; also Rg., J. pr. Ch., **35**, 106, 1887.

**Alt.**—On the supposed pseudomorphs (*natrocalcite*) after gay-lussite from Sangerhausen ("Gerstenkörner") and elsewhere, see p. 907 and p. 271.

**Ref.**—[1] Accepted by Dx., Min., **2**, 171, 1874; earlier, Ann. Ch. Phys., **7**, 489, 1843. Cf. also Cordier, Ann. Ch. Phys., **31**, 276, 1826; Ph., Phil. Mag., **1**, 263, 1827; Mlr., 597, 1852.

On Nevada crystals, Blake, Am. J. Sc., **42**, 221, 1866. On the form and optical properties of artificial crystals, cf. Arzruni, Zs. Kr., **6**, 24, 1882, who gives general literature.

**298. LANTHANITE.** Kohlensaures Cereroxydul *Berz.*, Zs. f. Min., **2**, 209, 1825; Kohl. Ceroxydul *Hisinger*, Afh. Min. Geog. Schwed., 144, 1826. Carbonate of Cerium. Carbocérine *Beud.*, Tr., **2**, 354, 1832. Lanthanit *Haid.*, Handb., 500, 1845. Hydrolanthanit *Glocker*, Synops., 248, 1847.

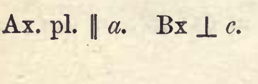
Orthorhombic. Axes: $\breve{a} : \bar{b} : \dot{c}$ = 0·9528 : 1 : 0·9023 Lang[1].

100 ∧ 110 = *43° 37′, 001 ∧ 101 = 43° 26½′, 001 ∧ 011 = 42° 3½′.

**Forms**: *a* (100, *i-ī*), *c* (001, *O*); *m* (110, *I*); *o* (111, 1).

Angles: *mm'''* = 87° 14′, *oo'* = 70° 13′, *oo''* 105° 12′, *oo'''* = 66° 28′, *oo*$^{iv}$ = *74° 48′.

In thin four-sided plates or minute tables ∥ *c*, with beveled edges. Also fine granular or earthy.



Cleavage: micaceous ∥ *c*. H. = 2·5–3. G. = 2·605 Genth; 2·666 (?) Blake. Luster pearly or dull. Color grayish white, delicate pink, or yellowish. Optically —. Ax. pl. ∥ *a*. Bx ⊥ *c*. Dispersion $\rho < v$ small. Axial angles:

$2E_r = 108° 1'$ $2E_{bl} = 108° 39'$ Dx.[2]

**Comp.**—Hydrous lanthanum carbonate, $La_2(CO_3)_3 + 9H_2O$ = Carbon dioxide 21·4, lanthanum trioxide 52·4, water 26·2 = 100.

Analyses, see 5th Ed., p. 710. Didymium is present with the lanthanum.

**Pyr., etc.**—In the closed tube yields water. B.B. infusible; but whitens and becomes opaque, silvery, and brownish; with borax, a glass, slightly bluish, reddish, or amethystine, on cooling; with salt of phosphorus a glass, bluish amethystine while hot, red when cold, the bead becoming opaque when but slightly heated, and retaining a pink color. Effervesces in acids.

**Obs.**—Found coating cerite at Bastnäs, Sweden; also in Silurian limestone with the zinc ores of the Saucon valley, Lehigh Co., Pa., in masses consisting of aggregated minute tables, very rare; at the Sandford iron-ore bed, Moriah, Essex Co., N. Y., in delicate scales, and a thin scaly crust, in fissures in the ore, and on crystals of allanite.

**Ref.**—[1] Phil. Mag., **25**, 43, 1863; cf. also Blake, Am. J. Sc., **16**, 228, 1853. [2] Min., **2**, 177, 1874.

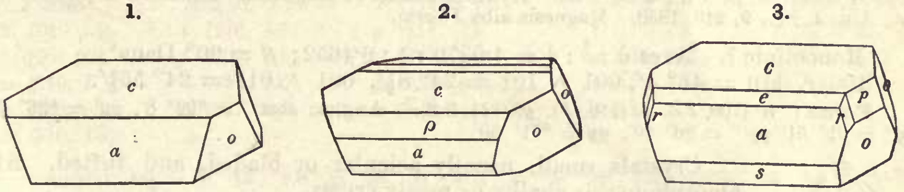
HYDROCONITE. Hydroconit *Hausm.*, Handb., **2**, 1405, 1847. A hydrous calcium carbonate, $CaCO_3 + 5H_2O$. It was formed artificially by Pelouze (Ann. Ch. Phys., **48**, 301, 1831), and noted as a recent formation in a water pipe by Salm-Horstmar (Pogg., **35**, 515, 1835), and as a deposit from a brook near Christiania, Norway, by Scheerer (ib., **68**, 381, 1846). It is described as occurring in acute colorless rhombohedrons with G. = 1·75; prismatic crystals obtained by Becquerel (Ann. Ch. Phys., **47**, 5, 1831) are also mentioned, and dimorphism suggested.

**299. TRONA.** Trona *Bagge*, Ak. H. Stockh., **35**, 140, 1773. Natrum von Tripole, Stralige Natrum, *Klaproth*, Beitr., **3**, 83, 1802. Urao *Boussingault*, Ann. Mines, **12**, 278, 1826.

Monoclinic. Axes: $\grave{a} : \overset{\scriptscriptstyle 1}{b} : \grave{c} = 2·8460 : 1 : 2·9697$; $\beta = {}^*77° 23' = 001 \wedge 100$ Zepharovich.

$100 \wedge 110 = 70° 11\frac{5}{6}'$, $001 \wedge 101 = 39° 40'$, $001 \wedge 011 = 70° 57\frac{3}{4}'$.

**Forms**[1]: $\rho$ (304, $-\frac{3}{4}$-ī) $\beta$ ($\bar{1}$·0·18, $\frac{1}{18}$-ī) $s$ ($\bar{3}$02, $\frac{3}{2}$-ī) $r$ (211, $-$ 2-$\bar{2}$)[2]
$a$ (100, $i$-ī) $e$ (101, $-$ 1-ī)[2] $\gamma$ ($\bar{2}$·0·13, $\frac{2}{13}$-ī) $p$ (111, $-$ 1)[2] $o$ ($\bar{1}$11, 1)
$c$ (001, $O$)



Figs. 1, 2, Zepharovich. 3, Ayres.

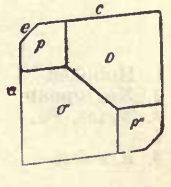
$c\rho = 33° \ 7'$
$ce = 39° 40'$
$ca = 77° 23'$
$cs = 66° 41'$

$cp = 68° 12\frac{1}{2}'$
$co = 75° 53\frac{1}{2}'$
$cr = 67° 39'$
$pp' = 122° 20'$

$rr' = 98° 21'$
$oo' = 132° 24\frac{1}{2}'$
$oo'' = {}^*47° 35\frac{1}{2}'$

$ar = 52° 59'$
$ap = 67° 34\frac{1}{2}'$
$a'o = {}^*74° 54'$

Crystals elongated ∥ axis $\overset{\scriptscriptstyle 1}{b}$, also flattened ∥ $c$. Faces in the orthodome zone striated horizontally. Often fibrous or columnar massive.



Cleavage: $a$ perfect; $o$, $c$ in traces. Fracture uneven to subconchoidal. H. = 2·5–3. G. = 2·11–2·14. Luster vitreous, glistening. Color gray or yellowish white. Translucent. Taste alkaline. Not altered by exposure to a dry atmosphere. Optically $-$. Ax. pl. and $Bx_a \perp b$; $Bx_o \wedge \grave{c} = 83° 6'$ Zeph. Dispersion $\rho < v$ small. Axial angles:

$2H_{a.r} = 78° 43'$ $2H_{o.r} = 107°$ $\therefore$ $2E_r = 136° 46'$ $\beta_r = 1·500$ Dx.[1]
$2H_{a.bl} = 79° \ 1'$ $2H_{o.bl} = 106° 50'$ $\therefore$ $2E_{bl} = 140° 12'$ $\beta_{bl} = 1·514$ Dx.
$2H_{a.y} = 73° 25'$ $2H_{o.y} = 99° 17\frac{1}{2}'$ $\therefore$ $2E_y = 137° 7'$ $2V_y = 76° 16'$ $\beta_y = 1·507$ Z.

**Comp.**—$Na_2CO_3.HNaCO_3 + 2H_2O$ or $3Na_2O.4CO_2.5H_2O$ = Carbon dioxide 38·9, soda 41·2, water 19·9 = 100, Chatard.

**Anal.**—1, Boussingault, l. c. 2, Reinitzer, Zs. Kr., **13**, 138, 1887. 3, T. M. Chatard, Am. J. Sc., **38**, 59, 1889, also other anals. on salts obtained by the evaporation of the water of Owen's Lake, and on artif. compounds.

| | | $CO_2$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|
| 1. *Urao* | | 39·00 | 41·22 | 18·80 = 99·02 |
| 2. *Trona* | | 38·93 | 40·77 | 19·96 $Na_2SO_4$ 0·20 = 99·86 |
| 3. Owen's Lake | G. = 2·147 | 38·13 | 41·00 | 20·07 Cl 0·19, $SO_3$ 0·70, insol. 0·02 = 100·11. |

Chatard establishes the above composition for urao, and shows that trona, sometimes called "sesquicarbonate of soda," is an impure form of the same compound; he also shows the variation which may come from the admixture of other carbonates (cf. l. c., and Natural Soda, its occurrence and utilization, Bull. **60**, U. S. G. Surv., 1887–88).

**Pyr., etc.**—In the closed tube yields water and carbon dioxide. B.B. imparts an intensely yellow color to the flame. Soluble in water, and effervesces with acids. Reacts alkaline with moistened test paper.

**Obs.**—Found in the province of Fezzan, Africa, forming thin superficial crusts at numerous points especially in connection with certain salt lakes. Urao is found at the bottom of a lake at Lagunilla, Venezuela, S. A., a day's journey from Merida. Also near soda lakes at other localities.

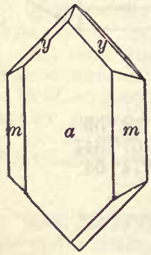
Efflorescences of trona occur near the Sweetwater river, Rocky Mountains, mixed with sodium sulphate and common salt. An extensive bed in Churchill Co., Nevada. In fine crystals at Borax lake, San Bernardino Co., California, with hanksite, glauberite, thenardite, etc.; also formed by the spontaneous evaporation of the saline waters of Owen's Lake, Inyo Co., Cal. (Cf. Chatard. l. c.).

**Ref.**—[1] On artif. cryst., Zs. Kr., **13**, 135, 1887; for earlier measurements cf. Haid., Ed. J. Sc., **2**, 325, 1825, or Pogg., **5**, 367, 1825. Dx., who makes $o = m$ (110), etc., adds two domes perhaps 407, $\bar{2}09$ (Z.), N. R., 182, 1867, Min., **2**, 169, 1874. [2] E. F. Ayres, Am. J. Sc., **38**, 65, 1889.

**300. HYDROMAGNESITE.** *T. Wachtmeister*, Ak. H. Stockh., 18, 1827. Hydromagnesit *v. Kobell*, J. pr. Ch., **4**, 80, 1835. Hydrocarbonate of Magnesia. Lancasterite pt. *Silliman, Jr.*, Am. J. Sc., **9**, 216, 1850. Magnesia alba *Pharm.*

Monoclinic ?. Axes $\grave{a} : \bar{b} : \dot{c} = 1·0379 : 1 : 0·4652$; $\beta = 90°$ Dana[1].
$100 \wedge 110 = 46° 4'$, $001 \wedge 101 = 24° 8\frac{1}{2}'$, $001 \wedge 011 = 24° 56\frac{5}{6}'$.

**Forms:** *a* (100, $i$-$\bar{i}$), *m* (110, *I*), *y* (121, 2-$\grave{2}$). Angles: $mm''' = *92° 8'$, $yy' = *36° 20'$, $yy'' = 91° 51'$ $yy''' = 80° 40'$, $ay = *71° 50'$.



Crystals small, usually acicular or bladed, and tufted. Also amorphous; as chalky or mealy crusts.

Brittle. H. = 3·5 cryst. G. = 2·145–2·18 S. & B. Luster vitreous to silky or subpearly; also earthy. Color and streak white.

**Comp.**—Basic magnesium carbonate, $3MgCO_3.Mg(OH)_2 + 3H_2O$ or $4MgO.3CO_2.4H_2O$ = Carbon dioxide 36·3, magnesia 43·9, water 19·8 = 100.

**Anal.**—1, Wachtmeister, l. c. 2, v. Kobell, l. c. 3. 4, Smith & Brush, of crystalline varieties, Am. J. Sc., **15**, 214, 1853. 5, Tschermak, Min. Mitth., 113, 1871.

| | | $CO_2$ | $MgO$ | $H_2O$ |
|---|---|---|---|---|
| 1. Hoboken | | 36·82 | 42·41 | 18·53 $SiO_2$ 0·57, $Fe_2O_3$ 0·27, earthy matter [1·39 = 99·99 |
| 2. Negroponte | | 36·00 | 43·96 | 19·68 $SiO_2$ 0·36 = 100 |
| 3. Texas, Pa. | G. = 2·16 | 36·69 | 43·20 | 19·83 Fe and Mn *tr.* = 99·72 |
| 4. " | | 36·74 | 42·30 | 20·10 Fe and Mn *tr.* = 99·14 |
| 5. Kraubat | | 35·71 | 44·02 | 19·74 insol. 0·99 = 100·46 |

**Pyr., etc.**—In the closed tube gives off water and carbon dioxide. B.B. infusible, but whitens, and the assay reacts alkaline to turmeric paper. Soluble in acids; the crystalline compact varieties are but slowly acted upon by cold acid, but dissolve with effervescence in hot acid.

**Obs.**—Occurs at Hrubschitz, in Moravia, in serpentine; also in acicular crystals in serpentine at Kraubat, Styria; in Negroponte, near Kumi; at Kaiserstuhl, in Baden, impure. In the

U. S., crystallized, with serpentine and brucite, near Texas, Lancaster Co., Penn., at Wood's and Low's mines; also in a similar way at Hoboken, N. J., in acicular crystals, and in earthy crusts. The brucite of Hoboken sometimes changes on exposure to an earthy hydromagnesite.

The *lancasterite* of Silliman (l. c.) is shown by Smith and Brush to be a mixture of brucite and hydromagnesite.

Pseudomorphs after brucite occur at Wood's mine.

**Ref.**—[1] Made monoclinic by J. D. D. (Am. J. Sc., **17**, 84, 1854), but the author's measurements make the variation from the orthorhombic type at least very small; this confirms Tschermak's optical results (l. c.).

**301. HYDROGIOBERTITE.** Idrogiobertite *E. Scacchi*, Rend. Accad. Sc., Napoli, Dec. 12, 1885.

In spherical forms, 2 to 15 mm. in diameter; compact. G. = 2·149–2·174. Color light gray.

**Comp.**—$MgCO_3.Mg(OH)_2 + 2H_2O$ or $2MgO.CO_2.3H_2O$ = Carbon dioxide 24·7, magnesia 44·9, $H_2O$ 30·4 = 100.

**Anal.**—1, 2, E. Scacchi, both calculated to 100 after deducting impurities.

| | $CO_2$ | MgO | $H_2O$ | | |
|---|---|---|---|---|---|
| 1. | 25·16 | 44·91 | 29·93 | = | 100 |
| 2. | 25·29 | 44·28 | 30·43 | = | 100 |

**Obs.**—Found in an augitophyre from the neighborhood of Pollena, Italy; magnetite is often embedded in the mineral.

**302. LANSFORDITE.** *F. A. Genth*, Zs. Kr., **14**, 255, 1888. *F. A. Genth* and *S. L. Penfield*, Am. J. Sc., **39**, 121, 1890.

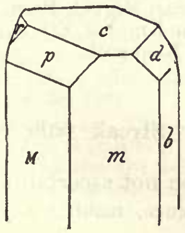
Triclinic. Axes $\breve{a} : \bar{b} : \grave{c} = 0·5493 : 1 : 0·5655$; $\alpha = 95° 21\frac{2}{3}'$; $\beta = 100° 15'$, $\gamma = 92° 27\frac{1}{2}'$ Penfield.

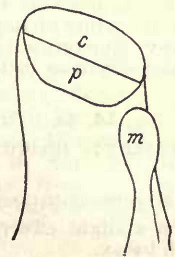
$100 \wedge 010 = 86° 31'$, $100 \wedge 001 = 79° 27\frac{2}{3}'$, $010 \wedge 001 = *84° 6'$.

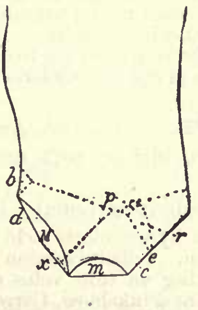
**Forms:**
*b* (010, *i*-ĭ)
*c* (001, *O*)
*m* (110, *I*')
*h* (150, *i*-$\breve{5}$')
*k* ($3\bar{1}0$, '*i*-$\bar{3}$)
*M* ($1\bar{1}0$, '*I*)
*l* ($1\bar{7}0$, '*i*-7)
*f* ($\bar{2}01$, ,2-ī,)
*d* (021, 2-ĭ')
*e* ($0\bar{2}1$, '2-ĭ)
*P* (111, 1')
*y* ($\bar{1}11$, ,1)
*z* ($\bar{3}12$, ,$\frac{3}{2}$-$\bar{3}$)
*x* ($\bar{1}32$, ,$\frac{3}{2}$-$\breve{3}$)
*w* ($\bar{5}$·15·1, ,15-$\breve{3}$)
*o* ($\bar{1}\bar{1}2$, $\frac{1}{2}$,)
*n* ($\bar{1}\bar{1}1$, 1,)
*ρ* ($\bar{1}\bar{3}1$, 3-$\breve{3}$,)
*π* ($\bar{1}\bar{5}2$, $\frac{5}{2}$-$\breve{5}$,)
*p* ($1\bar{1}1$, '1)
*q* ($3\bar{1}2$, '$\frac{3}{2}$-$\bar{3}$)
*τ* (10·$\bar{12}$·11, '$\frac{12}{11}$-$\frac{6}{5}$)
*r* ($1\bar{3}2$, '$\frac{5}{2}$-$\breve{3}$)
*s* ($1\bar{7}2$, '$\frac{7}{2}$-$\breve{7}$)

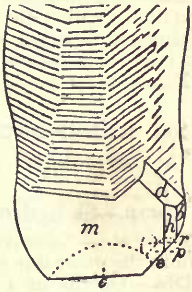
Angles: *cm* = 78° 12', *cM'* = *96° 35', *mM'* = *56° 57', *bM'* = *64° 13', *bd* = *39° 16', *cd* = 44° 50', *cp* = 44° 59', *ap* = 42° 40½'. For other angles, see Pfd.

In stalactitic forms, bounded at the free extremity with crystalline faces.









Cleavage: distinct, probably ‖ *c*. H. = 2·5. G. = 1·54 Stackhouse; 1·692 Keeley. Luster on original crystalline faces vitreous. White and translucent, resembling paraffin, when unaltered, but speedily becoming dull white and opaque.

**Comp.**—$3MgCO_3.Mg(OH)_2 + 21H_2O$ = Carbon dioxide 19·2, magnesia 23·2, water 57·6 = 100.

**Anal.**—F. J. Keeley, Zs. Kr., **14**, 255, 1888.

| $CO_2$ 18·90 | MgO 23·18 | $H_2O$ 57·79 = 99·87 |
|---|---|---|

Of the water 26·33 p. c. are lost over $H_2SO_4$, 12·31 p. c. at 110° C., 9·76 at 185° C., 9·39 at a red heat. Stackhouse (ib.) obtained: $CO_2 + H_2O$ [76·40], MgO 23·60 = 100.

**Obs.**—When first found, formed small stalactites (up to 20 mm. in length) attached to the carbonaceous shale forming the roof of a gallery in the anthracite mine at Nesquehoning near Lansford, Schuylkill Co., Penn. These were in part changed to nesquehonite (p. 300), and later when exposed to the exterior air the change became complete and they were converted into a white chalky mass showing dull crystalline planes at the extremity.

HYDRODOLOMITE. Hydromagnesit *v. Kobell*, J. pr. Ch., **36**, 304, 1845. Kalkmagnesit *Hausm.*, Handb., 1404, 1847. Hydromanganocalcit *Hartmann*, Nachr., 299. Hydromagnocalcit pt. Hydrodolomit *Rg.* Hydronickelmagnesite *Shep.*, Am. J. Sc., **6**, 250, 1848. Pennite *Herm.*, J. pr. Ch., **47**, 13, 1849.

This includes the *hydrodolomite* of Vesuvius, which is stalactitic and in globular forms; G. = 2·495; white or yellowish white. Also *pennite* of Hermann, from Texas, Pa., which occurs in apple-green to whitish crusts, having a surface of minute spherules, on serpentine and chromite: the color is due to nickel; a substance called pennite also occurs at Swinaness and Haroldswick, Unst, Shetland.

Analyses (see 5th Ed., p. 708) show hydrodolomite to be a hydrated carbonate of calcium and magnesium, but probably a mixture of hydromagnesite and calcite. Genth states that pennite is dolomite in minute hexagonal prisms, generally coated with deweylite, etc., so that the crystals can rarely be recognized.

HIBBERTITE *Heddle*, Min. Mag., **2**, 24, 1878. A pulverulent, lemon-yellow substance occurring with chromite on the island of Unst. It is a hydrous carbonate of magnesium and calcium, probably a mixture like the above. See 5th Ed., App. III, p. 58. Named after the discoverer of chromite on Unst.

**303. ZARATITE.** Hydrate of Nickel (fr. Texas, Pa.) *Silliman, Jr.*, Am. J. Sc., **3**, 407, 1847; Emerald Nickel *Id.*, ib., **6**, 248, 1848. Nickel Smaragd *Germ.* Texasit *Kenng.*, Min., 1853. Carbonato hidratado de Niquel (fr. Spain) *A. Casares*, A. M. Alcibar in Min. Revista of Madrid, 304, 1850; Zaratita *Casares*, ib., 176, March, 1851. Zamtit *wrong orthogr.*

Incrusting; often small stalactitic or minute mammillary; sometimes appearing prismatic with rounded summits. Also massive, compact.

Brittle. H. = 3–3·25. G. = 2·57–2·69. Luster vitreous. Color emerald-green. Streak paler. Transparent to translucent.

**Comp.**—A hydrated basic nickel carbonate, $NiCO_3.2Ni(OH)_2 + 4H_2O$ or $3NiO.CO_2.6H_2O$ = Carbon dioxide 11·7, nickel protoxide 59·6, water 28·7 = 100.

Analyses, 5th Ed., p. 711.

**Pyr., etc.**—In the closed tube yields water and carbon dioxide, and leaves a grayish black magnetic residue. B.B. infusible. With borax reacts for nickel. Dissolves easily with effervescence in heated dilute hydrochloric acid.

**Obs.**—Occurs on chromite at Texas, Lancaster Co., Pa., associated with serpentine; also at Swinaness, Unst, Shetland.

Also in Spain, near Cape Hortegal in Galicia, where it occurs as an incrustation on a magnetite in which there is some nickel sulphide; it is in clear emerald-green, vitreous crusts, sometimes transparent, and also in stalactites. From the mines of Rapi, San Miguel, Peru. In a chromite mine with millerite in peridotyte from the Sommergraben near Kraubat, Styria.

Named after Sen. Zarate of Spain. Casares's name antedates that of Kenngott.

**304. REMINGTONITE.** *J. C. Booth*, Am. J. Sc., **14**, 48, 1852.

A rose-colored incrustation, soft and earthy; opaque. Streak pale rose-colored.

**Comp.**—A hydrous cobalt carbonate, but precise composition not ascertained.

**Pyr., etc.**—Dissolves in hydrochloric acid with a slight effervescence, making a green solution, the color due to iron. Cobalt reaction with borax.

**Obs.**—Occurs as a coating on thin veins of serpentine, which traverse hornblende and epidote, at a copper mine near Finksburg, Carroll Co., Maryland. Named for Edward Remington, superintendent of the mine at which it was found.

**305. TENGERITE.** Kolsyrad Ytterjord *A. F. Svanberg* and *C. Tenger*, Årsb., **16**, 206, 1838. Tengerite *Dana.* Carbonyttrine *Adam*, Tabl. Min., 24, 1869.

Pulverulent. In thin coatings. Sometimes an appearance of radiated crystallization.

Luster dull, or like that of chalk. Color white.

**Comp.**—Stated to be an yttrium carbonate, but no analysis has been published.

**Pyr., etc.**—In the closed tube yields a considerable amount of water (Brush). Effervesces with acids.

**Obs.**—Occurs as a thin coating on gadolinite at Ytterby, and is evidently a result of its alteration. A similar mineral, sometimes in crystals, is associated with the gadolinite of Llano Co., Texas, but it has not been positively identified.

**306. BISMUTITE.** Bismutit *Breith.*, Pogg., **53**, 627, 1841. Kohlensaures Wismuthoxyd, Wismuthspath, *Germ.* Bismuthite. Carbonate of Bismuth.

Incrusting, or earthy and pulverulent; amorphous.

H. = 4–4·5. G. = 6·86–6·9 Breith.; 7·67 Rg. Luster vitreous when pure; sometimes dull. Color white, mountain-green, and dirty siskin-green; occasionally straw-yellow and yellowish gray. Streak greenish gray to colorless. Subtranslucent to opaque.

**Comp.**—A basic bismuth carbonate, exact composition doubtful, perhaps $Bi_2O_3.CO_2.H_2O$ (Louis, anal. 4). Cf. bismutosphärite, p. 290.

**Anal.**—1, Rg., Pogg., **76**, 564, 1849. 2, 3, Genth, Am. J. Sc., **23**, 426, 1857. 4, Louis, Min. Mag., **7**, 139, 1887.

| | | | $CO_2$ | $Bi_2O_3$ | $H_2O$ | |
|---|---|---|---|---|---|---|
| 1. | Chesterfield Distr. | G. = 7·67 | 6·56 | 90·00 | 3·44 | = 100 |
| 2. | " " | | 7·04 | 89·05 | 3·91 | = 100 |
| 3. | " " | | 7·30 | 87·67 | 5·03 | = 100 |
| 4. | Transvaal | | 8·04 | 88·95 | 3·00 | = 100 |

The material in most cases is very impure; from the above analyses iron oxide, silica, etc., have been deducted, e.g., in 1, 7 p. c.; in 4, 10·5 p. c., G. = 6·86 of the impure material.

Carnot obtained in bismuth carbonates from Meymac, Corrèze, France, with G. = 6·9–7·6: 86·9–89·7 p. c. $Bi_2O_3$, 3·14–6·43 $CO_2$, 1·94–4·86 $H_2O$, C.R., **79**, 304, 1874. Cf. also analyses by Frenzel, Liversidge, Winkler, 5th Ed., App. III, p. 16.

**Pyr., etc.**—In the closed tube decrepitates and gives off water. B.B. fuses readily, and on charcoal is reduced to bismuth, and coats the coal with yellow bismuth oxide. Dissolves in nitric acid, with slight effervescence. Dissolves in hydrochloric acid, affording a deep yellow solution.

**Obs.**—Bismutite occurs at Schneeberg and Johanngeorgenstadt, with native bismuth, and near Hirschberg in Russian Voigtland, with brown iron ore, native bismuth, and bismuthinite; at Joachimsthal; Neustädtel, Saxony; near Baden. At Meymac, Corrèze, France; with auriferous quartz in the Lydenburg district of the Transvaal. In New South Wales, at Pond's Creek with stream tin.

In the U. S., in So. Carolina, at Brewer's mine, in porous yellowish masses, sometimes reddish from iron oxide; surface of fracture white and vitreous, resembling somewhat calamine; in Gaston Co., N. C., in yellowish white concretions. In California, in gold placers on Big Pine Creek, Inyo Co.; also from Phœnix, Arizona.

WALTHÉRITE *Adam*, Tabl. Min., 27, 1869. A bismuth carbonate occurring with the bismutite of Joachimsthal in thin longish crystals, vitreous siskin-green to clove-brown, translucent. It contains, according to Lindacker (Vogl's Min. Joach., 168), bismuth oxide, carbon dioxide, water, silica; effervesces with acids, and B.B. gives bismuth reactions. Cf. Btd., Bull. Soc. Min., 4 58, 1881.

AGNESITE. Carbonate of Bismuth *W. Macgregor*, Sowerby's English Min., *Beud.*, Tr., 2, 375, 1832; Agnesite *B. & M.* Min., 591, 1852. Gregorite *Adam*, Tabl. Min., 27, 1869. An earthy steatite-like mineral from St. Agnes in Cornwall, made by Macgregor a bismuth carbonate, but his results have been shown to be totally erroneous. See further 5th Ed., p. 793.

**307. URANOTHALLITE.** Kalk-Uran-carbonat *Vogl.* Jb. G. Reichs., **4**, 221, 1853. Flutherite *Weisbach*. Synops. Min., 48, 1875. Uranothallit *Schrauf*, Zs. Kr., **6**, 410, 1882.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c}$ = 0·601 : 1 : 0·358 (approx.) Schrauf[1].

**Forms:** *b* (010, *i*-ĭ), *m* (110, *I*), *n* (130, *i*-3̆), *u* (201, 2-ī), *o* (221, 2), *φ* (263, 2-3̆).
Measured angles: *mm‴* = 60°–63°, *um* = 47°–49°, *mφ* = 56° 40′, *φo* = 25°–26°.

Crystals minute and indistinct, united in scaly or granular aggregates, often incrusting.

Cleavage: *a* (100) easy but imperfect. H. = 2·5–3·0. Luster vitreous, on cleavage-face pearly. Color siskin-green. Streak same but paler. Subtransparent to translucent.

**Comp.**—$2CaCO_3.U(CO_3)_2.10H_2O$ or $2CaO.UO_2.4CO_2.10H_2O$ = Carbon dioxide 23·8, uranium dioxide 36·8, lime 15·1, water 24·3 = 100.

**Anal.**—1, Lindacker, Jb. G. Reichs., **4**, 221, 1853. 2, Schrauf, l. c. 3, Foullon, Vh. G. Reichs., 269, 1883.

| | $CO_2$ | $UO_2$ | CaO | $H_2O$ |
|---|---|---|---|---|
| 1. | $\frac{8}{3}$ 24·18 | 37·03 | 15·55 | 23·24 = 100 |
| 2. | 22·95 | 36·29 | 16·42 | 23·72 = 99·38 |
| 3. | 23·13 | 35·45 | 16·28 | 22·44 FeO 2·48 = 99·78 |

**Pyr.**—B.B. on charcoal infusible; with borax and salt of phosphorus the reaction for uranium. Dissolves with effervescence in sulphuric acid, a white deposit being thrown down; solution in sulphuric and hydrochloric acids green, in nitric acid yellow.

**Obs.**—Occurs as an incrustation on uraninite at Joachimsthal, Bohemia.

**Ref.**—[1] L. c., cf. Brz., Vh. G. Reichs., 269, 1883.

308. **LIEBIGITE.** *J. L. Smith*, Am. J. Sc., **5**, 336, 1848, and **11**, 259, 1851. Uran-Kalk-Carbonat *Vogl*, Jb. G. Reichs., **4**, 221, 1853.

In mammillary concretions, or thin coatings; cleavage apparent in one direction.

H. = 2–2·5. Luster of fracture vitreous. Color beautiful apple-green. Transparent.

**Comp.**—A hydrous carbonate of uranium and calcium, formula perhaps $CaCO_3.(UO_2)CO_3.20H_2O$ (Rg.) = Carbon dioxide 11·1, uranium trioxide 36·4, lime 7·1, water 45·5 = 100.

**Anal.**—J. L. Smith:

| $CO_2$ | $UO_3$ | CaO | $H_2O$ |
|---|---|---|---|
| 10·2 | 38·0 | 8·0 | 45·2 = 101·4 |

**Pyr., etc.**—In a matrass yields much water and becomes yellowish gray. At redness it blackens, without fusing, and on cooling returns to an orange-red color. At a higher heat it blackens, and remains so on cooling. With borax or salt of phosphorus reacts for uranium. Dissolves readily in dilute acids with effervescence.

**Obs.**—Occurs with medjidite on uraninite near Adrianople, Turkey; also at Johanngeorgenstadt and Joachimsthal. Dr. Smith states that both the lime and uranium of this salt are derived from the uraninite. Named for Baron Justus Liebig (1803–1873), the German chemist.

309. **VOGLITE.** Uran-Kalk-Kupfer-Carbonat *Vogl*, Jb. G. Reichs., **4**, 222, 1853. Voglit *Haid.*, ib., 223.

In aggregations of crystalline scales. Scales rhomboidal somewhat like gypsum, with angles of 100° and 80°, Haid.

Luster pearly. Color emerald-green to bright grass-green. Dichroic.

**Comp.**—A hydrous carbonate of uranium, calcium and copper.

**Anal.**—Lindacker, ibid.

| $CO_2$ | UO | CaO | CuO | $H_2O$ |
|---|---|---|---|---|
| 26·41 | 37·00 | 14·09 | 8·40 | 13·90 = 99·80 |

**Pyr., etc.**—In the closed tube blackens and yields water. B.B. in the platinum forceps infusible, colors the flame deep green; if moistened with hydrochloric acid the flame is momentarily blue. With soda on charcoal yields metallic copper. With borax in O.F. the bead is yellow while hot and reddish brown on cooling; in R.F. green while hot and clouded when cold. Soluble in acids with effervescence.

**Obs.**—From the Elias mine, near Joachimsthal, implanted on uraninite.

SCHRÖCKINGERITE *Schrauf*, Min. Mitth., 137, 1873.

Occurs at Joachimsthal on uraninite, in small, six-sided tabular crystals referred to the orthorhombic system; *bm* = 58½°. A bisectrix is normal to *b*. Color greenish to yellow. It is stated to be hydrous oxycarbonate of uranium, containing only traces of $SO_3$. Loss by ignition ($H_2O$ and $CO_2$) = 36·7. Contains also a little lime. Named after Baron Schröckinger.

**RANDITE** *Koenig*, Proc. Ac. Philad., 408, 1878. A canary-yellow incrustation on granite, at Frankford, near Philadelphia, Penn. A hydrous carbonate of calcium and uranium. An analysis (on 0·047 gr.) of impure material: [$CO_2$ 29·34], $U_2O_3$ 31·63, CaO 32·50, $H_2O$ 6·53 = 100. T. D. Rand (ib., 274, 1880) shows that the coating consists largely of calcite, and after this has been removed by acetic acid, there remain the unattacked tufts of acicular crystals of randite; these, dissolved in hydrochloric acid, yielded largely of calcium and uranium, with a trace of phosphoric acid, alumina, etc.

**SELBITE.** Luftsaures Silber (from anal. by Selb) *Widenmann*, Min., 689, 1794, *Lenz*, Min., 95, 1794; Grausilber; Carbonate of Silver, *Selb*, Tasch. Min., **9**, 394, 1817; Selbit *Haid.*, Handb., 506, 1845. A grayish ore, made a carbonate by Selb, who discovered it, in 1788, at the mine Wenzel near Wolfach, Baden. According to Walchner (Mag. f. Pharm., **25**, 1) it is only a mixture; and, according to Sandberger (Jb. Min., 221, 1864), one of Selb's original specimens, under the lens, proved to contain within earthy argentite, dolomite and silver, and all parts afforded a sulphur reaction.

Del Rio described a silver carbonate from Real Catorce, Mexico, where it is called *Plata Azul* (Gilb. Ann., **71**, 11, 1822), which also is regarded as a mixture. Plata azul, however, is a term somewhat loosely used for a number of silver ores. Cf. Domeyko, Min. Chili, 420, 1879.

# Oxygen Salts.

## 2. SILICATES.

### A. Anhydrous Silicates.

### B. Hydrous Silicates.

This chapter closes with a section including the Titanates, Silico-titanates, Titano-niobates, etc., which connect the Silicates proper with the Niobates and Tantalates.

The line between the strictly anhydrous and hydrous silicates cannot be sharply drawn, since with many species which yield water upon ignition, the part played by the elements forming the water is as yet uncertain. Furthermore, in the cases of several groups the strict arrangement is deviated from, since the relation of the species is best exhibited by introducing the related hydrous species immediately after the others.

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### A. Anhydrous Silicates.

Some species strictly belonging here are placed among the Hydrous Silicates; see p. 563.

**I. Disilicates, Polysilicates.**
**II. Metasilicates.**
**III. Orthosilicates.**
**IV. Subsilicates.**

The Disilicates, $RSi_2O_5$, are salts of disilicic acid, $H_2Si_2O_5$, and have an oxygen ratio of silicon to bases of 4 : 1, as seen when the formula is written after the dualistic method, $RO.2SiO_2$.

The Polysilicates, $R_2Si_3O_8$, are salts of polysilicic acid, $H_4Si_3O_8$, and have an oxygen ratio of 3 : 1, as seen in $2RO.3SiO_2$. They have been called *trisilicates.*

The Metasilicates, $RSiO_3$, are salts of metasilicic acid, $H_2SiO_3$, and have an oxygen ratio of 2 : 1. They have hence been called *bisilicates.*

The Orthosilicates, $R_2SiO_4$, are salts of orthosilicic acid, $H_4SiO_4$, and have an oxygen ratio of 1 : 1. They have hence been called *unisilicates.* The majority of the silicates fall into one of the last two groups.

Furthermore, there are a number of species characterized by an oxygen ratio of less than 1 : 1, e.g., 3 : 4, 2 : 3, etc. These basic species are grouped as Subsilicates. Their true position is often in doubt; in some cases they are to be regarded as basic salts belonging to one of the other groups.

The above classification cannot, however, be carried through strictly. since there are many species which do not exactly conform to any one of the groups named, and often the true interpretation of the composition is doubtful. Furthermore, within the limits of a single group of species, connected closely in all essential characters, there may be a wide variation in the proportion of the acidic element. Thus the triclinic feldspars, placed among the polysilicates, range from the true polysilicate, $NaAlSi_3O_8$, to the orthosilicate, $CaAl_2Si_2O_8$, with many intermediate compounds, regarded as isomorphous compounds of these extremes. Similarly of the scapolite group, which, however, is included among the orthosilicates, since the majority of the compounds observed approximate to that type. The micas form another example. For a further discussion of the matter see the special groups in the pages which follow.

It is possible to reduce the number of acids assumed, as suggested by Groth, by regarding polysilicic acid as compounded of disilicic and metasilicic acids, $H_4Si_3O_8 = H_2Si_2O_5 + H_2SiO_3$. Or, as suggested by Becker, metasilicic acid may be regarded as formed from polysilicic acid and orthosilicic acid, $4H_2SiO_3 = H_4Si_3O_8 + H_4SiO_4$; while disilicic acid may be considered as a polysilicic acid from which orthosilicic acid has been isolated, $4H_2Si_2O_5 = 3H_4Si_3O_8 - H_4SiO_4$. Rammelsberg prefers to regard most of the more complex silicates, not conforming to the simple types, as compounds in varying proportions of metasilicates and orthosilicates, with sometimes disilicates, etc.

An excellent recent discussion of the composition of the Silicates as a whole is given by Groth in the last edition (1889) of his *Tabellarische Uebersicht der Mineralien*, pp. 87–102. Brief but suggestive remarks are made by Tschermak in his *Lehrbuch der Mineralogie* (1883). Important recent contributions to the subject have been made by F. W. Clarke, who has discussed the matter from a more or less theoretical standpoint (Am. J. Sc., **29**, 382, 1885, **31**, 270, 1886, **38**, 384, 1889, *et al.*) and also attacked the problem by analytical methods (ib., **40**, 303, 405, 452, 1890) with important results. Cf. also Id., U. S. G. Surv., Bull., **60**, 13, 1890, **78**, 11, 1891.

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## I. Disilicates, $RSi_2O_5$. Polysilicates, $R_2Si_3O_8$.

### Petalite Group.

| | | | | $\grave{a} : \grave{\bar{b}} : \grave{c}$ | $\beta$ |
|---|---|---|---|---|---|
| **310.** | **Petalite** | $LiAl(Si_2O_5)_2$ | Monoclinic | 1·1534 : 1 : 0·7436 | 67° 34′ |
| **311.** | **Milarite** | $HKCa_2Al_2(Si_2O_5)_6$ | Hexagonal | $\grave{c}$ = 0·6620 | |

| | | | | $\grave{a} : \grave{\bar{b}} : \grave{c}$ | $\beta$ |
|---|---|---|---|---|---|
| **312.** | **Eudidymite** | $HNaBeSi_3O_8$ | Monoclinic | 1·7107 : 1 : 1·1071 | 86° 14½′ |

**310. PETALITE.** Petalit *d'Andrada*, Scherer's J., **4**, 36, 1800. Castor (fr. Elba) *Breith.*, Lieb. Ann., **69**, 436, 1849. Berzeliite *Clarke*, Ann. Phil., **11**, 196, 1818.

Monoclinic. Axes: $\grave{a} : \grave{\bar{b}} : \grave{c} = 1·1534 : 1 : 0·7436$; $\beta = {}^*67° 34' = 001 \wedge 100$ Des Cloizeaux[1].

$100 \wedge 110 = 46° 50'$, $001 \wedge 101 = 25° 33\frac{1}{2}'$, $001 \wedge 011 = 34° 30\frac{1}{6}'$.

**Forms**[1]:
*a* (100, *i*-$\bar{i}$)
*b* (010, *i*-$\grave{i}$)
*c* (001, *O*)
*m* (110, *I*)
*g* (120, *i*-$\grave{2}$)
*y* (101, − 1-$\bar{i}$)
*ω* (403, − $\frac{4}{3}$-$\bar{i}$)
*o* (201, − 2-$\bar{i}$)
*z* ($\bar{9}05$, $\frac{9}{5}$-$\bar{i}$)? cleavage
*α* ($\bar{4}01$, 4-$\bar{i}$)
*e* (021, 2-$\grave{i}$)
*x* ($\bar{2}41$, 4-$\grave{2}$)

$mm''' = 93° 40'$
$bm = {}^*43° 10'$
$gg' = 50° 15'$
$c\omega = 30° 53\frac{1}{2}'$
$co = {}^*38° 37'$
$cz = 62° 33'$
$c\alpha = 89° 37'$
$ce = 53° 58'$
$cm = 74° 52'$
$cx = 80° 23'$
$xx' = 129° 32'$
$mo = 53° 14'$

The form of petalite approximates to that of the monoclinic pyroxenes, especially to spodumene; in composition also these two species are related, but in specific gravity they diverge widely.

Crystals rare, commonly tabular ∥ *b* or elongated ∥ $\grave{a}$; the faces *c*, *a*, *o* smooth, the others often striated or rough. Usually massive, foliated cleavable.

Cleavage: *c* perfect; *o* (201) easy, *z* ($\bar{9}05$) difficult and imperfect. Fracture imperfectly conchoidal. Brittle. H. = 6–6·5. G. = 2·39–2·46. Luster vitreous, on *c* pearly. Colorless, white, gray, occasionally reddish or greenish white. Streak uncolored. Transparent to translucent.

Optically +. Double refraction strong. Ax. pl. and $Bx_a \perp b$; the ax. pl. inclined $-87° 30'$ to *c* for red, hence $Bx_{o.r} \wedge \dot{c} = -75° 4'$; also $Bx_{o.bl} \wedge \dot{c} = -74° 30'$. Dispersion $\rho < v$ small; crossed, weak. Axial angles, castorite, Dx.[2]

$$2H_{a.r} = 86° 27\tfrac{1}{3}' \quad 2H_{a.y} = 86° 30\tfrac{1}{3}' \quad 2H_{a.bl} = 86° 42' \quad \beta_r = 1·5078 \quad \beta_y = 1·5096 \quad \beta_{bl} = 1·5180$$

$$\therefore \quad 2V_r = 83° 30' \qquad 2V_y = 83° 34' \qquad 2V_{bl} = 83° 52'$$

Also, petalite:

$$2H_{a.r} = 86° 24' \qquad 2H_{a.y} = 86° 28' \qquad 2H_{a.bl} = 86° 43'$$

$$\alpha_y = 1·504 \qquad \beta_y = 1·510 \qquad \gamma_y = 1·516 \text{ M. Lévy-Lcx.}^3$$

**Var.**—1. *Castorite*, in distinct transparent crystals, affording the above angles, Dx. G. = 2·38, Breith.; 2·397–2·405, Damour.

2. *Ordinary petalite*, cleavable massive; G. = 2·412, 2·420, 2·465 Utö, Dmr.

**Comp.**—$LiAl(Si_2O_5)_2$ or $Li_2O.Al_2O_3.8SiO_2$ = Silica 78·4, alumina 16·7, lithia 4·9 = 100.

**Anal.**—1, Sonden, G. För. Förh., **6**, 39, 1882. after deducting 0·5 p. c. apatite. 2, Smith and Brush, Am. J. Sc., **16**, 373, 1853. 3, Rg., Ber. Ak. Berlin, 13, 1878. 4, F. W. Clarke, priv. contr.

| | | $SiO_2$ | $Al_2O_3$ | $Li_2O$ | $Na_2O$ | $K_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. Utö | $\frac{2}{2}$ | 77·97 | 17·08 | 4·22 | 0·73 | — | = 100 [0·24 = 99·75 |
| 2. Bolton | $\frac{2}{2}$ | 77·92 | 16·24 | 3·63 | 0·51 | *tr.* | ign. 0·65, $Fe_2O_3$ 0·56, Mg |
| 3. Elba, *Castorite* G. = 2·386 | | 77·87 | 17·55 | 2·77 | 1·04 | 0·43 | $H_2O$ 0·34 = 100 [100·28 |
| 4. Peru, Maine | | 77·29 | 16·95 | 2·62 | 2·39 | *tr.* | ign., 1·03, $Fe_2O_3$,MnO *tr.* = |

The chemical composition and relation to spodumene are discussed by Doelter, Min. Mitth., **1**, 529, 1878.

**Pyr., etc.**—Gently heated emits a blue phosphorescent light. B.B. on charcoal becomes glassy, subtransparent, and white, and melts only on the edges; gives the reaction for lithia. With borax it forms a clear, colorless glass. Not acted on by acids.

**Obs.**—Petalite occurs at the iron mine of Utö, Sweden, accompanying lepidolite, tourmaline, spodumene, and quartz; on Elba (*castorite*) in attached crystals.

In the U. S., at Bolton, Mass., with scapolite; at Peru, Maine, with spodumene in albite. According to Bigsby, in a boulder containing tremolite, at York, near Toronto, Canada.

*Lithia* was first discovered in this mineral by Arfvedson. The name *petalite* is from *πέταλον, a leaf*, alluding to the cleavage.

**Ref.**—[1] Ann. Ch. Phys., 3, 264, 1864, and Pogg., **122**, 648, 1864. Cf. Svr., Zs. G. Ges., **22**, 668, 1870. [2] L. c., also Min., **2**, xxxvi, 1874. [3] C. R., **106**, 777, 1888.

HYDROCASTORITE. Idrocastorite *G. Grattarola*, Boll. Com. Geol., 323, 1876. A decomposition product of Elba castorite. Occurs as a white mealy aggregate of fine crystalline needles, surrounding a nucleus of the original mineral. H. = 2. G. = 2·16. Anal.—1, Grattarola, on material not entirely pure. 2, Sansoni, Att. Soc. Tosc., **4**, 320, 1879.

| | $SiO_2$ | $Al_2O_3$ | CaO | MgO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|
| 1. | 59·59 | 21·35 | 4·38 | — | 14·66 | = | 99·98 |
| 2. | 58·13 | 19·70 | 4·17 | 0·50 | 15·96 | = | 98·46 |

### 311. MILARITE. *Kenngott*, Jb. Min., 81, 1870. Giufite *Kuschel-Köhler*, ib., 926, 1877.

Hexagonal. Axis $\dot{c} = 0·6620$; $0001 \wedge 10\bar{1}1 = {}^*37° 23\tfrac{2}{3}'$ Rinne[1]. In hexagonal prisms with *c* (0001), *m* $(10\bar{1}0)$, *a* $(11\bar{2}0)$, *p* $(10\bar{1}1)$. Pyramidal angles : $pp' = 55°$ 21′, $pp^{vi} = 105° 13'$.

Cleavage not observed. Fracture conchoidal. Brittle. H. = 5·5–6. G. = 2·55–2·59. Luster vitreous. Colorless to pale green, glassy.

Basal sections show, in polarized light, a division into six radial sectors (biaxial), often with a central core diagonally placed and also divided into six sectors. The central portion is sometimes uniaxial. Hence regarded as pseudohexagonal (analogous to witherite) by Tschermak[2], Des Cloizeaux[3], Mallard[4]. Rinne[1], however, shows that the original position of equilibrium was hexagonal and the anomalous characters are secondary; this is confirmed by Ramsay[5], who finds that increase of temperature makes the biaxial portions become uniaxial.

**Comp.**—$HKCa_2Al_2(Si_2O_5)_6$ or $H_2O.K_2O.4CaO.2Al_2O_3.24SiO_2$ = Silica 72·7, alumina 10·3, lime 11·3, potash 4·8, water 0·9 = 100.

**Anal.**—1, Frenzel, Jb. Min., 797, 1873. 2, Finkener, ib., 62, 1874. 3, Ludwig, Min. Mitth., 347, 1877.

| | | | $SiO_2$ | $Al_2O_3$ | CaO | MgO | $Na_2O$ | $Ka_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | G. = 2·59 | | 71·12 | 8·45 | 11·27 | — | [7·61] | — | 1·55 | = 100 |
| 2. | G. = 2·5 | | 70·04 | 11·62 | 10·05 | 0·20 | 0·65 | 5·74 | 1·69 | = 99·99 |
| 3. | G. = 2·553 | $\frac{2}{3}$ | 71·81 | 10·67 | 11·65 | *tr.* | *tr.* | 4·86 | 1·36 | = 100·35 |

**Pyr., etc.**—B.B. in the closed tube becomes white and gives off water, but only at a high temperature. In the forceps fuses with intumescence to a white blebby glass. In salt of phosphorus slowly soluble to a colorless glass leaving a skeleton of silica. Insoluble in hydrochloric acid.

**Obs.**—Occurs in Val Giuf, Grisons, Switzerland, in a granitic rock with smoky quartz, orthoclase, apatite, titanite, chabazite; the crystals are often coated or penetrated by scales of chlorite. Also reported from the Strim glacier in the Tavetschthal. It was first incorrectly announced as having been found in Val Milar, hence the name first given.

**Ref.**—[1] Jb. Min., 2, 1, 1885; cf. Kenng., *pp'* = 35° 14'; also Tschermak[2], who shows the variation from strict hexagonal symmetry. [2] Min. Mitth., 350, 1877. [3] Jb. Min., 41, 371, 1878. [4] Bull. Soc. Min., 5, 241, 1882. [5] Öfv. Ak. Stockh., **42**, No. 9, 29, 1885.

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### 312. EUDIDYMITE. *W. C. Brögger*; Nyt Mag., 31, 196, 1887.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 1·71075 : 1 : 1·10712$; $\beta = 86° 14\frac{1}{2}' = 001 \wedge 100$ Brögger[1].

$100 \wedge 110 = 59° 38\frac{1}{3}'$, $001 \wedge 101 = 31° 46\frac{2}{3}'$, $001 \wedge 011 = 47° 51'$.

**Forms**[1]: *l* (310, *i*-$\bar{3}$) *x* (10·0·1, – 10-ĭ) *e* (0·10·3, $\frac{10}{3}$-ĭ) *o* (111, – 1) *v* ($\bar{3}$34, $\frac{3}{4}$)
*b* (010, *i*-ĭ) *d* (502, – $\frac{5}{2}$-ĭ) *q* ($\bar{5}$01, 5-ĭ) *u* (335, – $\frac{3}{5}$) *s* (552, – $\frac{5}{2}$) *t* ($\bar{5}$51, 5)
*c* (001, *O*)

Also doubtful 112, $\bar{3}$32.

*ll'''* = 59° 16'
*cl* = *86° 44'
*cd* = 55° 35'
*cq* = 76° 17'

*ee'* = 149° 37'
*cu* = 36° 49'
*co* = *50° 50'
*cs* = 70° 56'

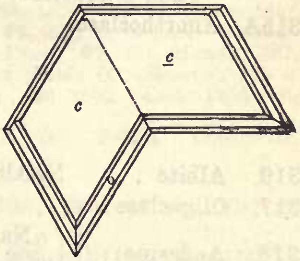
*cv* = 44° 45'
*ct* = 82° 59'
*uu'* = 62° 19'
*oo'* = *84° 2'

*ss'* = 109° 21½'
*vv'* = 74° 51½'
*tt'* = 117° 56'

Twins: tw. pl. (1) *c*, producing tw. lamellæ, also as penetration-twins; also (2) a plane normal to *c* in the zone *co*, contact-twins (f. 2), the axes crossing at angles of nearly 60°. Crystals always twins; habit tabular ‖ *c*. Faces *c*, also the pyramids, often striated ‖ their intersection edges.

1.

2.



Cleavage: *c* perfect; *t* ($\bar{5}$51) less perfect. H. = 6. G. = 2·553. Luster on crystalline faces vitreous, on *c* pearly, also on fracture surfaces in zone *co* silky. Color white. Transparent to translucent.

Optically +. Ax. pl. ‖ *b*. $Bx \wedge \grave{c} = -58° 30'$. Refractive indices:

$\alpha_r = 1·54444$ $\beta_r = 1·54479$ $\gamma_r = 1·54971$ $\therefore$ $2V_r = 30° 44'$
$\alpha_y = 1·54533$ $\beta_y = 1·54568$ $\gamma_y = 1·55085$ $\therefore$ $2V_y = 29° 55'$
$\alpha_{gr} = 1·54763$ $\beta_{gr} = 1·54799$ $\gamma_{gr} = 1·55336$ $\therefore$ $2V_{gr} = 28° 52'$

Also measured axial angles:

$2H_{a.r} = 30° 48'$ $2H_{o.r} = 155° 45'$ $\therefore$ $2V_r = 30° 23\frac{1}{2}'$
$2H_{a.y} = 29° 43'$ $2H_{o.y} = 157° 5'$ $\therefore$ $2V_y = 29° 19'$
$2H_{a.gr} = 28° 54'$ $2H_{o.gr} = 158° 40'$ $\therefore$ $2V_{gr} = 28° 30'$

**Comp.**—$HNaBeSi_3O_8$ or $H_2O.Na_2O.2BeO.6SiO_2$ = Silica 73·4, glucina 10·2, soda 12·7, water 3·7 = 100.

**Anal.**—1, G. Flink, Nyt Mag., l. c., as corrected by A. E. Nd., l. c. 2, A. E. Nordenskiöld, G. För. Förh., **9**, 434, 1887.

| | $SiO_2$ | BeO | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|
| 1. | 72·19 | 11·15 | 12·66 | 3·84 = 99·84 |
| 2. | 73·11 | 10·62 | 12·24 | 3·79 MgO *tr.* = 99·76 |

**Pyr.**—B.B. fuses easily to a colorless glass. Dissolves with difficulty and incompletely in acids. The water goes off completely only at a high temperature.

**Obs.**—Occurs very sparingly in zircon-syenite on the island Ovre-Arö, in the Langesundfiord, with ægirite, elæolite, brevicite, apophyllite, natrolite, etc.; it was formed at the same time with the zeolites with which it is associated.

Named from εὖ, *well*, δίδυμος, *twin*, in allusion to its occurrence in twin crystals.

It is interesting to note that a considerable number of the minerals containing beryllium as an essential constituent (*e.g.* beryl, phenacite) are hexagonal, like the element itself (Brögger & Flink, Zs. Kr., 9, 228, 1884), or approximate to this in angle and method of twinning (*e.g.* eudidymite, chrysoberyl, beryllonite, bertrandite, etc.).

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## Feldspar Group.

### α. *Monoclinic Section.*

| | | | $\grave{a} : \overset{\shortmid}{b} : \grave{c}$ | $\beta'$ |
|---|---|---|---|---|
| 313. | **Orthoclase** | $KAlSi_3O_8$ | 0·6585 : 1 : 0·5554 | 116° 3′ |
| | Soda-Orthoclase | $(K,Na)AlSi_3O_8$ | | |
| 314. | **Hyalophane** | $(K_2,Ba)Al_2Si_4O_{12}$ | 0·6584 : 1 : 0·5512 | 115° 35′ |

### β. *Triclinic Section.*

| | | |
|---|---|---|
| 315. | **Microcline** | $KAlSi_3O_8$ |
| | Soda-microcline | $(K,Na)AlSi_3O_8$ |
| 315A. | **Anorthoclase** | $(Na,K)AlSi_3O_8$ |

### Albite-anorthite Series.

| | | | $\breve{a} : \bar{b} : \grave{c}$ | α | β | γ |
|---|---|---|---|---|---|---|
| 316. | **Albite** | $NaAlSi_3O_8$ | 0·6335 : 1 : 0·5577 | 94° 3′ | 116° 29′ | 88° 9′ |
| 317. | **Oligoclase** | $\left.\right\}\begin{pmatrix} nNaAlSi_3O_8 \\ mCaAl_2Si_2O_8 \end{pmatrix}$ | 0·6321 : 1 : 0·5524 | 93° 4′ | 116° 23′ | 90° 5′ |
| 318. | **Andesine** | | 0·6357 : 1 : 0·5521 | 93° 23′ | 116° 29′ | 89° 59′ |
| 319. | **Labradorite** | | 0·6377 : 1 : 0·5547 | 93° 31′ | 116° 3′ | 89° 54½′ |
| 320. | **Anorthite** | $CaAl_2Si_2O_8$ | 0·6347 : 1 : 0·5501 | 93° 13′ | 115° 55′ | 91° 12′ |

The general characters of the species belonging in the FELDSPAR GROUP are as follows: 1, Crystallization in the monoclinic or triclinic systems, the crystals of the different species resembling each other closely in angle, in general habit, and in methods of twinning. 2, Cleavage in two similar directions inclined at an angle of 90° or nearly 90°. 3, Hardness between 6 and 6·5. 4, Specific Gravity varying between 2·5 and 2·9, and mostly between 2·55 and 2·75. 5, Colors white or pale shades of yellow, red or green, less commonly dark. 6, In composition silicates of aluminium with either potassium, sodium, or calcium, and rarely barium, while magnesium and iron are always absent. Furthermore, besides the several distinct species there are many intermediate compounds having a certain independence of character and yet connected with each other by insensible gradations; all the members of the series showing a close relationship not only in composition but also in crystalline form and optical characters.

The feldspars furnish a striking example how a species, or group of species, may approximate in angle to a system of higher symmetry, while diverging widely from it in actual form. Thus of the commonly occurring planes of orthoclase: *n* (021), *y* ($\bar{2}01$) correspond in angle to cubic planes; *q* ($\bar{2}03$) to an octahedral; *m, b, c, o* (111) to dodecahedral, and *z* (130), *x* ($\bar{1}01$) to trapezohedral. See further 5th Ed., p. 337, where this subject is developed and a relation to the isometric species leucite is shown.

The species of the Feldspar Group are classified, first as regards form, and second with reference to composition. The *monoclinic* species include (see above): ORTHOCLASE, potassium feldspar and SODA-ORTHOCLASE, potassium-sodium feldspar; also HYALOPHANE, barium feldspar.

The *triclinic* species include: MICROCLINE and ANORTHOCLASE, potassium-sodium feldspars; ALBITE, sodium feldspar; ANORTHITE, calcium feldspar.

Also intermediate between albite and anorthite the isomorphous sub-species, sodium-calcium or calcium-sodium feldspars: OLIGOCLASE, ANDESINE, LABRADORITE.

### *a. Monoclinic Section.*

**313. ORTHOCLASE.** Silex ex eo ictu ferri facile ignis elicitur—ex cubis aliisque figuris intersectis constans, *Agric.*, Foss., 314, 1546. Felt-Spat, Spatum pyrimachum (VAR. album, cinereum, rubrum), *Wall.*, Min., 65, 1747. Fältspat, Spatum scintillans, *Cronst.*, 60, 1758. Feldspath *Germ.*, *Fr.* Feldspar *Engl.* Felspar *bad orthogr.* dating from Kirwan. Feldstein *Hausm.*, Handb., 528, 1813, Orthose *H.*, Tr., **4**, 1801, in Index alone, p. 394, 4to edition. Adular *Breith.*, Char., 35, 1820. [In the preceding, the whole *group* of feldspars is included in the one species.]

Feldspath (Albite excluded) *Berz.*, 1815, N. Syst. Min. 1819. Feldspath (Albite, Labradorite, and Anorthite excl.) *G. Rose*, Gilb. Ann., **73**, 173, 1823. Orthoklas (id. excl.) *Breith.*, Char., 1823; (id. + Oligoklas excl.) *Breith.*, Pogg., **8**, 79, 1826. Potash-feldspar. Kalifeldspath *Germ.*

VAR. *introd. as sp.* Adulaire *Pini*, Mem. Feldsp., Milan, 1783; Adular *Germ.;* Adularia *Engl.;* Feldspath nacré *H.;* Mondstein var. Feldspath, *Wern.*, Ueb. Cronst., 1780; id. = Adularia *Wern.*, Bergm. J., 375, 1789; Moonstone. Sanidin *Nose*, Nöggerath Min. Stud. Geb. Niederrhein, 1808; Glasiger Feldspath *Klapr.*, Beitr., **1**, 15, 1795, and others. Necronite *Hayden*, Am. J. Sc., **1**, 306, 1819. Pegmatolith *Breith.*, Char., 1823, 1832. Murchisonite *W. Phillips*, Phil. Mag., **1**, 448, 1827. Ryakolith *G. Rose*, Pogg., **15**, 193, 1829, **28**, 143, 1833; Rhyacolite. Valencianit, Mikroklin *Breith.*, Schw. J., **60**, 322, 324, 1830. Erythrite, Perthite, *Thom.*, Phil. Mag., **22**, 188, 189, 1843. Loxoklas *Breith.*, Pogg., **67**, 419; Loxoclase. Chesterlite *Seal*, Dana Min., 678, 1850. Felsit von Marienberg *Breith.*, Pogg., **67**, 421, Handb., 527, 1847 = Paradoxit *Breith.*, B. H. Ztg., **25**, 35, 1866. Felsit von Mulda *id.*, Handb., 528 = Muldan *id.*, ib., 39, Cottait *id.*, ib. Weissigit *Jenzsch*, Jahrb. Min., 396, 1853. Lasur-Feldspath *N. Nd.*, Bull. Soc., Moscow, **30**, 225, 1857.

Hälleflinta, Petrosilex, Lapis Corneus, pt., *Cronst.*, Min., 57, 1758. Felsite. Leelite (fr. Westmannland) *Clarke*, Ann. Phil., 1818.

Monoclinic. Axes $\grave{a} : \overset{|}{b} : \acute{c} = 0{\cdot}65851 : 1 : 0{\cdot}55538$; $\beta = 63° \ 56' \ 46'' =$ 001 ∧ 100 Koksharov.[1]

100 ∧ 110 = 30° 36′ 30″, 001 ∧ $\bar{1}01$ = 50° 16′ 34″, 001 ∧ 011 = 26° 31′ 0″.

**Forms**[2]:
*a* (100, $i\text{-}\bar{\imath}$, k)
*b* (010, $i\text{-}\grave{\imath}$, M)
*c* (001, *O*, P)
*ζ* (210, $i\text{-}\bar{2}$)[10]
*m* (110, *I*, T)
*L* (120, $i\text{-}\grave{2}$)
*z* (130, $i\text{-}\grave{3}$)
*p* (190, $i\text{-}\grave{9}$)[7]
*t* (201, $-\ 2\text{-}\bar{\imath}$)[8]
*Δ* (501, $-\ 5\text{-}\bar{\imath}$)
*q* ($\bar{2}03$, $\frac{2}{3}\text{-}\bar{\imath}$)
*C* ($\bar{5}06$, $\frac{5}{6}\text{-}\bar{\imath}$)[8]
*x* ($\bar{1}01$, $1\text{-}\bar{\imath}$)
*θ* ($\bar{1}\bar{0}{\cdot}0{\cdot}9$, $\frac{10}{9}\text{-}\bar{\imath}$)[6, 9]
*w* ($\bar{8}07$, $\frac{8}{7}\text{-}\bar{\imath}$)[9]
*l* ($\bar{7}06$, $\frac{7}{6}\text{-}\bar{\imath}$)
*Ω* ($\bar{5}04$, $\frac{5}{4}\text{-}\bar{\imath}$)[5]
*r* ($\bar{4}03$, $\frac{4}{3}\text{-}\bar{\imath}$)
*y* ($\bar{2}01$, $2\text{-}\bar{\imath}$)
*ω* (017, $\frac{1}{7}\text{-}\grave{\imath}$)[10]
*h* (023, $\frac{2}{3}\text{-}\grave{\imath}$)
*n* (021, $2\text{-}\grave{\imath}$)
*i* (061, $6\text{-}\grave{\imath}$)
*e* (111, $-\ 1$)
*g* ($\bar{1}12$, $\frac{1}{2}$)
*o* ($\bar{1}11$, 1)
*u* ($\bar{2}21$, 2)
*A* ($\bar{1}\bar{0}{\cdot}1{\cdot}9$, $\frac{10}{9}\text{-}\bar{1}\bar{0}$)[6]
*f* ($\bar{5}\bar{6}{\cdot}7{\cdot}48$, $\frac{7}{6}\text{-}\bar{8}$)
*η* ($\bar{1}\bar{0}{\cdot}8{\cdot}1$, $10\text{-}\frac{5}{4}$)[5, 11]
*B* ($\bar{1}\bar{2}{\cdot}10{\cdot}1$, $12\text{-}\frac{6}{5}$)[8]
*d* (241, $-\ 4\text{-}2$)
*v* ($\bar{2}41$, $4\text{-}\grave{2}$)
*s* ($\bar{1}31$, $3\text{-}\grave{3}$)
*E* ($\bar{2}61$, $6\text{-}\grave{3}$)[7]
*σ* ($\bar{1}51$, $5\text{-}\grave{5}$)

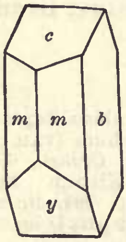
Many planes with abnormal indices have been noted, especially on adularia, also others of doubtful character. Of these "vicinal planes" Websky[8] describes a large number, and others have been added by Becker[4], Koksharov (l. c.), Des Cloizeaux[6], Cathrein[9, 10], Hamberg[19], Zepharovich[13].

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *mm‴* | = | *61° 13′ | *cy* | = | 80° 18′ | *co* | = | 55° 14½′ | *bo* | = | *63° 8′ 19″ |
| *LL′* | = | 80° 24½′ | *hh′* | = | 36° 48′ | *cu* | = | 81° 52′ | *uu′* | = | 65° 58′ |
| *zz′* | = | 58° 48′ | *nn′* | = | 89° 53′ | *cd* | = | 55° 13′ | *dd′* | = | 81° 42′ |
| *ct* | = | 41° 2′ | *ii′* | = | 143° 3½′ | *cv* | = | 84° 6′ | *vv′* | = | 104° 47′ |
| *cq* | = | 33° 53′ | *ce* | = | 33° 30′ | *ee′* | = | 35° 21′ | *σσ′* | = | 115° 46′ |
| *cx* | = | 50° 16½′ | *cm* | = | *67° 47′ 20″ | *gg′* | = | 31° 2′ | *m′y* | = | 45° 42′ |
| *cr* | = | 63° 23′ | *cg* | = | 29° 6′ | *oo′* | = | 53° 43′ | *m′x* | = | 69° 19′ |

Strüver has deduced for sanidine, in part from his own, in part from Rath's angles, the following axial ratios:

| | à : b̄ : c̍ | β |
|---|---|---|
| Laach | 0·64925 : 1 : 0·5517 | 63° 54′ |
| Latium | 0·6562 : 1 : 0·5522 | 63° 57′ |
| Vesuvius | 0·6538 : 1 : 0·5526 | 64° 7′ |

1.



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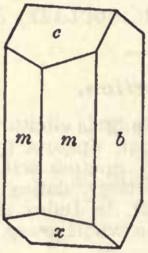

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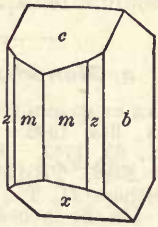
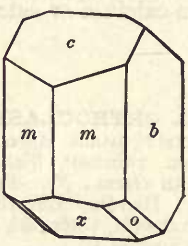


4.



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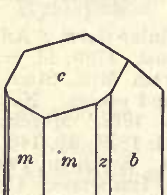

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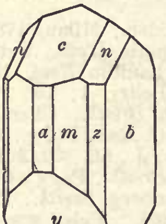

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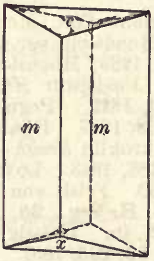

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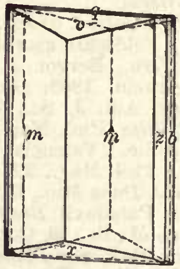


Figs. 1–5. Simple forms. 6, *Loxoclase*, Hammond, N. Y. 7, 8, *Adularia*, Brown.

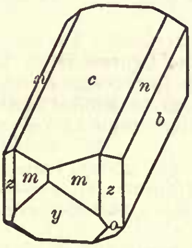
Twins: tw. pl. (1) *a*, or tw. axis c̍, the common *Carlsbad* twins, either of irregular penetration (f. 11) or contact type; the latter usually with *b* as composition-face, often then (f. 10) with *c* and $\underline{x}$ nearly in a plane, but to be distinguished by luster, etc.; also rarely united by *a*. (2) *n* (021), the *Baveno* twins forming nearly square prisms (f. 13, 14), since $cn = 44° 56\frac{1}{2}'$ and hence $c\underline{c} = 89° 53'$; often repeated as fourlings (f. 15), also in square prisms, elongated ‖ à. (3) *c*, the *Manebach* twins (f. 12), usually contact-twins with *c* as comp.-face. Less common than these, and usually of the penetration and cruciform type, often of Carlsbad twins: (4) *m*; (5) *z* (130); (6) $\bar{1}02$?; (7) *y* $(\bar{2}01)$; (8) 051; (9) *o* (111); (10) 454; (11) 2·5·15. Some of these apparent twins may be simply accidental groupings, analogous to those common with quartz.

Crystals often prismatic ‖ c̍; sometimes orthorhombic in aspect (f. 2, 7) since *c* and *x* are inclined at nearly equal angles to c̍; also elongated ‖ à (f. 9) with *b* and *c* nearly equally developed; also thin tabular ‖ *b*; rarely tabular ‖ *a*, a face not often observed. Faces $c$, $x$ often horizontally striated and united in oscillatory combination, forming flat or rounded summits. Faces $x$ often rough and thus distinguished from $c$ in twins (f. 10). Vicinal forms common, especially with adularia.

Often massive, coarsely cleavable to granular; sometimes lamellar. Also compact crypto-crystalline, and flint-like or jasper-like.

Cleavage: $c$ perfect; $b$ somewhat less so; prismatic $m$ imperfect, but usually more distinct parallel to one prismatic face than to the other. Parting[15] sometimes distinct parallel to $a$ (100), also to a hemi-orthodome $\varDelta$ ($\bar{7}01$, or $\bar{8}01$), inclined a few degrees to the orthopinacoid ($c\varDelta = 73°$ to $74°$); this may produce a satin-like luster or schiller, the latter also often present when the parting is not distinct. This parting and the schiller may be secondary in origin. Fracture conchoidal to uneven. Brittle. H. = 6–6·5. G. = 2·5–2·62. Luster vitreous; on a cleavage-surface ($c$) often pearly. Colorless, white, pale yellow and flesh-red common, gray; rarely green. Streak uncolored.

9.



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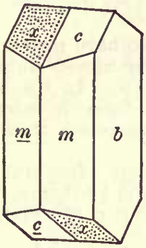

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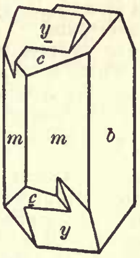

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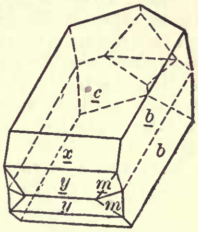

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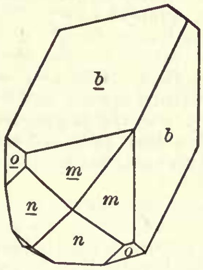
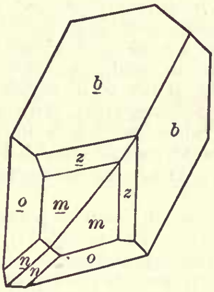
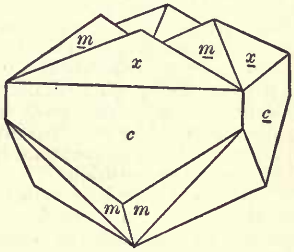


14.



15.



10, 11, Carlsbad twins. 12, Manebach twin, Sbk. 13, 14, Baveno twins, Brown.
15, Do., fourling, Hbg.

Optically negative ($Bx_a = \mathfrak{a}$) in all cases. Ax. pl. usually $\perp b$, sometimes $\parallel b$, also changing from the former to the latter on increase of temperature (see below). For *adularia* (Dx.) $Bx_{a.r} \wedge \grave{c} = -69° 11'$, $Bx_{a.bl} \wedge \grave{c} = -69° 37'$. Hence $Bx_a$ and the extinction-direction (cf. f. 3, p. 326) inclined a few degrees only to $\grave{a}$, or the edge $b/c$; thus $+3°$ to $+7°$ usually, or up to $+10°$ or $+12°$ (in varieties rich in $Na_2O$) according to Rosenbusch. Dispersion $\rho > v$; also horizontal, strongly marked, or inclined, according to position of ax. pl. Axial angles variable. Indices and axial angles at 18° C., Dx.:

*Adularia:*

No. 1 $\alpha_y = 1·5190$ $\beta_y = 1·5237$ $\gamma_y = 1·5260$ $\therefore$ $2V_y = 69° 43'$ $2E_y = 121°$ 6,
Also measured $2E_r = 120° 22'$, $2E_y = 120° 12'$, $2E_{bl} = 118° 37'$

No. 2 $\alpha_y = 1·5181$ $\beta_y = 1·5223$ $\gamma_y = 1·5243$ $\therefore$ $2V_y = 69° 1'$ $2E_y = 119°$ 11,
Measured $2Er_r = 120° 42'$, $2E_y = 129° 46'$, $2E_{bl} = 118° 18'$

*Sanidine*, Wehr, ax. pl. $\perp$ *b* for red rays:

$$\alpha_r = 1{\cdot}5170 \quad \beta_r = 1{\cdot}5239 \quad \gamma_r = 1{\cdot}5240 \quad \therefore \quad 2V_r = 13^\circ\, 34' \quad 2E_r = 20^\circ\, 45$$

Same, ax. pl. $\parallel$ *b* for blue rays:

$$\alpha_{bl} = 1{\cdot}5265 \quad \beta_{bl} = 1{\cdot}5355 \quad \gamma_{bl} = 1{\cdot}5356 \quad \therefore \quad 2V_{bl} = 11^\circ\, 51' \quad 2E_{bl} = 18^\circ\, 14'$$

Increase of temperature diminishes the axial angle when the ax. pl. is $\perp$ *b*, but increases it when $\parallel$ *b*. In the former case the angles for the different colors successively become 0° and the ax. pl. changes to the second position. If the temperature is maintained as high as 600° to 1000° the change becomes permanent. Cf. Dx., Weiss.[16] Pressure produces a like change.

**Comp., Var.**—A silicate of aluminium and potassium, $KAlSi_3O_8$ or $K_2O.Al_2O_3.6SiO_2$ = Silica 64·7, alumina 18·4, potash 16·9 = 100. Sodium is often also present, replacing part of the potassium.

The prominent varieties depend upon crystalline habit and method of occurrence more than upon difference of composition.

1. *Adularia.* The pure or nearly pure potassium silicate. Usually in crystals, like f. 7, 8 in habit; often with vicinal planes, especially on the Baveno twins, which are very common with this variety. G. = 2·565 Tsch. Transparent or nearly so. Often with a pearly opalescent reflection or schiller $\parallel$ *a* or *Δ*; sometimes with a delicate play of colors; some *moonstone* (Hecatolite *Delameth.*, T. T., 2, 201, from *ἑκάτη, the moon*) is here included, but the remainder belongs to albite or other of the triclinic feldspars.

The original adularia (Adular) is from the St. Gothard region in Switzerland. The name is derived from the Adular Mts., which term as used by Strabo embraced the Central High Alps, including the Gothard region and the Adular Mts., etc. In the latter, in the present restricted sense, the adularia is not found (Kenngott). The name is extended also to similar varieties from other points in the Alps and elsewhere. *Valencianite*, from the silver mine of Valencia, Mexico, is adularia.

2. *Sanidine* or *glassy feldspar.* Occurs in crystals, often transparent and glassy, embedded in lava, trachyte, phonolyte, etc. Habit often tabular $\parallel$ *b* (hence named from *σανίς*, a *tablet*, or *board*); also in square prisms (*b*, *c*); Carlsbad twins very common. Most varieties contain sodium as a prominent constituent. Cf. anal. 5–10.

*Rhyacolite. Eisspath* Werner. Occurs in glassy crystals at Monte Somma; named from *ρύαξ*, *stream* (lava stream), and *λίθος*, *stone;* anal. 11.

3. *Ordinary.* In crystals (f. 1–6, and f. 10) Carlsbad and other twins common; also massive or cleavable, varying in color from white to pale yellow, red, or green, translucent; sometimes aventurine. Here belongs the common feldspar of granitoid rocks or granite veins. Usually contains a greater or less percentage of soda (soda-orthoclase, Natronorthoklas *Germ.*, cf. anal. 22, 23). Compact crypto-crystalline orthoclase makes up the mass of much felsite, but to a greater or less degree admixed with quartz; it occurs of various colors, from white and brown to deep red. There are two kinds: (*a*) the *jasper-like*, with a subvitreous luster; and (*b*) the *ceratoid* or *wax-like*, with a waxy luster. Some red kinds look closely like red jasper, but are easily distinguished by the fusibility. *Leelite*, named after J. F. Lee, is a deep flesh-red variety, of waxy luster, from Grythyttan, Sweden. Other felsites contain soda and approximate to albite or oligoclase in composition.

Much of what has been called orthoclase, or common potash feldspar, has proved to belong to the related triclinic species, microcline. Cf. p. 323 on the relations of the two species. Chesterlite and Amazonite or Amazon stone, are microcline; also most aventurine orthoclase.

The following names belong to more or less distinctly characterized varieties of common orthoclase:

*Loxoclase.* Contains sodium in considerable amount (anal. 21). In grayish white or yellowish crystals (f. 6), a little pearly or greasy in luster, feebly shining, often large, lengthened usually in the direction of the clinodiagonal. From Hammond, St. Lawrence Co., N. Y. Named from *λοξός*, *transverse*, and *κλασις*, *fracture*, under the idea that the crystals are peculiar in having cleavage parallel to the orthodiagonal section.

*Paradoxite* Breith. is a flesh-red feldspar from the tin mines near Marienberg. *Cottaite* Breith. is a grayish white feldspar in twins from Carlsbad, Bohemia. *Muldan* is from Mulda near Freiberg. *Pegmatolite* Breith. is common feldspar.

*Erythrite* Thomson. A flesh-red variety from near Kilpatrick.

*Necronite.* A cleavable feldspar, fetid in odor when struck. The original was found by Hayden near the York and Lancaster road, 21 m. from Baltimore, in granular limestone, and was whitish or bluish in color. Named from *νεκρός*, *a corpse.*

*Lazurfeldspar* (Lasurfeldspath *Germ.*). A feldspar having H. = 6, and G. = 2·597, has the cleavage of orthoclase, found near Lake Baikal with lapis lazuli.

*Perthite.* A flesh-red aventurine feldspar, consisting of interlaminated albite and orthoclase. From Perth, Quebec. See further p. 321.

*Murchisonite.* A flesh-red feldspar similar to perthite, with gold-yellow reflections in a direction $\perp$ *b* and inclined 73° 13′ to *c* (Dx.), hence nearly parallel to $\bar{7}01$ or $\bar{8}01$ (see cryptoperthite, p. 321). Stated to have also an unusual cleavage direction besides the two observed. From Dawlish and Exeter, England. Named after its discoverer, Murchison the geologist.

*Weissigite* Jenzsch. In small whitish or reddish white twin crystals, from the cavities of amygdaloid at Weissig near Dresden; G. = 2·538–2·546. I. Lea has named (Proc. Ac. Philad., May, 1866) a greenish orthoclase from Lenni, Delaware Co., Pa., "almost without cleavage," *lennilite;* other specimens of the same locality, pearly and distinctly cleavable, *delawarite;* and a dull bluish-green subtransparent kind, of an aventurine character, from Blue Hill, 2 m. N. of Media, Pa., *cassinite* (see p. 322).

**Anal.**—1, Abich, Pogg., **51**, 528, 1840. 2, Tschermak, Ber. Ak. Wien, **50** (1), 577, 1865. 3, Abich, l. c. 4. Plattner, Pogg., **46**, 299, 1839. 5, Lewinstein, J. pr. Ch., **68**, 98, 1856. 6, Rg., Min. Ch., 1003, 1860. 7, Lewinstein, l. c. 8, 9, Rath, Pogg., **135**, 561, 564, 1868. 10, O. H. Drake, priv. contr. 11. Tschermak, l. c. 12, Redner, Zs. G. Ges., **18**, 394, 1866. 13, Kloos, Jb. Min., **2**, 106, 1884, after deducting apatite 0·26 p. c., and ignition. 14, Id., ibid., p. 109. 15, Rath, Zs. G. Ges., **22**, 652, 1870. 16–19, Id., Pogg., **144**, 376–382, 1871. 20, Genth, Am. Phil. Soc., **23**, 43, 1885. 21, Ludwig, quoted by Tschermak, l. c. 22, 23, Foerstner, Zs. Kr., **8**, 128, 1883.

| | G. | $SiO_2$ | $Al_2O_3$ | CaO | $K_2O$ | $Na_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. St. Gothard, *Adularia* | 2·576 | 65·69 | 17·97 | 1·34 | 13·99 | 1·01 | $Fe_2O_3$ *tr.* = 100 |
| 2. Pfitsch, " | 2·573 | 64·5 | 18·4 | 0·3 | 14·8 | 1·3 | = 99·3 |
| 3. Baveno | 2·555 | 65·72 | 18·57 | 0·34 | 14·02 | 1·25 | $Fe_2O_3$ *tr.* = 99·90 |
| 4. Mexico, *Valencianite* | | 66·82 | 17·58 | — | 14·80 | — | $Fe_2O_3$ 0·09 = 99·29 |
| 5. Perlenhardt, *Sanidine* | | 65·26 | 17·62 | 1·05 | 11·79 | 2·49 | $Fe_2O_3$ 0·91, MgO 0·35 = 99·47 |
| 6. Drachenfels, " | 2·60 | 65·87 | 18·53 | 0·95 | 10·32 | 3·42 | MgO 0·39, ign. 0·44 = 99·92 |
| 7. Pappelsberg, " | 2·616 | 66·03 | 17·87 | 0·47 | 8·86 | 6·08 | $Fe_2O_3$ 0·52, MgO 0·19 = 100·02 |
| 8. Laach, *cryst.*, " | 2·467 | 64·59 | 18·78 | 0·50 | 11·70 | 4·29 | BaO 0·41, ign. 0·11 = 100·38 |
| 9. " " | 2·575 | 66·92 | 19·86 | — | 6·48 | 6·94 | ign. 0·07 = 100·27 |
| 10. Yellowstone | 2·57–2·59 | 65·96 | 19·68 | 0·63 | 8·31 | 4·99 | ign. 0·20 = 99·77 |
| 11. Mt. Somma, *Rhyacolite* | 2·562 | 65·2 | 19·1 | 0·4 | 14·0 | 1·6 | = 100·3 [= 100 |
| 12. Carlsbad *twins* | 2·573 | 63·02 | 18·28 | — | 15·67 | 2·41 | BaO 0·48, MgO 0·14 |
| 13. Bodenmais | 2·588 | 64·59 | 19·60 | 0·82 | 11·80 | 2·90 | BaO 0·29 = 100 |
| 14. " | | 64·17 | 19·27 | 0·66 | 12·04 | 1·98 | BaO 0·10, ign. 0·44 |
| 15. San Piero, Elba | | 64·64 | 19·40 | — | 11·95 | 3·40 | = 99·39 [= 98·66 |
| 16. Pargas | 2·576 | 64·96 | 19·40 | 0·49 | 12·80 | 2·32 | MgO 0·25 = 100·22 |
| 17. Laurvik | 2·619 | 62·81 | 23·21 | 2·60 | 4·23 | 7·54 | MgO 0·07 = 100·46 |
| 18. Monzoni | 2·565 | 63·36 | 21·18 | 1·66 | [8·89] | 4·91 | = 100 |
| 19. Bolton, Mass. | 2·586 | 65·23 | 19·26 | 0·42 | 11·80 | 2·98 | = 99·69 [= 100·62 |
| 20. French Creek, Penn. | 2·528 | 62·68 | 20·90 | 0·15 | 15·99 | — | $Fe_2O_3$ 0·23, ign. 0·67 |
| 21. Hammond, N. Y., *Loxoclase* | 2·616 | 66·28 | 20·26 | 0·99 | 4·57 | 7·56 | MgO 0·22 = 99·88 |
| 22. Pantelleria, Bagno d'acqua | 2·59 | 66·06 | 19·24 | 1·11 | 5·45 | 7·63 | FeO 0·54, MgO 0·11 = 100·14 |
| 23. " Cala Porticello | 2·58 | 66·03 | 19·37 | 0·73 | 5·40 | 7·57 | $Fe_2O_3$ 1·53, MgO 0·02 = 100·65 |

**Pyr., etc.**—B.B. fuses at 5; varieties containing much soda are more fusible. Loxoclase fuses at 4. Not acted upon by acids.

**Obs.**—Orthoclase in its several varieties belongs especially to the crystalline rocks, occurring as an essential constituent of granite, gneiss, syenite, also porphyry, further (var., *sanidine*) trachyte, phonolyte, etc. In the massive granitoid rocks it is seldom in distinct, well formed, separable crystals, except in veins and cavities; such crystals are more common, however, in volcanic rocks like trachyte.

*Adularia* occurs in the crystalline rocks of the central and eastern Alps, associated with smoky quartz and albite, also titanite, apatite, etc.; the crystals are often coated with chlorite. Thus in the St. Gothard region, especially on Mt. Fibia; also the Maderanerthal in Uri, Kreuzlithal and Tavetschthal, Lukmanier in Grisons, Guttanen in the Bernese Oberland (cf. Kenng., Min. Schweiz, pp. 45–75). Further in the Eastern Alps, as at Schwarzenstein in the Zillerthal. Also in crevices in trachyte at Felsöbánya. On Elba. Fine crystals of orthoclase, often twins, are obtained from Baveno, Lago Maggiore; the Fleimsthal, a red variety; Valfloriana; Bodenmais, Carlsbad and Elbogen in Bohemia; Striegau, Hirschberg, and Lomnitz in Silesia. Also Ekaterinburg in the Ural; Albaschka near Mursinka; Arendal in Norway, and near Shaitansk in the Ural; Land's End and St. Agnes in Cornwall; at Rubislaw in Aberdeenshire, Scotland. The Mourne Mts., Ireland, with beryl and topaz. Tamagama Yama, Japan, with topaz and smoky quartz. *Moonstone* is brought from Ceylon.

Typical *sanidine* is prominent in the trachyte of the Drachenfels on the Rhine; at the Laacher See. *Rhyacolite* occurs in blocks on Mt. Somma and in the Albani Mts.; in Latium near Rome; in the lavas of Ischia; near Naples.

In the U. States, orthoclase in crystals occurs in *Maine*, on the island Mt. Desert, fine green;

at the tourmaline locality, Paris; at Buckfield. In *N. Hamp.*, at the Acworth beryl locality. In *Mass.*, at South Royalston and Barre, often large crystals; at Three Rivers, in Palmer. In *Conn.*, at the gneiss quarries of Haddam and the feldspar quarries of Middletown, crystals a foot long, and 6 or 8 in. thick; near Bradleysville, in the western part of Litchfield, crystals 2–3 in. long, abundant; at Willimantic. In *N. York*, in St. Lawrence Co., at Rossie, 2 m. N. of Oxbow, the crystals are white or bluish white, and sometimes an inch across; also 8 m. from Potsdam, on the road to Pierrepont, where crystals a foot through are said to have been found; and near DeLong's mills in the town of Hammond, with apatite and zircon, where the *loxoclase* is obtained; in Lewis Co., orthoclase occurs both crystallized and massive in white limestone near Natural Bridge, with scapolite and titanite; in Orange Co., crystals near West Point; more abundant and interesting forms are found at Rocky Hill, in Warwick, with tourmaline and zircon; and at Amity and Edenville; in Saratoga Co., at the Greenfield chrysoberyl locality, white translucent crystals, usually coated with silvery mica. In *Penn.*, in crystals at Leiperville, Mineral Hill, Delaware Co.; sunstone in Kennett Township; French Creek, a peculiar variety with divergent columnar structure of a reddish color (anal. 20). In *N. Car.*, at Washington Mine, Davidson Co., in white and yellowish crystals. At the Superior mine, Ontonagon, Lake Superior, in small reddish crystals, as a secondary product, in cavities in amygdaloid with epidote. In *Colorado*, at the summit of Mt. Antero, Chaffee Co., in fine crystals, often Carlsbad and Baveno twins, with beryl, phenacite, bertrandite, etc.; at Gunnison; Black Hawk; Kokoma, Summit Co., also at other points. Also similarly in Nevada and California.

Orthoclase as a secondary mineral in cavities in a basaltic rock, with calcite and phillipsite at Eulenberg, Bohemia, was described by Zepharovich, Ber. Ak. Wien, **91** (1), 158, 1885. Gränzer has further studied the same occurrence, and finds the mineral to deviate somewhat (but probably not essentially) from normal orthoclase; thus the composition $(H,K)AlSi_3O_8$ is assigned to it, with H : K = 1 : 8, Min. Mitth., **11**, 277, 1890.

**Alt.**—Feldspar may be altered through infiltrating waters carrying more or less carbon dioxide in solution (Forchhammer, Fournet, Bischof); also through the action of waters rendered acid by the decomposition of sulphides (Mitscherlich); also by ordinary waters holding traces of alkaline and other ingredients in solution (Bischof).

The presence of iron sulphide, or a mineral containing iron protoxide, as some mica, garnet, etc., is often the first occasion of the change. The decomposition of the mineral with the attendant oxidation of the iron distributes ferruginous waters through the rock (or ferrous sulphate from the altered sulphide), and thus, by a decomposing action, prepares the way for other agencies.

When the infiltrating waters contain traces of carbon dioxide, the feldspar acted on first loses its lime, if a lime feldspar, by a combination of the lime with this acid; next, its alkalies are carried off as carbonates, if the supply of carbonic acid continues, or otherwise as silicates in solution. The change thus going on ends in forming *kaolin* or some other aluminous silicate. The carbonate of soda or potash, or the silicate of these bases, set free, may go to the formation of other minerals—the production of pseudomorphic or metamorphic changes—and the supplying fresh and marine waters with their saline ingredients. When the change is not carried on to the exclusion of the protoxide bases, certain zeolites may result, especially, as Bischof states, when labradorite is the feldspar undergoing alteration, which species he describes as giving origin to the species mesolite. Massive nephelite or elæolite is a still more common source of zeolites. When the waters contain traces of a magnesian salt—a bicarbonate or silicate—the magnesia may replace the lime or soda, and so lead to a steatitic change, or to a talc when the alumina is excluded; and when augite or hornblende is present, it may give origin to chlorite. The action of sulphurous acid from volcanic fumaroles produces often a complete destruction of the feldspar and other minerals present, giving rise to deposits or incrustations of silica, in some of its various forms, and also halloysite, kaolin, etc.

Steatite, talc, chlorite, kaolin, lithomarge, mica, laumontite, occur as pseudomorphs after orthoclase or albite; and cassiterite and calcite often replace these feldspars by some process of solution and substitution. Labradorite more rarely forms kaolin. The triclinic lime-soda feldspars are sometimes altered to saussurite (wh. see); also to scapolite, cf. Judd, Min. Mag., **8**, 186, 1889.

On pseudomorphs of orthoclase after leucite, see E. Scacchi, Rend. Acc. Napoli, Dec. 1884. Sauer, Zs. G. Ges., **37**, 456, 1885.

**Artif.**—Artificial feldspar has been observed in crystals in furnace scoria at Mansfeld, Sangerhausen, near Laimbach and near Stolberg.

Obtained by Hautefeuille in distinct crystals with tridymite by heating at a temperature of 900° to 1000° a mixture of tungstic acid with an alkaline silico-aluminate of potash; also with quartz at a lower temperature after the addition of an alkaline fluoride, C. R., **85**, 952, 1877, **90**, 830, 1880. Again by Friedel and Sarasin in the wet way by the reaction of the silicates of alumina and potash and water under pressure, Bull. Soc. Min., **2**, 158, 1879, **4**, 171, 1881. Cf. also Fouqué and Lévy, C. R., **87**, 700, 830, 1878, and Synth. Min., p. 132, 1882.

**Ref.**—[1] Min. Russl., **5**, 115, 1866; cf. measurements by Rath on sanidine and adularia, Pogg., **135**, 454, 1868, and later Strüver on sanidine, Zs. Kr., **1**, 243, 1877. A comparison of results is given by Kk., Min. Russl., **5**, 329, also **9**, 252, 1886.

[2] Cf. Mlr., Min., 364, 1852; Dx., Min., **1**, 328 1862, **2**, xxxv, 1874; Kk., l. c.; Gdt, Index, **2**, 11, 1888. See also the following: Weiss, Abh. Ak. Berlin, 231, 1816–17, 145, 1820–21. Rose, Gilb. Ann., **73**, 181, 1823, Pogg., **15**, 193, 1829. Kupffer (early measurements), Pogg.,

**13**, 209. 1828. Hbg., Min. Not., **2**, 6, 1858. Rath, Pogg., **113**, 425, 1861, **135**, 454, 1868, **158**, 400, 1876.

[3] Websky, Zs. G. Ges., **15**, 677, 1863. [4] Becker, Inaug. Diss., Breslau, 1868. [5] Achiardi, Elba, Nuovo Cimento, **3**, Feb., 1870. [6] Dx., also $\beta$ ($\bar{2}\bar{9}\cdot27\cdot1$), l. c., and Zs. Kr., **11**, 605, 1886. [7] Cathrein, Valfloriana, Zs. Kr., **9**, 368, 1884. [8] Id., St. Gothard, Elba, ~~Zs. Kr.~~, **11**, 113, 1885. [9] Id., Schwarzenstein, he gives also $\epsilon$ (950), $\eta$ (850), $\lambda$ (750), $j$ (280·0·1), $\alpha$ ($\bar{6}\bar{3}\cdot7\cdot60$), Zs. Kr., **13**, 332, 1887. [10] Id., Schwarzenstein, also $\kappa$ ($\bar{3}\bar{9}\cdot0\cdot38$), Min. Mitth., **10**, 59, 1888. [11] Solly, Elba, Zs. Kr., **10**, 524. [12] Hamberg, adular, new forms and corrosion phenomena, $v$ ($\bar{1}5\cdot0\cdot13$), $\sigma$ (11·4·9), $\tau$ ($\bar{1}\bar{8}\cdot2\cdot19$), Ak. H. Stockh., Bihang, **13** (2), No. 4, 1888. [13] Ber. Ak. Wien, **98** (1), 404, 1889.

[14] On *twins*, see the following:

Weiss, Carlsbad twins, Schweigg. J., **10**, 223, 1814. Naumann, law 5, Kryst., **2**, 343, 1830. Breith., law 9, B. & H. Ztg., **17**, 1858. Blum, who names the Manebach twins, Jb. Min., 343, 1863. Lasp., laws 4, 8, 10, Zs. Kr., **1**, 204, 1877. Haushofer, law 6, Zs. Kr., **3**, 601, 1879; also 11 ib., **9**, 93, Ber. Ak. München, 641, 1882. Klockmann, law 7, Zs. Kr., **6**, 318, 493, 1882 Gonnard, Four la-Brouque twins (= Manebach), Bull. Soc. Min., **6**, 265, 1883, **8**, 307, 1885 Tschermak describes a group, which if not accidental has the normal to the edge *c*/*m* as tw axis, Min. Mitth., **8**, 414, 1887.

[15] On the *schiller*, or pearly opalescence observed in many varieties, see Reusch, Pogg., **116** 392, 1862, **118**, 256, 1863, **120**, 95, 1863; Dx., Min., **1**, 1862; Rath, Pogg., **135**, 480, 1868; Cross, Am. J. Sc., **27**, 94, 1884. See further Iddings under anorthoclase (p. 324) and Brögger under cryptoperthite, below.

[16] *Refractive indices* and optical phenomena: Heusser, Pogg., **91**, 514, 1854; Dx., Min., **1**, 332, 1862, N. R., 152, 1867, also references under microcline; Ch. E. Weiss, Beitr. z. Kenntniss d. Feldspathbildung, Haarlem, 1866. *Thermal expansion*, Beckenkamp, Zs. Kr., **5**, 452, 1881. *Pyroelectricity*, Hankel, Wied., **1**, 280, 1877.

Perthite *Thomson*, Phil. Mag., **22**, 189, 1843. A flesh-red aventurine feldspar from Perth, Quebec, Canada, called a soda-orthoclase, but shown by Gerhard (Zs. G. Ges., **14**, 151, 1862) to consist of interlaminated orthoclase and albite. Many similar occurrences have since been noted, as also those in which microcline and albite are similarly interlaminated, then called *microcline-perthite*, or microcline-albite-perthite; this is true in part of the original perthite. When the structure is discernible only with the help of the microscope it is called microperthite. See Mann, Jb. Min., 389, 1879; also Kloos, ib., **2**, 89, 1884; Woitschach, Zs. Kr., **7**, 82, 1883.

Brögger has investigated not only the microperthites of Norway (Orthoklasmikroperthit, Mikroklinmikroperthit) but also other feldspars characterized by a marked schiller; he assumes the existence of an extremely fine interlamination of albite and orthoclase ∥ $\bar{8}$01. not discernible by the microscope (cryptoperthite, Kryptoperthit) and connected with secondary planes of parting ∥ 100 or ∥ $\bar{8}$01, which is probably to be explained as due to incipient alteration. See further Zs. Kr., **16**, 524, 1890.

Krablite *Forchhammer*, 1842. Baulite. Kraflit *Flink*, Öfv. Ak. Stockh, Bihang., **12** (2), No. 2, 64, 1886. Described as a kind of feldspar, very high in silica, but shown by Brögger and Flink to be a liparyte, containing well formed crystals of orthoclase enclosing a plagioclase kernel, also quartz, etc. Flink calculates for the orthoclase: $\grave{a} : \bar{b} : \grave{c} = 0\cdot64374 . 1 : 0\cdot55079$; $\beta = 63° 52'$. From Krabla (Krafla), Iceland. See 5th Ed., pp. 359, 360.

## 314. HYALOPHANE. *S. von Waltershausen*, Pogg. Ann., **94**, 134, 1855; **100**, 547, 1857.

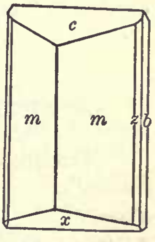
Monoclinic. Axes $\grave{a} : \overset{1}{\bar{b}} : \grave{c} = 0\cdot6584 : 1 : 0\cdot5512$ ; $\beta = 64° 25\frac{1}{4}' = 001 \wedge 100$ Obermayer[1].

$100 \wedge 110 = 30° 42\frac{1}{4}'$, $001 \wedge \bar{1}01 = 49° 47'$, $001 \wedge 011 = 26° 26\frac{1}{6}'$.

**Forms**[2]: *a* (100, $i$-$\bar{\imath}$)[4], *b* (010, $i$-$\grave{\imath}$), *c* (001, *O*); *m* (110, *I*), *z* (130, $i$-$\grave{3}$)[1]; *x* ($\bar{1}$01, 1-$\bar{\imath}$), $\omega$ ($\bar{3}$02, $\frac{3}{2}$-$\bar{\imath}$)[4]; *p* ($\bar{1}$11, 1)[3,4]; $\psi$ ($\bar{1}$41, 4-$\grave{4}$)[4].

Also probable, Rinne[4]: $\delta$ ($\bar{1}$03), $\phi$ ($\bar{1}$02), $\lambda$ ($\bar{6}$05), $\iota$ (113, $-\frac{1}{3}$), $\rho$ ($\bar{1}$13, $\frac{1}{3}$), $\alpha$ ($\bar{1}$12), $\epsilon$ ($\bar{7}$75, $\frac{7}{5}$); and Kenng.[3]: *q* ($\bar{2}$03), *y* ($\bar{2}$01).

$mm''' = {}^*61° 24\frac{1}{2}'$ $c\omega = 67° 59\frac{1}{2}'$ $c\psi = 73° 17\frac{1}{2}'$ $\psi\psi' = 127° 7'$
$zz' = 58° 37'$ $cp = 54° 46'$ $a'p = 68° 31'$ $m'x = {}^*69° 21\frac{1}{2}'$
$cx = 49° 47'$ $cm' = {}^*111° 47\frac{1}{2}'$ $pp' = 53° 23'$



Binnenthal, Obermayer.

In crystals, like adularia in habit. Also massive.

Cleavage: *c* perfect; *b* somewhat less so. Fracture conchoidal. Brittle. H. = 6–6·5. G. = 2·805. Luster vitreous. Colorless to white; also flesh-red. Transparent to translucent.

Optically −. Ax. pl. and $Bx_o \perp b$. $Bx_a \wedge \grave{c} = -69° 25'$, i.e. extinction on *b* inclined about + 5° or 6° to edge *b/c*. Dispersion horizontal, distinct. Axial angles, Rinne:

$2H_{a.r} = 83° 50'$ $2H_{o.r} = 107° 17'$ $\therefore 2V_r = 79° 21'$ $\beta_r = 1·5388$ Li
$2H_{a.y} = 83° 25'$ $2H_{o.y} = 107° 30'$ $\therefore 2V_y = 79° 3'$ $\beta_y = 1·5392$ Na
$2H_{a.gr} = 83° 2'$ $2H_{o.gr} = 107° 52'$ $\therefore 2V_{gr} = 78° 42'$ $\beta_{gr} = 1·5416$ Tl

**Comp.**—A silicate of aluminium, barium, and potassium, $(K_2,Ba)Al_2Si_4O_{12}$ or $K_2O.BaO.2Al_2O_3.8SiO_2$. This is usually written $BaAl_2Si_2O_8.2KAlSi_3O_8$, or a barium silicate analogous to anorthite with orthoclase. This requires: Silica 51·6, alumina 21·9, baryta 16·4, potash 10·1 = 100.

**Anal.**—1, Stockar-Escher, Kenng. Ueb., 107, 1856–57; also Uhrlaub, Pogg., **100**, 548, 1857. 2, Petersen, Jb. Min., 102, 1867. 3, Igelström, Öfv. Ak. Stockh., **24**, 15, 1867. 4, Id., Bull. Soc. Min., **6**, 139, 1883.

| | $SiO_2$ | $Al_2O_3$ | BaO | CaO | $K_2O$ | $Na_2O$ | ign. | MgO | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Binnenthal G. = 2·801 | $\frac{2}{2}$ 52·67 | 21·12 | 15·05 | 0·46 | 7·82 | 2·14 | 0·58 | 0·04 | = 99·88 |
| 2. " | 51·84 | 22·08 | 14·82 | 0·65 | [10·03] | | 0·48 | 0·10 | = 100 |
| 3. Jakobsberg | 51·14 | 22·86 | 9·56 | 4·28 | [9·06] | | — | 3·10 | = 100 |
| 4. " | 53·53 | 23·33 | 7·30 | — | 11·71 | — | — | 3·23 | = 99·10 |

**Pyr., etc.**—B.B. fuses with difficulty to a blebby glass. Unacted upon by acids.

**Obs.**—Occurs in a granular dolomite, along with white barite, greenish tourmaline, mica, realgar, dufrenoysite, and sphalerite, near Imfeld, in the Binnenthal in the Valais, in crystals 2 or 3 lines long, and rarely larger; also at the manganese mine of Jakobsberg in Wermland, Sweden, in limestone with a manganiferous epidote, in part looking much like common flesh-red orthoclase, also in bluish green varieties. A massive feldspar accompanies it, containing only 3·50 p. c. BaO, Igelström.

**Ref.**—[1] Zs. Kr., **7**, 64, 1882. [2] Cf. Waltershausen, l. c. [3] Min. Schweiz, p. 86, 1866. [4] Rinne, Jb. Min., **1**, 207, 1884.

The following are analyses of other BARIUM FELDSPARS, more or less fully investigated: 1, Knop, Jb. Min., 687, 1865; a monoclinic feldspar in the nephelite-doleryte of Meiches in the Vogelsberg. 2, Pisani, Bull. Soc. Min., **1**, 84, 1878; a feldspar of unknown source; optically it lies between oligoclase and albite, cleavage angle *bc* = 86° 37', Dx. 3, Genth, Proc. Ac. Philad., p. 110, 1866, Rep. Min., Penn., 224, 1876. 4, Sperry, Am. J. Sc., **36**, 326, 1888; cassinite of Lea from Blue Hill, Delaware Co., Penn.; shown by Penfield to be a monoclinic feldspar (extinction on *b* = + 6°) with albite running through it in thin tapering plates parallel to the orthopinacoid. The analysis corresponds to 35 p. c. albite, 51 p. c. orthoclase, and 13 p. c. of $BaAl_2Si_4O_{12}$. 5, 6, Igelström, G. För. Förh., **10**, 416, 1888; a cleavable feldspar from the Sjö mine, Grythyttan, Örebro, Sweden.

Mitscherlich also mentions finding 0·45 p. c. BaO in adularia, and small amounts (to 2·23) in other feldspars, J. pr. Ch., **81**, 113, 1860; cf. anals. 8, 12, 13, 14, under orthoclase.

| | G. | $SiO_2$ | $Al_2O_3$ | BaO | CaO | $K_2O$ | $Na_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Vogelsberg | | 59·69 | 21·04 | 2·27 | 0·95 | 8·61 | 6·55 | SrO 0·36, FeO 2·27 = 101·74 |
| 2. | 2·835 | 55·10 | 23·20 | 7·30 | 1·83 | 0·83 | 7·45 | MgO 0·56, $Fe_2O_3$ 0·45, ign. 3·72 [= 100·44 |
| 3. *Cassinite* | 2·692 | $\frac{3}{3}$ 62·60 | 19·97 | 3·71 | 0·19 | 8·95 | 4·31 | $Fe_2O_3$ 0·12, ign. 0·19 = 100·04 |
| 4. " | | 62·95 | 19·82 | 3·95 | 0·25 | 8·57 | 4·01 | $Fe_2O_3$ 0·17, ign. 0·11 = 99·83 |
| 5. Sjö mine, *red* | | 61·90 | 15·80 | 9·58 | 0·40 | [6·02] | | FeO,MnO 5·00, MgO 1·30 = 100 |
| 6. " " *white* | | 54·15 | 29·60 | 1·26 | 1·00 | [12·47] | | MgO 1·52 = 100 |

## β. *Triclinic Section.*

**315. MICROCLINE.** Mikroklin *Breith.* Schweigg. J., **60**, 324, 1830. *Des Cloizeaux*, Ann. Ch. Phys., **9**, 433, 1876.

Triclinic. Near orthoclase in angles and habit, but the angle *bc* = about 89° 30'.

**Forms**[1]:
*a* (100, *i*-$\bar{i}$, k)
*b* (010, *i*-$\breve{i}$, M)
*c* (001, *O*, P)
*m* (110, *I'*, l)
*M* (1$\bar{1}$0, '*I*, T)
*f* (130, *i*-$\breve{3}$')
*z* (1$\bar{3}$0, '*i*-$\breve{3}$)
*x* ($\bar{1}$01, ,1-$\bar{i}$,)
*ψ* ($\overline{10}$·0·9, ,$\frac{10}{9}$-$\bar{i}$,)
*y* ($\bar{2}$01, ,2-$\bar{i}$,)
*h* ($\bar{3}$01, ,3-$\bar{i}$,)
*p* ($\bar{1}$11, ,1)
*σ* ($\bar{4}$43, ,$\frac{4}{3}$)
*g* ($\bar{2}$21, ,2)
*o* ($\bar{1}\bar{1}$1, 1,)

For amazonite, Dx. (l. c.) gives, *bc* = 89° 44', *b'M* = 60° 58', *cM* = 68° 22'. For the white microcline from Leverett, Mass., *b'M* = 60° 49', *cm* = 67° 43', *cM* = 68° 43', *mM* = 61° 29'.

Klockmann[1] gives $bc = 89° 53'$, $cx = 50° 45'$, $cy = 80° 33'$. Also Schuster (N.-Z. Min., 690, 1885), $bc = 89° 25'$ to $89° 30'$; Sauer and Ussing[2], $bc = 89° 30'$, $cM = 67° 32'$, $b'M = 61°$.

Twins: like orthoclase, according to the Carlsbad, Baveno and Manebach laws. Also polysynthetic twinning according to the albite and pericline laws (p. 326) rarely absent; fine striations due to the former often observable on the basal face; the two methods together giving a double series of fine ~~lamellæ~~ nearly at right angles to each other, hence the peculiar and very characteristic grating-structure of a basal section viewed in polarized light. This structure may be in part secondary[3]. Crystals usually like ordinary orthoclase in habit. Simple crystals without twinning very rare. Also massive cleavable to granular compact.

Cleavage: *c* perfect; *b* somewhat less so; *M* sometimes distinct; *m* also sometimes distinct, but less easy. Fracture uneven. Brittle. H. = 6–6·5. G. = 2·54–2·57. Luster vitreous, on *c* sometimes pearly. Color white to pale cream-yellow, also red, green. Transparent to translucent.

Optically –. Ax. pl. nearly perpendicular (82°–83°) to *b*. $Bx_o$ inclined 15° 26' to a normal to *b*. Dispersion $\rho < v$ about $Bx_o$. Extinction-angle on *c* + 15° 30', on *b* + 5° to 6° (cf. f. 3, p. 326). Axial angles, Dx.:

$$2H_{a.r} = 88° \text{ to } 89° \qquad 2H_{o.r} = 101\tfrac{1}{2}° \text{ to } 104°$$

For the simple crystals from the pegmatyte of Gasern, Sauer and Ussing give: $bc = 89° 30'$; also extinction-angle (Na) on $c + 15° 30'$, on $b + 5° 15'$; also for a section ⊥ cleavages *c*, *b*, extinction-angle with the basal cleavage lines – 13° 48'. Axial angles, etc.:

$$2H_{a.y} = 87° 30' \qquad 2H_{o.y} = 101° 7' \qquad \gamma - \beta = 0·0032 \qquad \beta - \alpha = 0·0040$$

$$\therefore \; 2V_y = 83° 41' \qquad \alpha_y = 1·5224 \qquad \beta_y = 1·5264 \qquad \gamma_y = 1·5296$$

Also to fix the position of the planes of the axes of elasticity:

$$\mathfrak{bc} \wedge 001 = 83° 31' \qquad \mathfrak{ac} \wedge 001 = 12° 8' \qquad \mathfrak{ab} \wedge 001 = 79° 48'$$

$$\mathfrak{bc} \wedge 010 = 106° 1' \qquad \mathfrak{ac} \wedge 010 = 97° 34' \qquad \mathfrak{ab} \wedge 010 = 17° 48'$$

The essential identity of orthoclase and microcline has been urged by Mallard[4] and Michel-Lévy[4] on the ground that the properties of the former would belong to an aggregate of submicroscopic twinning lamellæ of the latter, according to the albite and pericline laws.

**Comp., Var.**—Like orthoclase, $KAlSi_3O_8$ or $K_2O.Al_2O_3.6SiO_2$ = Silica 64·7, alumina 18·4, potash 16·9 = 100. Sodium is usually present in small amount.

**Var.**—1. *Ordinary.* In crystals and cleavable masses chiefly in granitic veins, in external aspect not often to be distinguished from orthoclase. Much so-called aventurine feldspar belongs here, and this variety often encloses lamellæ of albite, as is true to a greater or less extent of most forms.

2. *Amazonstone* or *amazonite.* Bright verdigris-green. Often coated with albite crystals in parallel position.

3. *Chesterlite.* In white crystals, smooth, but feebly lustrous, implanted on dolomite in Chester Co., Penn. It contains but little soda.

**Anal.**—1–4, 6, 7, 10–12, Pisani, quoted by Dx. 5, Smith and Brush, Am. J. Sc., **16**, 42, 1853. 8, 9, Dmr., quoted by Dx. 13, Scharizer, Jb. G. Reichs., **30**, 593, 1880. 14, Oebbeke, Zs. Kr., **11**, 256, 1885. 15, 16, Beutell, Zs. Kr., **8**, 363, 1883. 17, Kloos, Jb. Min., **2**, 9, 1884. 18, Penfield, Am. J. Sc., **20**, 273, 1880. 19, F. J. Wiik, Zs. Kr., **7**, 76, 1882. Also Sauer and Ussing, l. c.; *et al.*

| | G. | $SiO_2$ | $Al_2O_3$ | $K_2O$ | $Na_2O$ | ign. | |
|---|---|---|---|---|---|---|---|
| 1. Magnet Cove, Ark. | 2·54 | 64·30 | 19·70 | 15·60 | 0·48 | 0·35 | $Fe_2O_3$ 0·74 = 101·17 |
| 2. Ural, *Amazonite* | 2·55 | 64·08 | 20·70 | 13·75 | 1·27 | 0·20 | = 100 |
| 3 Ilmen Mts., *Amazonite* | 2·562 | 64·80 | 19·60 | 13·50 | 1·56 | 0·20 | = 99·66 |
| 4. Ural | 2·54 | 65·75 | 20·90 | 13·20 | 1·60 | 0·20 | = 101·65 |
| 5. Chester, Penn., *Chesterlite* $\frac{2}{2}$ | — | 64·97 | 17·65 | 14·02 | 1·69 | 0·65 | $Fe_2O_3$ 0·50, CaO 0·61, [MgO 0·27 = 100·36 |
| 6. Mursinka, *Amazonite* | 2·576 | 65·55 | 20·30 | 13·90 | 1·66 | — | = 101·41 |
| 7. Leverett, Mass. | 2·47 | 64·97 | 21·47 | 12·20 | 1·78 | 0·81 | MgO 0·32 = 101·55 |
| 8. Broye, Saône-et-Loire | 2·548 | 64·80 | 19·90 | 12·11 | 2·10 | 0·30 | = 99·21 |
| 9. Sunganarsuk | 2·584 | 65·43 | 19·58 | 12·45 | 2·31 | — | $Fe_2O_3$ 0·35 = 100·12 |
| 10. Arendal | 2·543 | 65·40 | 18·63 | 11·75 | 3·25 | — | $Fe_2O_3$ 1·09 = 100·12 |
| 11. Sedlovatoi Is. | 2·58 | 64·70 | 19·50 | 12·90 | 3·40 | — | = 100·50 |
| 12. Mineral Hill, Penn. | 2·57 | 64·90 | 20·92 | 10·95 | 3·95 | 0·20 | $Fe_2O_3$ 0·28 = 101·20 |
| 13. Freistadt | 2·549 | 63·46 | 18·12 | 10·57 | 5·10 | 0·88 | $Fe_2O_3$ 0·97, Ca 0·92 [= 100·02 |
| 14. Forst, Tyrol | 2·57 | 65·12 | 19·56 | 12·96 | 2·16 | 0·32 | FeO 0·16. CaO 0·26, [MgO 0·09 = 100·63 |

| | G. | SiO₂ | Al₂O₃ | K₂O | Na₂O | ign. | |
|---|---|---|---|---|---|---|---|
| 15. Striegau, *cryst.* | $\frac{2}{2}$ | 64·73 | 18·60 | 14·00 | 1·92 | 0·20 | $Fe_2O_3$ 0·21, CaO 0·18 [= 99·84 |
| 16. " " | $\frac{2}{2}$ | 65·28 | 18·71 | 10·82 | 3·82 | 0·25 | $Fe_2O_3$ 0·19, CaO 0·30, [MgO 0·64 = 100·01 |
| 17. L. Baikal | 2·616 | 64·83 | 22·04 | 7·21 | 4·03 | 0·31 | CaO 1·38 = 99·80 |
| 18. Branchville, *pseud.* | $\frac{2}{2}$ | 64·55 | 19·70 | 15·62 | 0·58 | 0·12 | = 100·57 |
| 19. Pargas, "*Ersbyite*," *pseud.* | 2·57 | 66·18 | 19·52 | 13·03 | 0·91 | — | CaO 0·36 = 100 |

**Obs.**—Much of the potash feldspar formerly called orthoclase belongs here; in general only an optical examination serves to establish the difference. It hence occurs under the same conditions as common orthoclase. Some localities are mentioned with the list of analyses; that from Magnet Cove, Arkansas, is nearly pure microcline. The beautiful amazonstone from the Ural, also in fine groups of large crystals of deep color in the granite of Pike's Peak, Colorado, is microcline. *Chesterlite* from Poorhouse quarry, Chester Co., Penn., and the aventurine feldspar of Mineral Hill, Penn., belong here.

Microcline, pseudomorph after spodumene (anal. 18), has been described by Brush and Dana from Branchville, where the species also occurs in very large cleavage masses and crystallized in a pegmatyte vein. Simple crystals occur in pegmatyte of the Gaserntbal near Meissen, Saxony.

The name *mikroklin* was given by Breithaupt to a feldspar occurring chiefly in cleavable masses in the zircon-syenite of Fredriksvärn, also Laurvik and Brevik, Norway. Breithaupt made the angle between the two cleavage planes 90° 22′–90° 23′, instead of 90°; and hence derived the name, from *μικρός*, *little*, and *κλινειν*, *to incline.* Breithaupt referred to microcline the feldspar of Arendal, which afforded him the same angle, also feldspars from a number of other localities. The species, however, was first established by Des Cloizeaux. He shows moreover that the Fredriksvärn feldspar is true orthoclase (cf. remarks by Bgr., cryptoperthite, p. 321).

**Ref.**—[1] Cf. Dx., l. c.; also Klockmann, Zs. G. Ges., **34**, 410, 1882; Zs. Kr., **8**, 317, 1883; Beutell, Zs. Kr., **8**, 352, 1883; Kloos, Jb. Min., **2**, 87, 1884. [2] Sauer and Ussing, Zs. Kr., **18**, 192, 1890. [3] Rinne, Jb. Min., **2**, 66, 1890. [4] Mld., Ann. Mines, **10**, 10, 1876; Michel-Lévy, Bull. Soc. Min., **2**, 135, 1879.

**315 A. Anorthoclase.** Anorthoklas *Rosenbusch*, Mikr. Phys., 550, 1885. Anorthose *Fr.* Natronorthoklas pt. Natronmikroklin *Förstner*. Mikroklinalbit. Mikroklas *F. J. Wiik*.

A triclinic feldspar with a cleavage-angle, *bc*, varying but little from 90°. Form like that of the ordinary feldspars. Twinning in accordance with the Carlsbad, Baveno, and Manebach laws; also polysynthetic according to the albite and pericline laws; but in many cases the twinning laminæ very narrow and hence not distinct. Rhombic section inclined on *b*, 4° to 6° to edge *b*/*c*. G. = 2·57–2·60. Cleavage, hardness, luster, and color as with other members of the group.

Optically −. Extinction-angle on *c*, + 5° 45′ to + 2°; on *b*, 6° to 9°·8. $Bx_a$ nearly ⊥ *y*. Dispersion $\rho > v$; horizontal distinct. Axial angles (Förstner).

$2E_y = 71° 40′$ Khagiar 88° 27′ Rakhall $\beta_y = 1·5040$ to $1·5810$.

Axial angle variable with temperature, becoming in part monoclinic in optical symmetry between 86° and 264° C., but again triclinic on cooling; this is true of those containing little calcium.

**Comp.**—Chiefly a soda-potash feldspar, $NaAlSi_3O_8$ and $KAlSi_3O_8$, the sodium silicate usually in larger proportion (2 : 1, 3 : 1, etc.), calcium ($CaAl_2Si_2O_8$) present in relatively very small amount.

**Anal.**—1–9, Förstner, Zs. Kr., **8**, 193, 1883. 10, J. Vogt, quoted by Bgr., l. c., p. 261. 11, Jannasch, quoted by Klein, l. c. 12, Kjerulf, Bgr,, l. c., p. 295. 13, Fischer, Mgg., l. c., p. 119, also other anals. 14, F. J. Wiik, Zs. Kr., **8**, 203, 1883. 15, Fletcher, Min. Mag., **7**, 131, 1887. 16. Hyland, Min. Mitth., **10**, 256, 1888. 17, Penfield, U. S. G. Surv., 7 Ann. Rep., p. 269, 1885–86 (1888).

| | G. | SiO₂ | Al₂O₃ | CaO | K₂O | Na₂O | |
|---|---|---|---|---|---|---|---|
| 1. Montagna Grande | 2·595 | 68·23 | 18·30 | 1·26 | 2·53 | 7·99 | $Fe_2O_3$ 1·01, MgO 0·51 = 99·83 |
| 2. Mte. Gibele | 2·605 | 63·41 | 20·32 | 2·76 | 2·53 | 7·42 | $Fe_2O_3$ 3·27, MgO 0·30 = 100·01 |
| 3. Khania | 2·592 | 66·67 | 19·74 | 1·37 | 4·34 | 6·93 | $Fe_2O_3$ 0·56, MgO 0·13 = 99·74 |
| 4. Khagiar | 2·574 | 66·34 | 19·05 | 1·08 | 4·96 | 8·07 | $Fe_2O_3$ 0·96, MgO 0·04 = 100·50 |
| 5. Zichidi | 2·584 | 64·81 | 20·65 | 2·01 | 3·84 | 7·13 | $Fe_2O_3$ 0·95, MgO 0·09 = 99·48 |
| 6. Sidori | 2·578 | 66·74 | 19·98 | 1·25[a] | 4·48 | 7·10 | $Fe_2O_3$ 0·31 = 99·86 |
| 7. Rakhalè | 2·566 | 66·20 | 19·86 | 0·80 | 4·10 | 7·45 | $Fe_2O_3$ 1·03, MgO 0·17 = 99·61 |
| 8. S. Marco | 2·577 | 66·79 | 19·36 | 0·80 | 4·95 | 7·34 | $Fe_2O_3$ 0·91, MgO 0·13 = 100·28 |
| 9. Cuddia Mida | 2·56 | 66·63 | 19·76 | 0·38 | 4·86 | 7·31 | $Fe_2O_3$ 0·72, MgO 0·30 = 99·96 |
| 10. Svenör | | 61·35 | 22·37 | 4·66 | 4·97 | 6·59 | MgO 0·04 = 99·98 |
| 11. Hohe Hagen | | 64·33 | 21·97 | 2·07 | 4·95 | 6·99 | $Fe_2O_3$ 0·45, MgO 0·13 = 100·89 |
| 12. Lille Frogner | | 58·18 | 22·89 | 4·61 | 4·17 | 2·97 | $Fe_2O_3$ 4·58, MgO 0·71, $H_2O$ 0·96 [= 99·07 |

| | | G. | $SiO_2$ | $Al_2O_3$ | CaO | $K_2O$ | $Na_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 13. | Tyveholmen | 2·651 | 59·51 | 22·69 | 5·05 | 2·50 | 6·38 | $Fe_2O_3$ 2·47, MgO 0·42, $H_2O$ 1·34 [= 100·36 |
| 14. | St. Gothard, *mikroklas* | 2·567 | [66·40] | 16·23 | — | 11·90 | 5·47 | = 100 |
| 15. | Kilima-njaro | | $\frac{2}{2}$ 60·78 | 23·00 | 2·84 | 4·50 | 6·65 | $H_2O$ 0·21, $Fe_2O_3$ 2·32 = 100·30 |
| 16. | " | 2·63 | $\frac{2}{2}$ 61·30 | 23·10 | 3·02 | 5·34 | 7·11 | $H_2O$ 0·09 = 99·96 |
| 17. | Obsidian Cliff | | $\frac{2}{2}$ 67·53 | 17·99 | 0·09 | 5·08 | 8·36 | $Fe_2O_3$ 0·60, ign. 0·30 = 99·95 |

[a] Incl. some BaO.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Extinction on *c* | 5°·75 | 4°·59 | 4°·63 | 4°·37 | 3°·60 | 3°·14 | 3°·80 |
| " " *b* | 6°·04 | 6°·43 | 6°·50 | 6°·88 | 7°·37 | 8°·75 | 8°·75 |

| | 8 | 9 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|
| Extinction on *c* | 3°·50 | 2°·10 | 3°·5 | 0° to 3° | 0° to 2° | 1° 30′ to 5° 12′ |
| " " *b* | 9°·50 | 9°·80 | 6°·40 | – 5° to – 8° | 5½° to 6½° | 6° to 10° |

**Obs.**—These triclinic soda-potash feldspars are chiefly known from the andesytic lavas of Pantelleria. Most of these feldspars come from a rock, called by Förstner pantellerite, which is characterized by the presence of cossyrite; a similar feldspar (anal. 11) resembling sanidine occurs in the basalt of the Hohe Hagen near Göttingen. Also from the augite-syenite of southern Norway and from the "Rhomben-porphyr" near Christiania. The feldspar of Kilima-njaro investigated by Hyland belongs here; probably also other feldspars from Teneriffe; Fréjus in Esterel. An abnormal feldspar from Quatro Ribeiras is mentioned under albite. A feldspar in crystals of unusual habit, tabular ‖ *c*, and twinned according to the Manebach and less often Baveno laws occurs in the lithophyses of the rhyolyte of Obsidian Cliff, Yellowstone Park. It shows the blue opalescence in a direction parallel with a steep orthodome (cf. p. 317).

**Ref.**—Förstner, Zs Kr., **8**, 125, 1883, and on the effect of heat upon the optical character, Zs. Kr., **9**, 333, 1884; also earlier Zs. Kr., **1**, 547, 1877, in which the feldspars examined were all referred to orthoclase. See also Klein, Nachr. Ges. Gött., No. 14, 1878, Jb. Min., 518, 1879, who proves the triclinic character of the Pantelleria feldspar. On the feldspars from the "Rhomben-porphyr" of the Christiania region, as of Tyveholmen (2·5 p. c. $K_2O$) and elsewhere, see Mügge, Jb. Min., **2**, 107, 1881, Bgr., die Silur. Etagen, etc., im Kristiania-Gebiete, etc., pp. 252–307, 1882.

### Albite-Anorthite Series.*

Between the isomorphous species

| | | |
|---|---|---|
| ALBITE | $NaAlSi_3O_8$ | Ab |
| ANORTHITE | $CaAl_2Si_2O_8$ | An |

there are a number of intermediate subspecies, regarded as isomorphous mixtures of these molecules, and defined according to the ratio in which they enter; their composition is expressed in general by the formula $Ab_nAn_m$. They are:

| | | | |
|---|---|---|---|
| OLIGOCLASE | $Ab_6An_1$ | to | $Ab_3An_1$ |
| ANDESINE | $Ab_3An_1$ | to | $Ab_1An_1$ |
| LABRADORITE | $Ab_1An_1$ | to | $Ab_1An_3$ |
| and Bytownite | $Ab_1An_3$ | to | $Ab_1An_6$ |

From albite through the successive intermediate compounds to anorthite with the progressive change in composition (and specific gravity), there is also a corresponding change in crystallographic form, and as developed by Schuster in certain fundamental optical properties.

The relations of the triclinic feldspars, albite, anorthite, and the intermediate compounds in which both sodium and calcium enter, have been discussed by many writers, and various authors, as von Waltershausen, Rammelsberg, Scheerer, and later Delesse and Hunt have made important contributions to the subject. The establishment of the view now accepted, however, is chiefly due to Tschermak[1].

*Crystalline form.* The axial ratios and angles given on p. 314 show that these triclinic feldspars approach orthoclase closely in form, the most obvious difference being in the cleavage-angle *bc*, which is 90° in orthoclase, 86° 24′ in albite, and 85°

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* The triclinic feldspars of this series, in which the two cleavages *b* and *c* are oblique to each other, are often called in general *plagioclase* (from *πλάγιος, oblique*), a name first introduced by Breithaupt, Min., **3**, 492, 1847.

50′ in anorthite. The transition in form from albite to anorthite is distinctly shown in the change in this angle, *bc*. Thus

| | *bc* | |
|---|---|---|
| Albite | 86° 24′ | Rose |
| Oligoclase (sunstone) | 86° 8′ | Mgc. |
| Andesine | 86° 14′ | Rath |
| Labradorite | 86° 4′ | Tsch. |
| Anorthite | 85° 50′ | Mgc. |

A series of similar measurements is given by Wiik, Zs. Kr., 11, 312, 1885.

There is also a change in the axial angle $\gamma$, which is 88° in albite, about 90° in oligoclase and andesine, and 91° in anorthite. This transition appears still more strikingly in the position of the "rhombic section," by which the twins according to the pericline law are united as explained below.

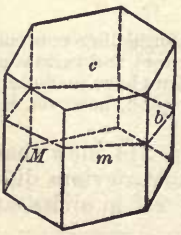
*Twinning.* The plagioclase feldspars are often twinned in accordance with the Carlsbad, Baveno, and Manebach laws common with orthoclase (p. 316). Twinning is also almost universal according to the *albite law*—twinning plane the brachypinacoid; this is usually polysynthetic, i.e. repeated in the form of thin lamellæ, giving rise to fine striations on the basal cleavage surface. Twinning is also common according to the *pericline law*—twinning axis the macrodiagonal axis $\bar{b}$; when polysynthetic this gives another series of fine striations seen on the brachypinacoid.

The composition-face in this pericline twinning is a plane passing through the crystal in such a direction that its intersections with the prismatic faces and the brachypinacoid make equal plane angles with each other. The position of this rhombic section ("rhombische Schnitt") and the consequent direction of the striations on the brachypinacoid change rapidly with a small change in the angle $\gamma$. In general it may be said to be approximately parallel to the base, but in albite it is inclined backward (+, f. 1, cf. also f. 3) and in anorthite to the front (−, f. 2); for the intermediate species its position varies progressively with the composition (Rath, Wiik, et al.). Thus for the angle between the trace of this plane on the brachypinacoid and the edge *b*/*c*, we have

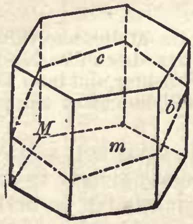
| | | |
|---|---|---|
| Albite | Ab | + 22° to + 20° |
| Oligoclase-Albite | $Ab_{12}An_1$<br>$Ab_6An_1$ | + 20° to + 10° |
| Oligoclase | $Ab_6An_1$<br>$Ab_3An_1$ | + 9° to + 3½° |
| Andesine | $Ab_3An_2$<br>$Ab_4An_3$<br>$Ab_1An_1$ | + 1°<br>0°<br>− 1° to − 2° |
| Labradorite<br>Bytownite | $Ab_3An_4$<br>$Ab_1An_3$<br>$Ab_1An_6$ | − 9° to − 10° |
| Anorthite | An | − 15° to − 17° |

For special observations see under the individual species beyond.

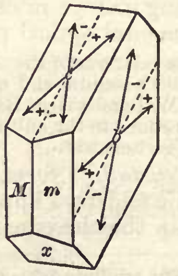
1.



2.



3.

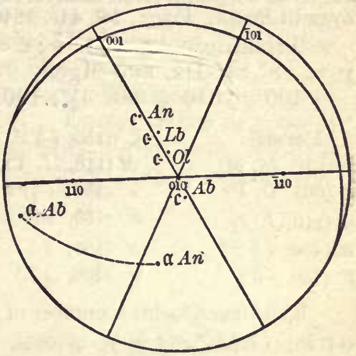


1, Rhombic section in albite. 2, Same in anorthite; 1, 2, after Rath. 3, Typical form showing directions of light-extinction on *c* and *b*.

*Optical characters.* There is also a progressive change in the position of the axes of light-elasticity and the optic axial plane in passing from albite to anorthite, as has been shown by Schuster. This is most simply exhibited by the position of the planes of light-vibration, as observed in sections parallel to the two cleavages, basal *c* and clinopinacoidal *b*, in other words the extinction-angle formed on each face with the edge *b*/*c* (cf. f. 3).

The approximate position of the axes of elasticity for the different feldspars is shown in figure 4 (from Schuster). The axis of least elasticity ($\mathfrak{c}$) does not vary very much from the zone *bc*, but the axis of greatest elasticity ($\mathfrak{a}$) varies widely, and hence the axial plane has an entirely different position in albite from what it has in anorthite. Furthermore albite is optically positive, that is $\mathfrak{c} = \mathrm{Bx}$, while anorthite is negative or $\mathfrak{a} = \mathrm{Bx}$; for certain andesines the axial angle is sensibly 90°.

4.



The following table gives the percentage composition of the various molecular compounds of albite and anorthite, with the calculated specific gravity (Tschermak), and also certain of the optical characters connected with them by the researches of Schuster and Mallard. These latter values are calculated by Schuster from an equation deduced by Mallard, in which certain observed values are assumed as fundamental. Observed angles for many cases are given in the pages which follow.

| | Ratio of Albite to Anorthite $Ab_nAn_m$ | | Percentage Composition | | | | Extinction-angle with edge *c*/*b* | |
|---|---|---|---|---|---|---|---|---|
| | *n* : *m* | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | on *c* | on *b* |
| Albite | 1 : 0 | 2·624 | 68·7 | 19·5 | 0 | 11·8 | + 4° 30′ | 19° |
| Oligoclase-albite | 12 : 1 | 2·635 | 66·6 | 20·9 | 1·6 | 10·9 | + 3° 38′ to 2° 45′ | + 15° 35′ to 11° 59′ |
| | 8 : 1 | 2·640 | 65·7 | 21·5 | 2·4 | 10·4 | | |
| | 6 : 1 | 2·645 | 64·9 | 22·1 | 3·0 | 10·0 | | |
| Oligoclase | 4 : 1 | 2·652 | 63·3 | 23·1 | 4·2 | 9·4 | + 1° 55′ to − 0° 35′ | + 8° 17′ to − 2° 15′ |
| | 3 : 1 | 2·659 | 62·0 | 24·0 | 5·3 | 8·7 | | |
| | 2 : 1 | 2·671 | 59·9 | 25·4 | 7·0 | 7·7 | | |
| Andesine | 3 : 2 | 2·680 | 58·1 | 26·6 | 8·4 | 6·9 | − 2° 12′ to − 5° 10′ | − 7° 58′ to − 16° |
| | 4 : 3 | 2·684 | 57·4 | 27·1 | 8·9 | 6·6 | | |
| | 1 : 1 | 2·694 | 55·6 | 28·3 | 10·4 | 5·7 | | |
| Labradorite | 3 : 4 | 2·703 | 53·7 | 29·6 | 11·8 | 4·9 | − 7° 53′ to − 17° 40′ | − 20° 52′ to − 29° 28′ |
| | 2 : 3 | 2·708 | 53·0 | 30·1 | 12·3 | 4·6 | | |
| | 1 : 2 | 2·716 | 51·4 | 31·2 | 13·7 | 3·8 | | |
| | 1 : 3 | 2·728 | 49·3 | 32·6 | 15·3 | 2·8 | | |
| Bytownite | 1 : 4 | 2·735 | 48·0 | 33·4 | 16·3 | 2·3 | − 21° 5′ to − 28° 4′ | − 31° 10′ to − 33° 40′ |
| | 1 : 6 | 2·742 | 46·6 | 34·4 | 17·4 | 1·6 | | |
| | 1 : 8 | 2·747 | 45·9 | 34·9 | 18·0 | 1·2 | | |
| Anorthite | 0 : 1 | 2·758 | 43·2 | 36·7 | 20·1 | 0 | − 37° | − 36° |

Careful determinations of the specific gravity of these feldspars have been made by Goldschmidt, see Jb. Min., Beil. Bd., **1**, 203, 1881.

**Ref.**—[1] Tschermak, Ber. Ak. Wien, **50** (1), 566–613, 1865 (read Dec. 15, 1864). Cf. also Rg., Zs. G. Ges., **18**, 200, 1866; Streng, Jb. Min., 411, 1865, 598, 1871; Rath, Pogg., **144**, 219, 1871.

[2] Schuster, Min. Mitth., **3**, 117, 1881, **5**, 189, 1882. Dx., Min., **1**, 1862, N. R., 1867; also Ann. Ch. Phys., **4**, 1875, **9**, 433, 1876; Bull. Soc. Min., **6**, 89, 1883. etc. Wiik, Öfv. Finsk. Soc., **19**, 60, 1876–77, Zs. Kr., **8**, 203, 1883, **11**, 312, 1885. Mallard, Bull. Soc. Min., **4**, 96. 1881. Michel-Lévy, Min. Micr., 1879, Ann. Mines, **12**, 440, 1877. Thoulet, Ann. Mines, **14**, 115, 1878.

[3] Position of the *rhombic section*, Rath, Jb. Min., 689, 1876; Wiik, Zs. Kr., **2**, 498, 1878. Schuster, l. c., p. 240; Pfd., Am. J Sc., **34**, 390, 1887. Gdt., Ueb. Proj., 64, 1887.

**316. ALBITE.** Feltspat hvit pt. *Wall.*, 65, 1747. Feldspath pt., Schorl blanc pt., *de Lisle*, Crist., **2**, 409, Pl. v., f. 15, 16, 1783. Krummblätteriger Feldspath *Hedenberg*, Afh., **1**, 118, 1806. Albit *Gahn & Berz.*, Afh., **4**, 180, 1815. Tetartin *Breith.*, Char., 1823. Soda Feldspar.

VAR. *introd. as species.* Cleavelandite (fr. Chesterfield) *Brooke*, Ann. Phil., **5**, 381, 1823. Periklin *Breith.*, Char., 1823; Pericline. Hyposklerit (fr. Arendal) *Breith.*, Schw. J., **3**, 316, 1830. Peristerite (fr. Perth, Can.) *Thom.*, Phil. Mag., **22**, 189, 1843. Olafit *Breith.*, B. H. Ztg., **25**, 88 = Oligoklas-Albit *Scheerer*, Pogg., **89**, 17. Adinole (fr. Sala) *Beud.*, Tr., **2**, 126, 1832. Zygadit *Breith.*, Pogg., **59**, 441, 1846. Tschermakit *Fr. von Kobell*, J. pr. Ch., **8**, 411, 1873.

Triclinic. Axes $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}63347 : 1 : 0{\cdot}55771$; $\alpha = 94^\circ\ 3'$, $\beta = 116^\circ\ 28\tfrac{5}{6}'$, $\gamma = 88^\circ\ 8\tfrac{2}{3}'$ Dx. and Mgc.[1]

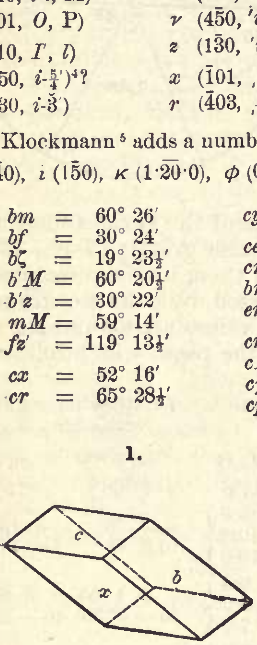
$100 \wedge 010 = 90^\circ\ 3\tfrac{1}{2}'$, $100 \wedge 001 = 63^\circ\ 34\tfrac{3}{4}'$, $010 \wedge 001 = 86^\circ\ 24'$.

**Forms**[2]:
$b$ (010, $i\text{-}\breve{i}$, M)
$c$ (001, $O$, P)
$m$ (110, $I'$, $l$)
$\mu$ (450, $i\text{-}\tfrac{5}{4}'$)[4]?
$f$ (130, $i\text{-}\breve{3}'$)
$\zeta$ (150, $i\text{-}\breve{5}'$)[3]
$M$ ($1\bar{1}0$, $'I$, T)
$\nu$ ($4\bar{5}0$, $'i\text{-}\tfrac{5}{4}$)[4]?
$z$ ($1\bar{3}0$, $'i\text{-}\breve{3}$)
$x$ ($\bar{1}01$, $,1\text{-}\bar{i},$)
$r$ ($\bar{4}03$, $,\tfrac{4}{3}\text{-}\bar{i},$)
$y$ ($\bar{2}01$, $,2\text{-}\bar{i},$)
$e$ (021, $2\text{-}\breve{i}'$)
$n$ ($0\bar{2}1$, $'2\text{-}\breve{i}$)
$\gamma$ ($\bar{1}12$, $,\tfrac{1}{2}$)
$p$ ($\bar{1}11$, $,1$)
$\Delta$ ($\bar{4}43$, $,\tfrac{4}{3}$)
$g$ ($\bar{2}21$, $,2$)
$\delta$ ($\bar{1}\bar{1}2$, $\tfrac{1}{2},$)
$o$ ($\bar{1}\bar{1}1$, $1,$)
$\pi$ ($\bar{6}\bar{6}5$, $\tfrac{6}{5},$)
$\sigma$ ($\bar{4}\bar{4}3$, $\tfrac{4}{3},$)
$\lambda$ ($\bar{3}\bar{3}2$, $\tfrac{3}{2},$)
$u$ ($\bar{2}\bar{2}1$, $2,$)
$\tau$ ($\bar{1}\bar{3}2$, $\tfrac{3}{2}\text{-}\breve{3},$)[4]
$\psi$ ($5\bar{5}2$, $'\tfrac{5}{2}$)[3]

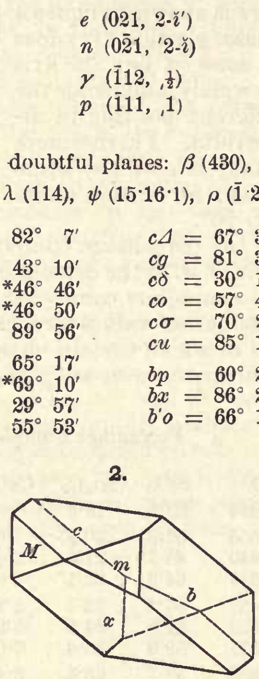
Klockmann[5] adds a number of doubtful planes: $\beta$ (430), $\alpha$ (270), $\delta$ ($5\bar{3}0$), $\epsilon$ ($4\bar{3}0$), $\eta$ ($1\bar{2}0$), $\vartheta$ ($1\bar{4}0$), $\iota$ ($1\bar{5}0$), $\kappa$ ($1{\cdot}\overline{20}{\cdot}0$), $\phi$ (085), $\lambda$ (114), $\psi$ ($15{\cdot}16{\cdot}1$), $\rho$ ($\bar{1}{\cdot}20{\cdot}1$), $\sigma$ ($\bar{1}81$), $\tau$ ($\bar{4}14$).

$bm = 60^\circ\ 26'$
$bf = 30^\circ\ 24'$
$b\zeta = 19^\circ\ 23\tfrac{1}{2}'$
$b'M = 60^\circ\ 20\tfrac{1}{2}'$
$b'z = 30^\circ\ 22'$
$mM = 59^\circ\ 14'$
$fz' = 119^\circ\ 13\tfrac{1}{2}'$
$cx = 52^\circ\ 16'$
$cr = 65^\circ\ 28\tfrac{1}{2}'$
$cy = 82^\circ\ 7'$
$ce = 43^\circ\ 10'$
$cn = {}^*46^\circ\ 46'$
$bn = {}^*46^\circ\ 50'$
$en = 89^\circ\ 56'$
$cm = 65^\circ\ 17'$
$cM = {}^*69^\circ\ 10'$
$c\gamma = 29^\circ\ 57'$
$cp = 55^\circ\ 53'$
$c\Delta = 67^\circ\ 33'$
$cg = 81^\circ\ 33'$
$c\delta = 30^\circ\ 11'$
$co = 57^\circ\ 49'$
$c\sigma = 70^\circ\ 21'$
$cu = 85^\circ\ 10'$
$bp = 60^\circ\ 26\tfrac{1}{2}'$
$bx = 86^\circ\ 20'$
$b'o = 66^\circ\ 18'$
$op = 53^\circ\ 15'$
$b\gamma = 70^\circ\ 41\tfrac{1}{2}'$
$b'\delta = 78^\circ\ 12\tfrac{1}{2}'$
$me = 51^\circ\ 18'$
$mp = 94^\circ\ 59'$
$m'y = 45^\circ\ 42\tfrac{1}{2}'$
$Mn = {}^*51^\circ\ 36'$
$Mo = 98^\circ\ 33'$
$M'y = {}^*42^\circ\ 27'$

1.



2.



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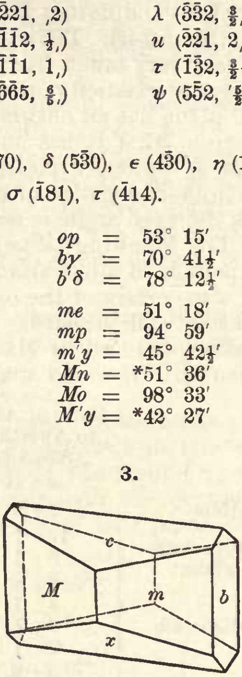

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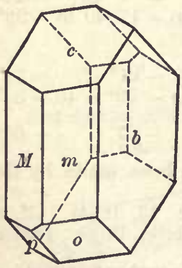

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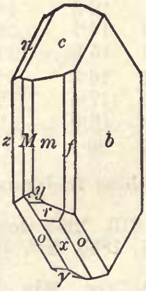

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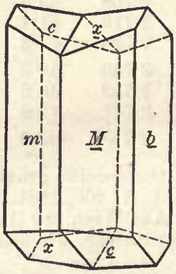

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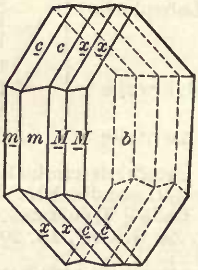


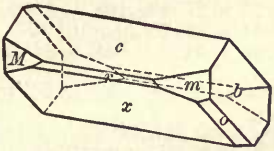
Figs. 1, 2, Schneeberg, Passeir, Rumpf. 3, Pfitsch, Schrauf. 4, Zillerthal, Id. 5, Middletown. 6, Carlsbad twin; 7, Albite and Carlsbad twins combined, Schrauf.

Twins[6]: similar to the (1) Carlsbad, (2) Baveno and (3) Manebach twins of orthoclase (p. 316); (4) tw. pl. *b*, *albite law* (p. 326), usually contact-twins, and polysynthetic, consisting of thin lamellæ and with consequent fine striations on *c*; this twinning is rarely absent in embedded masses and may be sometimes of secondary origin. (5) tw. axis $\bar{b}$, *pericline law*, in contact-twins whose composition-face is the so-called rhombic section (cf. f. 1 p. 326); also often polysynthetic and then showing fine striations which on *b* are inclined backward + 22° to the edge *b/c*. (6) Tw. axis $\breve{a}$, not common. (7) Tw. axis a line in 010 normal to $\dot{c}$.

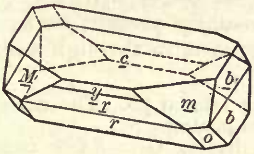
Crystals often tabular ∥ *b*; also elongated ∥ axis $\bar{b}$, as in the variety pericline. Also massive, either lamellar or granular; the laminæ often curved, sometimes divergent; granular varieties occasionally quite fine to impalpable.

Cleavage: *c* perfect; *b* somewhat less so; *m* imperfect. Fracture uneven to conchoidal. Brittle. H. = 6–6·5. G. = 2·62–2·65. Luster vitreous; on a cleavage surface often pearly. Color white; also occasionally bluish, gray, reddish, greenish, and green; sometimes having a bluish opalescence or play of colors on *c*. Streak uncolored. Transparent to subtranslucent.

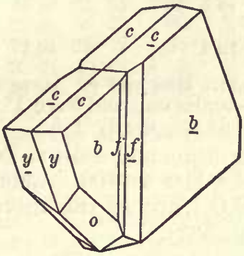
8.



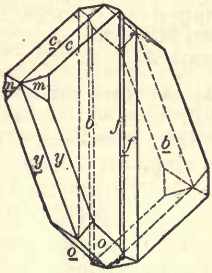
9.



10.



11.



**8, 9, Pericline, Schrauf. 10, 11, Roc Tourné, Savoy, Rose.**

Optically +. Plane (S) ⊥ to $Bx_a$ inclined 100° to 102° to *c* on acute edge *b/c*. Extinction-angle with edge *b/c* = + 4° 30′ to 2° on *c*, and = + 20° to 15° on *b*. Dispersion for $Bx_a$, $\rho < v$; also inclined, horizontal; for $Bx_o$, $\rho > v$; inclined, crossed, Dx. Change of axial angle on elevation of temperature small, 2° 30′ from 21°·5 C. to 170°·8 Dx. Axial angles:

$$2H_{a.r} = 80° \text{ to } 84° \qquad 2H_{o.r} = 106° \text{ to } 109°$$

The following table gives the extinction-angles on *b* and *c*; the angle formed by the trace of the rhombic section on *b* with the edge *b/c*; also so far as possible the lime percentage and specific gravity. The authors quoted are Schuster, Rath, Beutell, Cathrein, Krenner, Wiik, Penfield; for references see p. 327 and analyses below.

| | G. | CaO | Extinction on *c* | Extinction on *b* | Rhombic section. |
|---|---|---|---|---|---|
| Kasbék | 2·618 | — | + 4° 12′ | + 18° 44′ | |
| Fusch, Pinzgau | | — | 3° 47′ | 17° 35′ | |
| Schmirn, *Pericline* | | — | 3° 54′ to 3° 40′ | 17° 54′ to 17° 35′ | + 22° |
| Schwarzbach | | 0·47 | 4° 5′ | 16° 30′ | |
| Striegau | | 0·45 | 4° 50′ | 19° 30′ | |
| Reichenbach | | 1·05 | 3° 20′ | 20° 40′? | |
| Brixlegg | 2·630 | 0·72 | 4° | 18° | |
| Andreasberg, *Zygadite* | | 0·30 | 4° 36′ | 17° 12′ | |
| Kragerö | | 0·35 | | | 22° |
| Somero | 2·622 | | | 20° | 20° |
| Branchville | 2·610 | 1·18 | | 15° | 12° |
| Hitterö | 2·632 | 1·46 | | 15° | 14° |
| Haddam | 2·633 | 1·80 | | 16° | 13° |
| Mineral Hill | 2·627 | 1·85 | | 12° | 12° |
| Danbury | 2·628 | 1·95 | | 15° | 10° |

The following table, from Des Cloizeaux, gives the extinction-angles, also the acute axial angle, about the + Bx and the real angle between the plane normal to Bx (S) and the plane *c*;

further the specific gravities and lime percentage, the last from analyses by Pisani, Damour, Dirvell (cf. Dx.):

| | | Extinction | | Axial Angle | |
|---|---|---|---|---|---|
| | CaO | on *c* | on *b* | $2H_a$ | *cS* |
| Roc Tourné | | + 3° to 4° | +18° 34′ to 20° 46′ | 80° to 82° | 101° to 102° |
| Dauphiny | | 3° 52′ to 5° | 20° | 84° to 87° | 105° |
| Middletown | | 2° to 3° 50′ | 16° 30′ to 20° | 90° 20′ to 91° 12′ | 101° to 102° |
| Noeskiln | 0·19 | 2° to 3° | 18° to 21° | | |
| Ural | 0·50 | 3° 58′ | 16° 30′ to 21° | 83° 10′ to 83° 54′ | 102° 30′ |
| Bathurst, Canada, *Peristerite* | | 3° 30′ to 3° 50′ | 14° to 15° | 89° to 91° | 95° to 98° 20′ |
| Burgess, Canada, *Peristerite* | | 1° 30′ to 3° | 15° to 16° | 88° 30′ to 91° 10′ | 95° to 97° 25′ |
| Irigny, Rhône | 0·88 | 1° 30′ to 5° | 11° to 14° 10′ | 90° 36′ to 91° 36′ | 96° to 97° |
| Kårarfvet | 1·32 | 2° to 2° 36′ | 15° to 18° | 87° 26′ to 93° | 97° to 100° 55′ |
| Bamle, *Tschermakite* | 1·40 | 2° to 3° 30′ | 15° to 17° 30′ | 86° 16′ to 87° 42′ | 100° to 101° |
| Snarum, *olafite* | 1·56? | 4° 8′ to 4° 21′ | 19° 16′ to 21° | 81° 54′ to 83° 26′ | 101° 50′ |
| St. Vincent, Styria | 1·56 | 1° 40′ to 2° 45′ | 13° 30′ to 14° 30′ | 88° 30′ to 91° | 95° to 94° 25′ |
| Mineral Hill, Pa., *Moonstone* | 2·5 | 2° to 4° | 15° to 17° | 88° 4′ to 91° 29′ | 93° to 94° 16′ |

An abnormal albite from Quatre Ribeiras, on Terceira, Azores (anal. 24), has been investigated by Fouqué. Its extinction-angles on *c* and *b* are 1° 30′ and 9° to 9° 30′ respectively; it is optically — with $Bx_a$ nearly ⊥ *y* and $Bx_o$ nearly ⊥ *b*.

**Comp.**—A silicate of aluminium and sodium, $NaAlSi_3O_8$ or $Na_2O.Al_2O_3.6SiO_2$ = Silica 68·7, alumina 19·5, soda 11·8 = 100. Calcium is usually present in small amount, as anorthite ($CaAl_2Si_2O_8$), and as this increases it graduates through oligoclase-albite to oligoclase (cf. p. 332).

**Var.**—*Ordinary.* In crystals and massive. The crystals often tabular ∥ *b*. The massive forms are usually nearly pure white, and often show wavy or curved laminæ.

*Peristerite* is a whitish adularia-like albite, slightly iridescent, having G. = 2·626; named from *περιστερά*, *pigeon*, the colors resembling somewhat those of the neck of a pigeon.

*Aventurine* and *moonstone* varieties also occur as under oligoclase.

*Pericline* from the chloritic schists of the Alps is in rather large opaque white crystals, with characteristic elongation in the direction of the $\bar{b}$ axis, as shown in figs. 8, 9, and commonly twinned with this as the twinning axis (pericline law, see above).

*Hyposclerite* is blackish green from Arendal; H. = 5·5; G. = 2·63–2·66; it contains, according to Rammelsberg, 5 p. c. of pyroxene. Named from *ὑπό*, *under*, *σκληρός*, *hard*, with reference to the inferior hardness.

*Cleavelandite* is a white lamellar kind found at Chesterfield, Mass., and similarly elsewhere, and named after Dr. P. Cleaveland (1780 1858), the mineralogist.

*Olafite*, called also oligoclase-albite by Scheerer, is an albite from Snarum, Norway.

*Zygadite* occurs in thin tabular twin crystals. Translucent or milky. Color yellowish white to reddish. G. = 2·511–2·512, Breith. Found with milky quartz, stilbite, and sphalerite, in fissures in argillyte, at Andreasberg in the Harz. It was named from *ζυγάδην*, *in pairs*, or *twinned*. The identity with albite was made probable by Des Cloizeaux (Min., **1**, 326), and further proved by Krenner and Loczka, cf. anal. 13.

*Tschermakite*, Fr. von Kobell. Described as a magnesian oligoclase, but on the basis of an analysis of impure material; later shown to belong with oligoclase-albite. Cf. Hawes, anal. 14, also Pisani and Dx., l. c. From Kjörrestad near Bamle, Norway, where it occurs with quartz and wagnerite (kjerulfine). Named for Prof. G. Tschermak of Vienna.

**Anal.**—1, Bärwald, Zs. Kr., **8**, 48, 1883, cf. Schuster. Min. Mitth., **7**, 373, 1886. 2. Rath. Jb. Min., 699, 1876. 3, G. Rose, Gilb. Ann., **73**, 173, 1823. 4, Thaulow. Pogg., **42**, 571, 1837. 5. C. Hidegh, Tsch., Ber. Ak. Wien, **50** (1), 587, 1865. 6, Ludwig, after deducting 2·24 $Fe_2O_3$ from pyrrhotite, Min. Mitth., 100, 1874. 7, Tschermak, Ber. Ak. Wien, **50** (1), 578, 1865. 8, Beutell, Zs. Kr., **8**, 360, 1883. 9, Id., ib., p. 369. 10, Id., ib., p 376. 11, Cathrein, Zs. Kr., **7**, 239, 1882. 12, Rath, Pogg., Jbl. Bd., 547, 1874. 13, Loczka, Zs. Kr., **11**, 260, 1885. 14, Hawes, Am. J. Sc., **7**, 579, 1874. 15, Musgrave, Ch. News, **46**, 204, 1882. 16, Leeds, Am. J. Sc., **6**, 25, 1873. 17, Brush, Am. J. Sc., **8**, 390, 1849. 18, Tschermak, Ber. Ak. Wien, **50** (1), 587, 1865. 19–23, F. L. Sperry, Am. J. Sc., **34**, 392, 1877. 24, Fouqué, Bull. Soc. Min., **6**, 197, 1883. See also 5th Ed., p. 351.

| | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | ign. | |
|---|---|---|---|---|---|---|---|---|
| 1. Kasbék | 2·618 | 68·75 | 19·73 | — | 12·29 | — | — | = 100·77 |
| 2. Kragerö | 2·600 | 66·30 | 20·90 | 0·35 | [12·10] | — | 0·35 | = 100 |
| 3. Arendal | 2·616 | 68·46 | 19·30 | 0·68 | 11·27 | — | — | $Fe_2O_3$ 0·28 = 99·99 |
| 4. St. Gothard, *pericline* | | 69·00 | 19·43 | 0·20 | 11·47 | — | — | = 100·10 |
| 5. Pfitsch, Tyrol, “ | 2·620 | 68·75 | 19·53 | 0·32 | 11·04 | — | — | MgO 0·03 = 99·67 |

| | | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | ign. | |
|---|---|---|---|---|---|---|---|---|---|
| 6. | Schneeberg, Passeir | 2·61 | 66·93 | 21·18 | 0·65 | 11·23 | — | — | = 100 |
| 7. | Windisch Matrei | 2·624 | 68·8 | 19·3 | 0·4 | 11·1 | 0·5 | — | $Fe_2O_3$ 0·1 = 100·2 |
| 8. | Schwarzbach | | $\frac{2}{2}$ 67·25 | 19·67 | 0·47 | 11·57 | — | 0·51 | $Fe_2O_3$ 0·26 = 99·73 |
| 9. | Striegau | | 67·51 | 19·97 | 0·45 | 11·50 | — | 0·12 | = 99·55 |
| 10. | Reichenbach | | 66·17 | 20·72 | 1·05 | 10·56 | 1·15 | 0·56 | = 100·21 |
| 11. | Brixlegg | 2·630 | 67·49 | 20·35 | 0·72 | 11·27 | 0·29 | — | = 100·12 |
| 12. | Langenberg | 2·573 | 66·65 | 20·15 | 0·74 | [12·46] | — | — | = 100 |
| 13. | Andreasberg, *Zygadite* | | 68·81 | 19·41 | 0·30 | 11·05 | 0·41 | *tr.* | = 99·98 |
| 14. | Bamle, "*Tschermakite*" | 2·67 | 66 04 | 20·33 | 1·29 | 10·01 | 0·21 | 0·95 | $Fe_2O_3$ 0·29, MgO 1·11 |
| 15. | Amelia Co., Va. | 2·605 | 68 44 | 19·35 | — | 11·67 | 0·43 | — | = 99·89 [= 100·23 |
| 16. | Media, Penn., *moonstone* | 2·59 | 67·70 | 19·98 | 1·47 | 8·86 | 1·36 | 0·08 | MgO 0·11 = 99·56 |
| 17. | Unionville, Penn. | | 66·65 | 20·79 | 2·05 | 9·36 | — | — | MgO 0·52 = 99·37 |
| 18. | Laacher See | 2·636 | 66·9 | 20·8 | 2·00 | 10·2 | 0·6 | — | = 100·5 |
| 19. | Branchville, Ct. | 2·610 | 66·58 | 21·26 | 1·18 | 10·26 | 0 76 | 0·16 | $Fe_2O_3$ 0·07 = 100·27 |
| 20. | Hitterö | 2·632 | 66·83 | 20·88 | 1·46 | 10·36 | 0·70 | 0·27 | $Fe_2O_3$ 0·25 = 100·75 |
| 21. | Haddam, Ct. | 2·633 | 66·06 | 21·57 | 1·80 | 9·57 | 1·01 | — | $Fe_2O_3$ 0·18 = 100·19 |
| 22. | Mineral Hill, Penn. | 2·627 | 66·34 | 20·72 | 1·85 | 9·44 | 0·98 | 0·38 | = 99·71 |
| 23. | Danbury, Ct. | 2·628 | 65·73 | 21·32 | 1·95 | 9·66 | 0·95 | 0·19 | $Fe_2O_3$ 0·12 = 99 92 |
| 24. | Quatre Ribeiras | 2·593 | 68·73 | 19·76 | 1·12 | 9·45 | 1·37 | — | = 100·43 |

**Pyr., etc.**—B B. fuses at 4 to a colorless or white glass, imparting an intense yellow to the flame. Not acted upon by acids.

**Obs.**—Albite is a constituent of many crystalline rocks. With hornblende it constitutes *dioryte.* It occurs with orthoclase (or microcline) in much granite, and in such cases is usually distinguishable by its greater whiteness. In perthite (p. 321) it is interlaminated with orthoclase or microcline, and similar aggregations, often on a microscopic scale, are common in many rocks. Albite is common also in gneiss, and sometimes in the crystalline schists. Veins of albitic granite are often repositories of the rarer minerals and of fine crystallizations of gems, including beryl, tourmaline, allanite, columbite, etc. It occurs also in some volcanic rocks, especially in the andesytes, as with allanite at Langenberg, near Heisterbach in the Siebengebirge; similarly at Felsöbánya. Hungary. It is found in disseminated crystals in granular limestone; thus in the limestone (Jura and Trias) of the Col du Bonhomme, near Modane in Savoy; also in microscopic crystals with quartz and orthoclase in limestone at Meylan near Grenoble; in minute crystals in fossil Radiolarians in limestone near Rovegno, Province of Pavia. Italy, also in the limestone itself; in limestone at Bedous, Basses Pyrénées, at the contact with diabase.

Some of the most prominent European localities are in cavities and veins in the granite or granitoid rocks of the Swiss and Austrian Alps, associated with adularia, smoky quartz, chlorite, titanite, apatite, and many rarer species; it is often implanted in parallel position upon the orthoclase. Thus in the St. Gothard region; Roc Tourné near Modane, Savoy; on Mt. Skopi (pericline); Tavetschthal; Schmirn, Tyrol; also Pfitsch, Rauris, the Zillerthal, Kriml, Schneeberg in Passeir in simple crystals. Also in Dauphiné in similar association; on Elba. Also Hirschberg in Silesia; Penig in Saxony; with topaz at Mursinka in the Ural and near Miask in the Ilmen Mts. At the foot of Kasbék in the Caucasus in cavities in granite, the crystals often simple. Cornwall, England; Mourne Mts. in Ireland.

In the United States, in *Maine*, at Paris, with red and blue tourmalines. In *Mass.*, at Chesterfield, with the same minerals, in lamellar masses (cleavelandite), slightly bluish, also fine granular, and rarely in small crystals; at Goshen. In *New Hamp.*, at Acworth and Alstead; at the slide on Tripyramid Mt., White Mts., in small crystals implanted in parallel position upon orthoclase. In *Conn.*, at Haddam, with chrysoberyl, beryl, columbite, and black tourmaline; at the Middletown feldspar quarry, in fine transparent or translucent crystals (fig. 5); at Monroe, a fine granular variety containing beryl; at Branchville, in fine crystals and massive with microcline, and many rare species. In *N. York*, at Granville, Washington Co., white transparent crystals; at Moriah, Essex Co., of a greenish color, with smoky quartz, and resembling green diallage. In *Penn.*, at Unionville, Chester Co., a granular variety is the matrix of the corundum, having the hardness of quartz; it had been taken for indianite. In *Virginia*, at the mica mines near Amelia Court-House in splendid crystallizations. In *Colorado*, in the Pike's Peak region with smoky quartz and amazon stone coating the crystals, also in composite rosettes forming their base. In *California*, Calaveras Co., with native gold and auriferous pyrites.

In Canada, in fine crystals, at the Suffield silver mine, near L. Massawippi, N.E. of L. Memphremagog; at the Lakes of Three Mountains, Clyde, Ottawa Co., Quebec. *Peristerite* occurs in the township of Bathurst, Lanark Co., also on Stoney Lake, Burleigh, Peterborough Co., Ontario.

The name *Albite* is derived from *albus*, white, in allusion to its color, and was given the species by Gahn and Berzelius in 1814.

**Alt.**—Cf. remarks under orthoclase, p. 320.

Occurs as a pseudomorph after spodumene at Branchville, Ct. (cf. p. 368).

**Artif.**—Obtained by Hautefeuille and also by Friedel and Sarasin by methods similar to those employed with orthoclase; by Fouqué and M.-Lévy direct from the fusion of the constituents. Further, the last-mentioned authors have obtained a series of feldspars intermediate between albite and anorthite, as well as these species themselves; also further certain feldspar-like compounds containing barium, strontium, and lead. For a summary of their results and those of others, see Fouqué-Lévy, Synth. Min., pp. 128–150, 1882.

**Ref.**—[1] Dx., Min., **1**, 317, 1862, cf. Rose, Gilb. Ann., **73**, 186, 1823, Pogg., **125**, 457, 1865; Neumann, Abh. Ak. Berlin, 189, 1830; Rath, Pogg. Erg., **5**, 425, 1870; Brz., Min. Mitth., 19, 1873; Bärwald, Kasbék, Zs. Kr., **8**, 48, 1883, and Schuster, Min. Mitth., **7**, 373, 1886. [2] Cf. Lévy, Min. Heuland, **2**, 189, 1837; Mlr., Min., 370, 1852, Dx., l. c.; Schrauf, Atlas, II–IV, 1864. [3] Rumpf, Min. Mitth., 97, 1874. [4] Rath, Mt. Skopi, Zs. Kr., **5**, 27, 1880. [5] Klockmann, Hirschberg, Zs. G. Ges., **34**, 416, 1882, Zs. Kr., **8**, 318, 1883.

[6] On *twins:* Neumann, Abh. Ak. Berlin, 189, 1830; Kayser, Pogg., **34**, 109, 301, 1835; Dx., l. c.; Rose, l. c., also Pogg., **125**, 457, 1865; Streng, Jb. Min., 613, 1871; Rath, Jb. Min., 689, 1876 (Ber. Ak. Berlin, 147, 1876), also Pogg., Erg. **5**, 425, 1870; Sbk., Ang. Kryst., 145, 1876; van Werweke, Jb. Min., **2**, 97, 1883. On *pyro-electricity,* see Hankel, Wied. Ann., **1**, 283, 1877.

**317. Oligoclase.** Natron-spodumen *Berz.*, Arsb., 160, 1824 = Soda-spodumene. Oligoklas *Breith.*, Pogg., 8, 79, 1826.

Triclinic. Axes: $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}63206 : 1 : 0{\cdot}55239$; $\alpha = 93° 4\frac{1}{3}'$, $\beta = 116° 22\frac{1}{2}'$, $\gamma = 90° 4\frac{1}{2}'$ Rath[1].

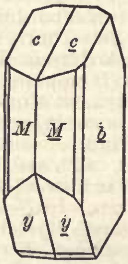
$100 \wedge 010 = 88° 23\frac{1}{2}'$, $100 \wedge 001 = 63° 34\frac{3}{4}'$, $010 \wedge 001 = *86° 32'$.

**Forms**[2]:
*a* (100, *i*-ī, k)
*b* (010, *i*-ĭ, M)
*c* (001, *O*, P)
*m* (110, *I*′)
*f* (130, *i*-3̆′)
ζ (150, *i*-5̆′)
*M* ($1\bar{1}0$, ′*I*)
*z* ($1\bar{3}0$, ′*i*-3̆)
*L* ($1\bar{5}0$, ′*i*-5̆)
*x* ($\bar{1}01$, ,1-ī,)
*r* ($\bar{4}03$, ,$\frac{4}{3}$-ī,)
*y* ($\bar{2}01$, ,2-ī,)
*e* (021, 2-ĭ′)
*n* ($0\bar{2}1$, ′2-ĭ)
η (112, $\frac{1}{2}$′)
𝔪 (111, 1′)
*p* ($\bar{1}11$, ,1)
*g* ($\bar{2}21$, ,2)
*o* ($\bar{1}\bar{1}1$, 1,)
*u* ($\bar{2}\bar{2}1$, 2,)
ω ($1\bar{1}2$, ′$\frac{1}{2}$)

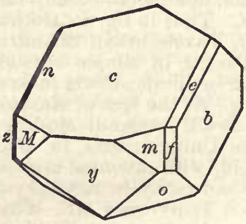
*bm* = 59° 14′
*bf* = 30° 2′
*mM* = 59° 6′
*zz* = 119° 7′
*b′M* = *61° 40′
*b′z* = 30° 51½′
*cx* = 51° 57′
*cy* = 81° 52′
*ce* = 42° 59′
*be* = 43° 33′
*cn* = 46° 25′
*an* = 72° 11′
*en* = 89° 25′
*c*𝔪 = 33° 7′
*cm* = 65° 40½′
*cM* = *68° 48′
*cp* = 55° 13½′
*cg* = 81° 17′
*co* = 57° 50′
*cu* = *84° 57′
*bp* = 61° 50½′
*b′u* = *58° 13′
*yu* = 32° 12′
*gu* = 64° 10′

1.

2.



3.



Figs. 1, 2, Vesuvius, Rath. 3, Fine, St. Lawrence Co., N. Y., Pfd.

Twins observed according to the Carlsbad, albite, and pericline laws. Crystals not common. Usually massive, cleavable to compact.

Cleavage: *c* perfect; *b* somewhat less so. Fracture conchoidal to uneven. Brittle. H. = 6–7. G. = 2·65–2·67. Luster vitreous to somewhat pearly or waxy. Color usually whitish, with a faint tinge of grayish green, grayish white, reddish white, greenish, reddish; sometimes aventurine. Transparent, subtranslucent. Optical characters, see pp. 326, 327, and 336.

**Comp., Var.**—Intermediate between albite and anorthite and corresponding to $Ab_6An_1$ to $Ab_2An_1$, but chiefly to $Ab_3An_1$, p. 327.

Analyses, see p. 337; also 5th Ed., pp. 347, 348.

**Var.**—1. *Ordinary.* In crystals or more commonly massive, cleavable. The varieties containing soda up to 10 p. c. are called *oligoclase-albite.*

2. *Aventurine oligoclase,* or *sunstone.* Heliolite *Delameth,* Pierre de Soleil *Fr.* Color

grayish white to reddish gray, usually the latter, with internal yellowish or reddish fire-like reflections proceeding from disseminated crystals of probably either hematite or göthite.

Much oligoclase has a faint greenish tinge and pearly luster, in which it somewhat resembles spodumene, whence the name *soda-spodumene*.

**Pyr., etc.**—B.B. fuses at 3·5 to a clear or enamel-like glass. Not materially acted upon by acids.

**Obs.**—Occurs in porphyry, granite, syenite, serpentine, and also in different eruptive rocks, as andesyte. It is sometimes associated with orthoclase in granite, or other granite-like rock. Among its localities are Danviks-Zoll near Stockholm; Kimito in Finland, forming with quartz and mica the granite containing columbite; Pargas in Finland; Ariége and Arendal, with calcite, epidote, etc., crystals sometimes 2 or 3 in. long; Shaitansk, Ural, greenish, in a gangue of quartz and mica and yellowish white feldspar; in gneiss of the Schwarzwald of Goggenau, north-east of Baden; in syenite of the Vosges; at Albula in the Grisons; in a dark green porphyry at Quenast in Belgium; at Boden near Marienberg; in the amphibolyte of Marienbad, Bohemia; in a green porphyry near Elbingerode in the Harz; Chalanches in Allemont and Bourg d'Oisans; as *sunstone* at Tvedestrand in the Christiania-fiord, Norway; at Hitterö; Lake Baikal; in Donegal, Ireland, in granite, with orthoclase, etc. In lavas and trachyte (*oligoclase-trachyte*) at Teneriffe, and in the Euganean Mts. near Padua; in the domyte (trachyte) of Puy-de-Dôme; in the Eifel; in pumice at Arequipa in Peru; in obsidian, with sanidine, at Zimapan in Mexico.

In the United States, at Fine and Macomb, St. Lawrence Co., N. Y., in good crystals; at Danbury, Ct., with orthoclase and danburite; Haddam, Ct., often transparent, with iolite and black tourmaline; at Orange Summit, N. Hamp., slightly greenish and pearly; at the emery mine, Chester, Mass., granular; at Unionville, Pa., with euphyllite and corundum; Mineral Hill, Delaware Co.; at Bakersville, N. C., in clear glassy masses, showing cleavage but no twinning (see p. 336 and anal. 13, p 337)

Named in 1826 by Breithaupt from ὀλίγος, *little*, and κλάσις, *fracture*. Berzelius had previously (in 1824) recognized it as a new mineral from specimens from Danviks-Zoll; and he afterward named it Natron-spodumen (soda-spodumene).

**Alt., Artif.**—See under Orthoclase and Albite.

**Ref.**—[1] Pogg., **138**, 464, 1869. The angles belong to crystals from Vesuvius whose composition is given in anal. 5, p. 337; other Vesuvian crystals (anal. 16) are referred by Rath to andesine, cf. Pogg., **144**, 225, 1871. [2] Cf. Mlr., Min., 372, 1852. See also Dx., Min., **1**, 312, 1862, who gives 112 ($f^1$) and $1\bar{1}2$ ($d^1$) on sunstone, omitted by Gdt., Index, **2**, 31, 1888.

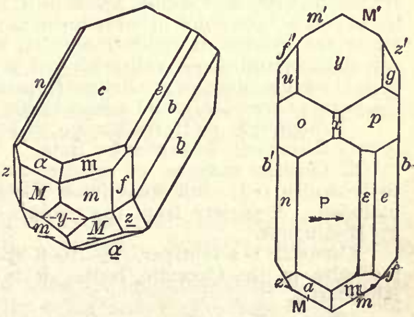
**318. Andesine.** Andesin *Abich*, Jahresb., **21**, 167, 1841. Pseudoalbit. Saccharit *Glocker*, J. pr. Ch., **34**, 494, 1845. Andesite.

Triclinic. Axes: $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}63556 : 1 : 0{\cdot}55206$; $\alpha = 93°\ 22\frac{3}{4}'$, $\beta = 116°\ 28\frac{1}{2}'$, $\gamma = 89°\ 58\frac{5}{6}'$ Rath[1].

$100 \wedge 010 = 88°\ 20\frac{1}{6}'$, $100 \wedge 001 = 63°\ 28\frac{1}{2}'$, $010 \wedge 001 = {*}86°\ 14'$.

**Forms**[2]:
$b$ (010, $i$-$\breve{i}$, M)
$c$ (001, $O$, P)
$m$ (110, $I'$, l)
$f$ (130, $i$-$\breve{3}'$)
$M$ ($1\bar{1}0$, $'I$, T)
$z$ ($1\bar{3}0$, $'i$-$\breve{3}$)
$x$ ($\bar{1}01$, $_{,}1$-$\bar{i}_{,}$)
$y$ ($\bar{2}01$, $_{,}2$-$\bar{i}_{,}$)
$\epsilon$ (045, $\frac{4}{5}$-$\breve{i}'$)
$e$ (021, 2-$\breve{i}'$)
$n$ ($0\bar{2}1$, $'2$-$\breve{i}$)
m (111, 1$'$)
$p$ ($\bar{1}11$, $_{,}1$)
$g$ ($\bar{2}21$, $_{,}2$)
$o$ ($\bar{1}\bar{1}1$, $1_{,}$)
$u$ ($\bar{2}\bar{2}1$, $2_{,}$)
$\alpha$ ($1\bar{1}1$, $'1$)

$bm = 59°\ 4'$
$b'M = {*}61°\ 35'$
$mM = 59°\ 20'$
$cx = 51°\ 42'$
$cy = 81°\ 44'$
$ce = 42°\ 48'$
$cn = 46°\ 31'$
$en = 89°\ 19'$
$c$m $= 65°\ 27\frac{1}{2}'$
$cM = {*}68°\ 54'$
$cp = 54°\ 56'$
$bp = 61°\ 34\frac{1}{2}'$
$bx = 87°\ 39'$
$co = {*}57°\ 44'$
$b'o = {*}65°\ 20'$



Figs. 1, 2, Arcuentu, Sardinia, Rath.

Twins observed according to the Carlsbad, albite, and pericline laws. Also[2], tw. axis $\breve{a}$, comp.-face $c$ (f. 1); and since the axial angle is nearly 90°, these twins correspond closely to the Manebach twins of orthoclase. Crystals rare. Usually massive cleavable or granular.

Cleavage: $c$ perfect; $b$ less so; also $M$ sometimes observed. H. = 5–6. G. = 2·68–2·69. Color white, gray, greenish, yellowish, flesh-red. Luster subvitreous to pearly. Optical characters, see pp. 326, 327, and 336.

**Comp.**—Intermediate between albite and anorthite, corresponding to Ab : An in the ratio of 3 : 2, 4 : 3 to 1 : 1, see p. 327.

Analyses, see p. 337; also 5th Ed., pp. 344, 345.

**Pyr., etc.**—Andesine fuses in thin splinters before the blowpipe. Imperfectly soluble in acids.

**Obs.**—Occurs in the Andes, at Marmato, as an ingredient of the rock called *andesyte;* in the porphyry of l'Esterel, Dept. of Var, France; in the syenite of Alsace in the Vosges; white at Servance, red at Coravillers; in the porphyry near Chagey, Haute Saône; at Vapnefiord, Iceland, in honey-yellow transparent crystals; at Baumgarten in Silesia; Bodenmais, Bavaria; Mt. Arcuentu (or Pollice di Oristáno), Sardinia, in a pumice-tuff; at Sanford, Me., with vesuvianite in distinct crystals (anal. 22).

*Saccharite* is granular massive, occurring in veins in serpentine at the chrysoprase mines near Frankenstein, in Silesia; originally referred to andesine, but shown by Lasaulx to be a mixture, Jb. Min., 623, 1878.

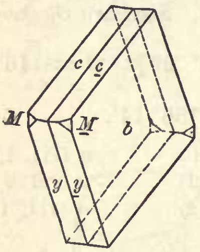
**Ref.**—[1] Mt. Arcuentu, Sardinia, Festschrift Ver. Cassel, 1886; the identification with andesine rests on the determination, $SiO_2 = 60{\cdot}2$ p. c., and the position of the axial plane oblique to *b*, extinction ‖ edge *b/c* (Dx.). [2] Rath, l. c.

**319. Labradorite.** Labradorstein (under Feldspat) *Wern.*, Ueb. Cronst., 149, 1780, Bergm. J., 375, 1789. Labradorstein, Schillernder Quarzspath *Pallas*, Nord. Beiträge, **2**, 233, 1781. Pierre de Labrador *Forst.*, Cat., 82, 1780; *de Lisle*, Crist., **2**, 497, 1783. Labrador Feldspar. Labrador *G. Rose*, Gilb. Ann., **73**, 173, 1823; *Breith.*, Char., 1823. Lime Feldspar. Hafnefjordite, Kalkoligoklas *Forchhammer*, Skand. Nat. Samml. i Stockholm, July 1842, J. pr. Ch **30**, 389, 1842.

Mornite *Thom.*, Ed. N. Phil. J., **13**, 1832. Silicite *Thom.*, Phil. Mag., **22**, 190, 1843. Saussurite pt. Radauit *Breith.*, B. H. Ztg., **25**, 87.

Triclinic. Form near that of andesine, but not accurately known. Cleavage angle $bc = 86° \ 4'$ Tsch. Obermayer[1] has calculated: $\breve{a} : \bar{b} = 0{\cdot}6377 : 1$; also $\alpha = 93° \ 31'$, $\beta = 116° \ 3'$, $\gamma = 89° \ 54\frac{1}{2}'$.

These are based upon the measured angles: $b'c = 93° \ 52'$, $b\lambda = 19° \ 2'$, $bL' = 19° \ 23'$, $b'M = 61° \ 22'$, $cba = 63° \ 57'$. $\lambda = 150$, $L = \bar{1}50$ are cleavage directions.



Forms like those of the other plagioclase species, and twinning common according to the albite law, also the pericline, Carlsbad, Baveno, and Manebach laws; also twinning[2] with tw. axis a normal to ć in the plane *b*. Crystals often very thin tabular ‖ *b*, and rhombic in outline bounded by *cy* or *cx*. Also massive, cleavable or granular; sometimes cryptocrystalline or hornstone-like.

Cleavage: *c* perfect; *b* less so; *M* sometimes distinct; also *l* and *L* sometimes observed, Obermayer; (180), ($1\bar{7}0$) Schrauf, as parting surfaces. H. = 5–6. G. = 2·70–2·72. Luster on *c* pearly, passing into vitreous; elsewhere vitreous or subresinous. Color gray, brown, or greenish; sometimes colorless and glassy; rarely porcelain-white; usually a beautiful change of colors in cleavable varieties, especially ‖ *b*. Streak uncolored. Translucent to subtranslucent. Optical characters, see pp. 326, 327, and 336.

**Var.**—1. *Cleavable.* (*a*) Well crystallized, to (*b*) massive.

Play of colors either wanting, as in some colorless crystals; or pale or deep. Blue and green are the predominant colors; but yellow, fire-red, and pearl-gray also occur. Vogelsang[3] regards the common blue color of labradorite as a polarization-phenomenon due to its lamellar structure. while the golden or reddish schiller, with the other colors, is due to the presence of black acicular microlites and yellowish red microscopic lamellæ, or to the combined effect of these with the blue reflections. Schrauf[3] has examined the inclusions, their position, etc., and given the names *microplakite* and *microphyllite* to two groups of them.

*Hafnefjordite*, or Hafnefiordite, of Forchhammer from the dolerite of Hafnefiord, Iceland, is only labradorite as shown by Rath.

2. *Compact massive*, or *cryptocrystalline; Labradorite-Felsite.* The color sometimes gray to brownish red; but sometimes porcelain-white. Some of the so-called *saussurite* is here included. A variety from the gabbro of Baste in the Radau valley, Harz, is called *Radauite* by Breithaupt.

*Carnatite* is a feldspar, described by Beudant, occurring at the localities of corundum and indianite in the Carnatic, India; it is pronounced by Breithaupt and von Kobell to be labradorite.

**Comp., Var.**—Intermediate between albite and anorthite and corresponding chiefly to Ab : An in a ratio of from 1 : 1 to 1 : 3, p. 327.

For analyses see p. 337; also 5th Ed., p. 342.

The feldspars which lie between labradorite proper and anorthite have been embraced by Tschermak under the name bytownite. The original bytownite of Thomson (Min., **1**, 372, 1836) was a greenish-white feldspathic mineral found in a boulder near Bytown (now Ottawa) in Ontario, Canada. It was analyzed, 1, by Thomson (l. c.) and, 2, by Hunt (Am. J. Sc., **12**, 212, 1851). Tschermak (Ber. Ak. Wien, **50** (1), 590, 1865) has recalculated the latter analysis, rejecting the water; his results are given in 3. Zirkel has shown, however, that the mineral is a mixture; see Min. Mitth., 61, 1871.

| | | $SiO_2$ | $Al_2O_3$ | CaO | MgO | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. | G. = 2·80 | $\frac{2}{2}$ 47·57 | 29·65 | 9·06 | 0·40 | 7·60 | 1·98 | $Fe_2O_3$ 3·57 = 99·83 |
| 2. | G. = 2·73 | 47·40 | 30·45 | 14·24 | 0·87 | 2·82 | 2·00 | FeO 0·80, $K_2O$ 0·38 = 98·96 |
| 3. | | 48·82 | 31·49 | 14·67 | — | 2·90 | — | FeO 0·82, $K_2O$ 0·39 = 99·09 |

**Pyr., etc.**—B.B. fuses at 3 to a colorless glass. Decomposed with difficulty by hydrochloric acid, generally leaving a portion of undecomposed mineral.

**Obs.**—Labradorite is an essential constituent of various rocks, especially of the basic kinds and usually associated with some member of the pyroxene or amphibole groups. Thus with hypersthene in hyperyte and noryte, with diallage in gabbro, with some form of pyroxene in diabase, basalt, doleryte, also andesyte, tephryte, etc. Labradorite also occurs in other kinds of lava, and is sometimes found in them in glassy crystals, as in those of Etna, Vesuvius, the Sandwich Islands at Kilauea.

The labradoritic massive rocks are most common among the formations of the Archæan era. Such are part of those of British America, northern New York, Pennsylvania, Arkansas; those of Greenland, Norway, Finland, Sweden, and probably of the Vosges. Being a feldspar containing comparatively little silica, it occurs mainly in rocks which include little or no quartz (free silica) and no orthoclase.

On the coast of Labrador, labradorite is associated with hornblende, hypersthene, and magnetite. It is met with in place at Mille Isles, Chateau Richer, Rawdon, Morin, Abercrombie and elsewhere, in Quebec; and in boulders at Drummond and elsewhere, in Ontario. It occurs abundantly through the central Adirondack region in northern New York; also occasionally in Orange, Lewis, Warren, Scoharie, and Greene Cos.; in the Wichita Mts., Arkansas.

*Silicite* and *mornite* are from Antrim, Ireland.

Labradorite was first brought from the Isle of Paul, on the coast of Labrador, by Mr. Wolfe, a Moravian missionary, about the year 1770, and was called by the early mineralogists Labrador stone (*Labradorstein*), and also chatoyant, opaline, or Labrador feldspar.

**Alt.**—See remarks under orthoclase, p. 320; also Tschermak, Min. Mitth., 269, 1874. The alteration of labradorite is the common source of the zeolites and associated secondary minerals (calcite, datolite, etc.) frequently present in cavities and veins in basic igneous rocks.

**Artif.**—See p. 332.

**Ref.**—[1] Zs. Kr., **7**, 66, 1882. Groth gives the axis $\acute{c}$ = 0·5547.

[2] Rath, Pogg., **144**, 255, 1871. [3] Cf. Reusch, Pogg., 120, 95, 1863 (earlier Brewster, etc.); Vogelsang, Arch. Néerland., **3**, 32, 1868; Schrauf, Ber. Ak. Wien, **60** (1), 996, 1869.

MASKELYNITE *Tschermak*, Ber. Ak. Wien, **65** (1), 127, 1872.

Isometric; form a distorted cube (?). In grains, transparent, colorless, with milky portions arising from alteration. In microscopic sections seen to have a rectangular outline, and shown by optical properties to be isotropic. H. = about 6·5. G. = 2·65 corrected for impurities. B.B. fusible with difficulty to a transparent glass. Analysis, 1*a*, also 1*b*, after deducting a little magnetite present:

| | | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | |
|---|---|---|---|---|---|---|---|
| 1*a*. | G. = 2·71 | $\frac{2}{2}$ 54·3 | 24·8 | 11·1 | 4·9 | 1·2 | $Fe_2O_3$,FeO 4·7, MgO *tr.* = 101·0 |
| 1*b*. | G. = 2·65 | 56·3 | 25·7 | 11·6 | 5·1 | 1·3 | = 100 |

Occurs in the meteorite from Shergotty, near Behar, India; also in other chondrites. Tschermak suggests that this apparently isometric mineral may be in fact a fused feldspar, which seems not improbable (Ber. Ak. Wien, **88** (1), 355, 1883). Groth, on the other hand, is inclined to regard it as an independent species allied to leucite (Tab. Ueb., 136, 1889).

### *Optical Relations of Oligoclase, Andesine, Labradorite.*

The general position of the axes of elasticity and the consequent directions of the light extinction upon the base, *c*, and the brachypinacoid, *b*, of these feldspars are given on pp. 326, 327. The following are special observations.

The following table gives for a series of plagioclase feldspars, oligoclase-albite to bytownite (p. 327) the observed extinction-angles on *b* and *c*, and the angle made by the trace of the rhombic section on *b* with the edge *b/c* (cf. f. 1–3, p. 326); also the percentage of lime (cf. anals., p. 337) and the specific gravity. The observations are taken from Schuster, l. c.; Wiik, Zs. Kr., **2**, 498, 1878; Pfd., Am. J. Sc., **34**, 390, 1887; Schuster and Foullon, l. c.; Bath, Jb. Min., 689, 1876.

| | G. | CaO | Extinction on c | Extinction on b | Rhombic section |
|---|---|---|---|---|---|
| Sobboth | | 2·67 (anal. 2) | + 2° 33′ | + 11° 36′ | |
| Wilmington | | 2·84 (anal. 3) | + 2° 29′ to 2° 03′ | + 11° 44′ to 11° 13′ | |
| Sillböle | 2·643 | | | 7° to 9° | 15° to 10° |
| Pierrepont | 2·622 | 3·05 (anal. 4) | | + 6° | + 10° |
| Tvedestrand | | 4·78 (anal. 11) | + 1° 10′ | + 3° 54′ | |
| Kimito | 2·664 | | | 0° | 4° to 5° |
| Bodenmais | | 7·08 (anal. 18) | − 1° to 2° 20′ | − 4° 30′ to 5° 15′ | |
| St. Raphael | | 8·21 | − 1° to 3° 6′ | − 4° 30′ to 8° | |
| Vesuvius | | | | | + 1° to 1½° |
| Stansvik | 2·670 | | | − 10° | 0° |
| Lojo | 2·699 | | | − 15° | 0° |
| Ojamo | | | − 4° 30′ to 4° 42′ | − 16° 40′ | − 1° to 2° |
| Labrador | | 10·33 | − 5° 12′ to 5° 24′ | − 17° to 18° 30′ | |
| " | 2·684 | 10·60 (anal. 25) | | − 19° | ± 0° |
| Kamenoi-Brod | | | − 6° 42′ to 6° 54′ | − 19° to 21° | |
| Närodal | | 15·20 (anal. 33) | − 14° 30′ to 20° | − 28° to 32° | − 8° 48′ |
| Vischegrad | | | | | − 10° |

The following are observations by Des Cloizeaux, Bull. Soc. Min., **6**, 89, 1883, **7**, 249, 1884, **8**, 6, 1885. He distinguishes four classes ranging from oligoclase-albite to andesine. The observations quoted give the lime percentage (from complete analyses by Damour, Dirvell, etc.); the extinction-angles on *c* and *b*; the axial angle about the negative bisectrix, and the angle made by the base with the plane, S, normal to the plane of the optic axes.

1. *Abnormal oligoclase.* Ax. plane inclined 83° 10′ to *b*. Plane ⊥ to ax. pl. (S) truncates the acute edge *b*/*c*. Extinction (edge *b*/*c*) + 6° or 7° to 12° on *b*.

2. *Abnormal oligoclase.* Ax. plane ∥ *c* or ⊥ *b*. Extinction-angle with edge *b*/*c* = + 6° to 9°.

3. *Normal oligoclase.* Plane ⊥ ax. pl. truncates obtuse edge *b*/*c* and inclined 98° to 104° on *c*. Ax. pl. cuts *b*, 84° 50′ to 79° 50′. Extinction + 1° to 6° with *b*/*c*.

4. *Andesine.* Plane ⊥ ax. pl. truncates obtuse edge *b*/*c* and inclined 110° to 120° to base. Ax. plane on *b*, 73° 50′ to 63° 50′. Extinction − 1° to 10° to *b*/*c*.

| | CaO percentage | Extinction on c | Extinction on b | Axial angle (− Bx) 2Hr | cS |
|---|---|---|---|---|---|
| Colton, N. Y. | 2·29 | +2° 40′ to 4° | 9° to 11° 30′ | 96° 30′ to 98° 2′ | 91° 10′ to 93′ |
| Arendal | 2·50 | 0° to + 2° | 10° to 12° 30′ | 97° 30′ to 98° 10′ | 94° |
| " | 2·60 | 0° to 1° 30′ | 9° to 12° | 96° 22′ to 97° 54′ | 93° to 94° |
| " | 2·81 | 0° to 2° | 10° to 12° | 96° 12′ | 94° |
| Colton | 2·44 | 0° 30′ to 3° 30′ | 9° to 10° | 95° 40′ to 97° 40′ | |
| Ytterby | 2·81 | 1° 30′ | 7° to 10° | 90° 48′ to 93° 54′ | |
| Arendal | 3·39 | 1° 30′ to 2° | 6° to 8° 30′ | 89° 56′ to 90° | |
| Mineral Hill, Pa. | 3·56 | 1° 45′ | 6° to 9° | 92° to 92° 48′ | |
| Ytterby | 4·81 | 2° | 8° 30′ to 9° 10′ | 95° to 95° 30′ | |
| Helle, Norway | 5·60 | 0° 30′ to 1° 30′ | 7° 10′ to 11° | 96° 24′ to 97° 28′ | |
| Bamle | 2·38 | 1° 15′ to 1° 35′ | 2° 12′ | 89° 48′ to 91° 46′ | 103° to 104° 30′ |
| Norway | 4·39 | 1° to 2° | 2° to 5° | 89° 2′ to 91° 30′ | 101° 50′ to 102° |
| Arendal | 4·20 | 0° 30′ to 1° | 2° to 4° | 87° 52′ to 90° 50′ | 99° to 100° |
| Tvedestrand, *sunstone* | | 1° 30′ | 2° to 4° | 89° 38′ | 106° |
| Fredriksvärn, *sunstone* | | 0° 30′ to 2° | 1° 30′ to 2° | 88° 40′ to 89° 10′ | 102° to 103° |
| Danviks-Zoll | | 0° 30′ to 1° | 1° to 3° | 99° 28′ to 101° 28′ | 101° to 102° 40′ |
| Moss, Norway | 6·20 | − 2° 30′ | − 1° to − 2° | | |
| Bodenmais | 6·48 | − 3° 16′ to 3° 20° | 5° to 7°[a] | 88° 14′ to 90° 50′[a] | 112° |
| Coromandel | 6·50 | − 1° 30′ to 2° | 2° to 3° | 93° 52′ to 95° 18′ | 108° |
| Francheville, Rhône | 6·52 | − 3° | 10° to 12° | 94° 23′ to 95° 30′ | 110° to 112°? |
| Tilasinwuori | 5·63 | 0° to − 3° | − 3° to 4° 30′ | 94° to 96° | 108° to 109° |
| Orijärvi | 8·09 | − 1° 57′ | 4° to 7°, 9° | 91° 20′ to 91° 38′[a] | 111° 50′ |
| Esterel | | − 2° 16′ | − 2° to 7° | 95° 40′ to 96° | 117° |
| Rochesauve | 9·05 | − 2° to − 3° | − 10° | 79° 22′ to 81° 50′ | 118° |

[a] Also larger values.

The glassy oligoclase from Bakersville, N. C., (anal. 13,) has an exceptionally abnormal character: extinction-angle on *c* = + 39° to + 40°, sections ∥ *b* give an optic axis with bar nearly ∥ edge *b*/*c*. Cleavage angle *bc* = 88° 2′, twinning entirely absent. Cf. Penfield, Am. J. Sc., **36**, 324, 1888.

**Anal.**—*Oligoclase to Bytownite.* 1, Rath, Pogg., **144**, 256, 1871. 2, A. Smita, Min. Mitth., 265. 1877. 3, Teclu, ib., 55, 1871. 4, F. L. Sperry, Am. J. Sc., **34**, 392, 1887. 5, Rath, Pogg., **138**, 466, 1869. 6, Ludwig, Pogg., **141**, 151, 1870. 7, Rath, Pogg., **147**, 274, 1872. 8, Id., ib., **144**, 240, 1871. 9, Id., ib., p. 236. 10, Id., Ber. Ak. Berlin, 165, 1876. 11, Scheerer, Pogg., **64**, 155, 1845. 12, Haushofer, Zs. Kr., **3**, 602, 1879. 13, E. S. Sperry, Am. J. Sc., **36**, 325, 1888; also F. W. Clarke, ib., p. 223. 14, Rath, Pogg., **144**, 242, 1871. 15, Id., Pogg., **147**, 276, 1872. 16, Id., Pogg., **144**, 226, 1871. 17, Rg., Min. Ch., 607, 1860. 18, Schuster and Foullon, Jb. G. Reichs., **37**, 219, 1887. 19, Rath, Pogg., **152**, 39, 1874. 20, Sipöcz, Min. Mitth., **3**, 176, 1880. 21, Rath, Pogg., **144**, 245, 1871, also earlier Rg. 22, W. B. Payne, priv. contr. 23, Tschermak, l. c., p. 586. 24, Klement, Min. Mitth., **1**, 366, 1878. 25, Penfield, Am. J. Sc., **34**, 393, 1887. 26, Rath, Pogg., **152**, 39, 1874. 27. Id., ib., **144**, p. 246. 28, Id., ib., **144**, p. 251. 29, Schuster, Min. Mitth., **1**, 367, 1878. 30, Rath, Pogg., **144**, 253, 1871. 31, Kersten, Pogg., **63**, 128, 1844. 32. Dmr., Bull. Soc. G. Fr., **7**, 88, 1850. 33, Ludwig, quoted by Schuster, Min. Mitth., **3**, 203, 1880. 34, Holland, Min. Mag., **8**, 154, 1889.

| | G. | | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | ign. | |
|---|---|---|---|---|---|---|---|---|---|
| *Oligoclase-Albite* and *Oligoclase.* | | | | | | | | | |
| 1. Hartenberg | 2·632 | $\frac{2}{2}$ | 63·58 | 21·81 | 2·32 | 6·84 | 3·65 | 0·43 | $Fe_2O_3$ 0·66, MgO 0·95 [= 100·35 |
| 2. Sobboth, Styria | 2·62 | | 64·75 | 22·25 | 2·67 | 10·17 | 0·37 | — | = 100·21 |
| 3. Wilmington, Del. | | | 64·75 | 23·56 | 2·84 | 9·04 | 1·11 | — | = 101·30 |
| 4. Pierrepont, N. Y. | 2·622 | | 63·76 | 22·67 | 3·05 | 6·89 | 3·60 | 0·40 | $Fe_2O_3$ 0·41 = 100·78 |
| 5. Vesuvius | 2·601 | $\frac{2}{2}$ | 62·36 | 23·38 | 2·88 | 7·42 | 2·66 | 0·13 | = 98·83 |
| 6. Ytterby | | $\frac{11}{11}$ | 64·81 | 22·99 | 3·15 | 8·89 | 0·82 | — | = 100·66 |
| 7. Shaitansk | 2·642 | $\frac{2}{2}$ | 63·83 | 22·58 | 3·42 | 8·86 | 1·02 | — | MgO 0·06 = 99·77 |
| 8. Veltlin | 2·632 | $\frac{2}{2}$ | 64·58 | 23·08 | 3·49 | 8·98 | 0·62 | 0·53 | = 101·28 |
| 9. Niedermendig | 2·611 | $\frac{2}{2}$ | 63·06 | 23·27 | 4·16 | 8·93 | 0·62 | — | = 100·04 |
| 10. Bamle | | | 61·91 | 23·68 | 4·45 | [9·64] | — | 0·32 | = 100 |
| 11. Tvedestrand, *sunstone* | 2·656 | | 61·30 | 23·77 | 4·78 | 8·50 | 1·29 | — | $Fe_2O_3$ 0·36 = 100 |
| 12. Dürrsmorsbach | 2·663 | | 59·30 | 25·75 | 4·79 | 5·63 | 2·78 | 1·29 | = 99·54 |
| 13. Bakersville, N. C. | 2·651 | | 62·60 | 23·52 | 4·47 | 8·62 | 0·56 | 0·10 | $Fe_2O_3$ 0·08 = 99·95 |
| *Andesine.* | | | | | | | | | |
| 14. Mte. Mulatto | 2·663 | $\frac{2}{2}$ | 60·35 | 25·45 | 5·14 | 7·63 | 1·21 | 0·26 | MgO 0·03 = 100·07 |
| 15. Uvelka, Orenburg | 2·654 | $\frac{2}{2}$ | 60·34 | 24·39 | 5·56 | 8·44 | 0·73 | — | $Fe_2O_3$ 0·18 = 99·64 |
| 16. Vesuvius | 2·647 | $\frac{2}{2}$ | 58·53 | 26·55 | 6·43 | 7·74 | 0·89 | — | = 100·14 |
| 17. Marmato | 2·674 | | 60·26 | 25·01 | 6·87 | 7·74 | 0·84 | — | MgO 0·14 = 100·86 |
| 18. Bodenmais | 2·666 | | 59·22 | 25·88 | 7·08 | 6·79 | 0·54 | — | MgO 0·28 = 99·79 |
| 19. Moganda, S. A. | 2·666 | | 60·48 | 25·35 | 7·25 | 7·28 | 0·08 | — | = 100·44 |
| 20. St. Raphael | 2·679 | | 58·48 | 26·94 | 8·21 | 6·87 | 0·50 | 0·49 | MgO 0·11 = 101·60 |
| 21. Fréjus, Esterel | 2·636 | $\frac{2}{2}$ | 58·03 | 26·64 | 8·07 | 6·16 | 0·97 | — | = 99·87 |
| 22. Sanford, Me. | | | 56·65 | 25·56 | 8·25 | 6·18 | 1·34 | 1·58 | $Fe_2O_3$ 0·22 = 99·78 |
| *Labradorite.* | | | | | | | | | |
| 23. Labrador | 2·697 | | 56·0 | 27·5 | 10·1 | 5·0 | 0·4 | — | $Fe_2O_3$ 0·7, MgO 0·1 [= 99·8 |
| 24. " | 2·698 | | 56·18 | 27·33 | 10·33 | 5·17 | 0·36 | — | $Fe_2O_3$ 1·38 = 100·75 |
| 25. " | 2·684 | | 54·75 | 27·76 | 10·60 | 5·13 | 0·53 | 0·56 | $Fe_2O_3$ 0·69 = 100·02 |
| 26. Pomasqui | 2·644 | | 55·86 | 28·10 | 10·95 | [5·09] | — | — | = 100 |
| 27. Veltlin | 2·690 | $\frac{2}{2}$ | 55·15 | 29·15 | 9·90 | 5·23 | 0·80 | 0·67 | = 100·90 |
| 28. Tannbergthal | 2·711 | | 53·61 | 29·68 | 10·96 | 4·36 | 1·15 | 0·65 | = 100·41 |
| 29. Kamenoi-Brod | 2·700 | | 54·55 | 28·68 | 11·23 | 4·62 | 0·42 | — | $Fe_2O_3$ 1·03 = 100·53 |
| 30. Hafnefiord | 2·729 | | 54·23 | 29·64 | 12·01 | 4·41 | *tr.* | 0·07 | MgO 0·11 = 100·47 |
| 31. Egersund | 2·72 | | 52·45 | 29·85 | 11·70 | 3·90 | 0·60 | — | $Fe_2O_3$ 1·00, MgO 0·16 [= 99·66 |
| *Bytownite.* | | | | | | | | | |
| 32. Berufiord | 2·709 | | 52·17 | 29·22 | 13·11 | 3·40 | — | — | $Fe_2O_3$ 1·90 = 99·80 |
| 33. Närodal | 2·729 | | 48·94 | 33·26 | 15·20 | 3·30 | — | — | = 100·60 |
| 34. Mull | 2·720 | | 50·80 | 31·54 | 12·83 | 3·96 | *tr.* | 0·52 | = 99·65 |

**320. ANORTHITE.** Matrix of Corundum (fr. the Carnatic, India) *Bourn.*, Phil. Trans., 1802. Indianite *Bourn.*, Cat., 60. 1817; *Phillips*, Min., 44. 1823. Anorthit (fr. Vesuv.) *G. Rose*, Gilb. Ann., **73**, 197, 1823. Cristianite (Christianite), Biotina (fr. Vesuv.). *Mont. & Cov.*, Min. Vesuv., 1825. Tankit (fr. Norway) *Breith.*, Schweigg. J., **55**, 246, 1829. Thiorsauit (fr. Iceland) *Genth*, Lieb. Ann., **66**, 18. 1848; Thiorsanit *bad orthogr.*

Latrobite (fr. Labrador) *Brooke*, Ann. Phil., **5**, 383, 1823; *Children*, ib., **8**, 38. 1824 = Diploit *Breith.*, C. G. Gmelin's Chem. Unters. Dipl., Tübingen, 1825. Amphodelit (fr. Finland) *N. Nd.*, Pogg., **26**, 488, 1832; = Lepolit *v. Jossa*, Breith. Handb., 531, 1847. Cyclopit *v. Walt.*, Vulk. Gest., 292, 1853. Anorthoït *Wiik*, Zs. Kr., **8**, 205, 1883. Lindsayit or Linseit *N. Nd.*, Vh. Min. Ges., 112, 1843.

Triclinic. Axes ă : b̄ : ć = 0·63473 : 1 : 0·55007; α = 93° 13⅓′, β = 115° 55½′, γ = 91° 11⅔′ Marignac[1].

100 ∧ 010 = 83° 54′, 100 ∧ 001 = 63° 57′, 010 ∧ 001 = 85° 50′.

**Forms**[2]:
*a* (100, *i*-ī, h)
*b* (010, *i*-ĭ, M)
*c* (001, *O*, P)

*m* (110, *I*′)
*φ* (120, *i*-2̆′)[4]
*f* (130, *i*-3̆′)
*M* ($1\bar{1}0$, ′*I*)
*ζ* ($1\bar{2}0$, ′*i*-2̆)[4]

*z* ($1\bar{3}0$, ′*i*-3̆)
*t* (207, ′$\frac{2}{7}$-ī′)
*q* ($\bar{2}01$, ′2-ī′)
*E* ($\bar{2}03$, ,$\frac{2}{3}$-ī,)
*D* ($\bar{3}04$, ,$\frac{3}{4}$-ī,)[3]?
*x* ($\bar{1}01$, ,1-ī,)
*y* ($\bar{2}01$, ,2-ī,)

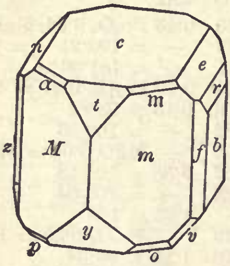
*γ* (013, $\frac{1}{3}$-ĭ′)
*Θ* (023, $\frac{2}{3}$-ĭ′)

*e* (021, 2-ĭ′)
*r* (061, 6-ĭ′)
*A* (081, 8-ĭ′)[3]
*B* ($0\bar{1}3$, ′$\frac{1}{3}$-ĭ)[3]
*k* ($0\bar{2}3$, ′$\frac{2}{3}$-ĭ)
*n* ($0\bar{2}1$, ′2-ĭ)
*ϑ* ($0\bar{4}1$, ′4-ĭ)
*C* ($0\bar{3}1$, ′3-ĭ)[3]?
*κ* ($0\bar{6}1$, ′6-ĭ)

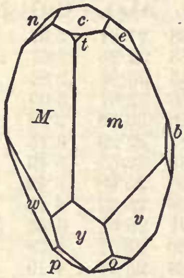
𝔪 (111, 1′)
*β* (241, 4-2̆′)
*s* ($\bar{4}23$, ,$\frac{4}{3}$-2̄)
*μ* ($\bar{4}21$, ,4-2̄)
*p* ($\bar{1}11$, ,1)
*g* ($\bar{2}21$, ,2)
*w* ($\bar{2}41$, ,4-2̆)
*i* ($\bar{4}\bar{2}3$, $\frac{4}{3}$-2̄,)
*d* ($\bar{4}\bar{2}1$, 4-2̄,)

*δ* ($\bar{1}\bar{1}2$, $\frac{1}{2}$,)
*o* ($\bar{1}\bar{1}1$, 1,)
*u* ($\bar{2}\bar{2}1$, 2,)
*v* ($\bar{2}\bar{4}1$, 4-2̆,)
*π* ($\bar{1}\bar{3}1$, 3-3̆,)
*α* ($1\bar{1}1$, ′1)
*χ* ($2\bar{4}1$, ′4-2̆)
*ρ* ($1\bar{3}1$, ′3-3̆)[3]

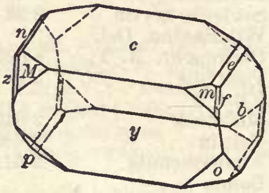
1.



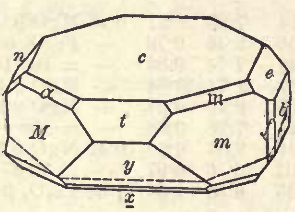
2.



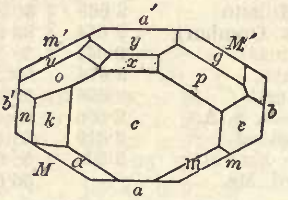
3.



4.



5.



Figs. 1–4, Rath; 1, 2, 4, from Vesuvius, 3, Pesmeda Alp. 5, *Lepolite*, Kk.

*bf* = 29° 29⅓′
*bm* = 58° 4′
*b′M* = 62° 26½′
*bz* = 30° 58′
*mM* = 59° 29′

*cq* = 34° 46′
*cx* = 51° 26′
*cy* = 81° 14′

*cγ* = 9° 14′
*cΘ* = 17° 49′
*ce* = 42° 38½′
*cr* = 67° 41′
*ck* = 18° 38′
*cn* = 46° 46′
*cκ* = 75° 10′

*c*𝔪 = 33° 17′
*cm* = 65° 53′

*cp* = 54° 17′
*cg* = 80° 18′
*cδ* = 30° 24′
*co* = 57° 52′
*cu* = 84° 50′
*cα* = 34° 10′
*cM* = 69° 20′
*b*𝔪 = 68° 51′

*bp* = 62° 13′
*bx* = 88° 20′
*bo* = 64° 53′
*bw* = 38° 41½′
*bg* = 58° 13′
*by* = 90° 32½′
*b′u* = 57° 26½′
*b′v* = 38° 16′
*b′α* = 76° 32′

Twins[5]: (1) *Albite law,* tw. pl. and comp.-face *b,* often polysynthetic. (2) *Pericline law,* tw. axis *b̄*, composition-face the rhombic section, whose trace on *b* makes an angle of − 14° to − 18° with the edge *b/c* (f. 2, p. 326). (3) *Carlsbad law,* tw. axis *ć*, the individuals also usually twinned according to law 1. (4) tw. axis[5] ⊥ *ć* in *b* (010).

Crystals usually prismatic ‖ *ć*, less often elongated ‖ *b̄*, like pericline (f. 3). Also massive, cleavable, with granular or coarse lamellar structure.

Cleavage: *c* perfect; *b* somewhat less so. Fracture conchoidal to uneven. Brittle. H. = 6–6·5. G. = 2·74–2·76. Color white, grayish, reddish. Streak uncolored. Transparent to translucent.

Optically −. Ax. pl. nearly ⊥ *e*, and its trace inclined 60° to the edge *c/e* from left above behind to right in front below (Schuster). Extinction-angles on *c*, − 34° to − 42° with edge *b/c*; on *b*, − 35° to − 43°. Dispersion $\rho < v$, also inclined. Axial angles:

$$2H_{a.r} = 84^\circ\ 50', \quad 2H_{a.gr} = 85^\circ\ 24', \quad 2H_{a.bl} = 85^\circ\ 59'.$$

The following table gives the extinction-angles and the position of the rhombic section, with CaO percentage (see anals. below), as observed by Schuster, l. c., Lsx., l. c., and Kikuchi, J. Coll. Sc. Japan, **2**, I, 31, 1888.

| | G. | $Na_2O$ | Extinction angles on *c* | Extinction angles on *b* | Rhombic section |
|---|---|---|---|---|---|
| Vesuvius | 2·763 | 0·47 | −36° 37′ to 37° 22′ | −38° to 39° 44′ | − 16° 2′ |
| Pesmeda | | 1·0 to 1·3 | −37° 30′ | − 38° 24′ | − 17° 54′ |
| Lojo, *Lepolite* | 2·7–2·8 | 1·50 $K_2O$ | | − 35° to 40° | −14° to 15° |
| Etna, *Cyclopite* | 2·682 | 2·32 | − 38° to 40° | − 35° to 36° | |
| Mikaje, Japan | 2·761 | 0·23 | − 38° to 40° | − 40° to 41° | −15° to 17° |

**Comp.**—A silicate of aluminium and calcium, $CaAl_2Si_2O_8$ or $CaO.Al_2O_3.2SiO_2$ = Silica 43·2, alumina 36·7, lime 20·1 = 100. Soda (as $NaAlSi_3O_8$) is usually present in small amount, and as it increases there is a gradual transition through bytownite to labradorite.

**Var.**—*Anorthite* was described from the glassy crystals of Somma; and *christianite* and *biotine* are the same mineral. *Thiorsauite* is the same from Iceland.

*Indianite* is a white, grayish, or reddish granular anorthite from India, where it occurs as the gangue of corundum, first described in 1802 by Count Bournon.

*Amphodelite* is a reddish gray or dingy peach-blossom-red variety, partly in rather large crystals, from Lojo, Finland, and Tunaberg, Sweden. *Lepolite* of Breithaupt (or, as he says, of von Jossa, who sent it to him) comes from Lojo and Orijärvi in Finland, and is the same variety; some of the crystals are 2 inches long. It has been studied crystallographically by Koksharov (Min. Russl., **4**, 234), who finds the crystals highly complex and near Vesuvian anorthite in angle. *Lindsayite* (Linseit, Lindseit) from Orijärvi, Finland, is a somewhat altered variety of lepolite, cf. Wiik, Zs. Kr., **8**, 205, 1883. *Latrobite*, from Amitok Island on the coast of Labrador, is pale rose-red, and closely resembles amphodelite.

*Cyclopite* occurs in small, transparent, and glassy crystals, tabular ‖ *b*, coating cavities in the doleryte of the Cyclopean Islands and near Trezza on Etna. Its identity with anorthite was established by Lasaulx, Zs. Kr., **5**, 326, 1881.

*Anorthoïte* agrees in angles with anorthite but is different in habit, being prismatic ‖ *ă* with *n* and *e* prominent; it shows extinction ‖ *ă* and in a direction normal it appears optically uniaxial. G. = 2·76. A partial analysis gave: $SiO_2$ 37 to 38, $Al_2O_3$ 32·2, CaO 13. The suggestion is made that it may be an anorthite partly altered to scapolite. The single crystal found was embedded in red limestone at the Sillböle iron mine in Finland. Cf. F. J. Wiik, Zs. Kr., **8**, 205, 1883.

*Tankite* occurs in cleavable masses, with *bc* = 86° 20′, of a gray or slightly pinkish color. The original crystals, examined by Dx., are stated to have been brought from Arendal in 1825 by Mr. Tank of Friedrikshold (Dx.). It is (Dx.) a hydrated anorthite, cf. anal. 6.

**Anal.**—1, Damour, Bull. G. Fr., **7**, 88, 1850. 2, Deville, Ann. Ch. Phys., **40**, 286, 1854. 3. Pisani, Ann Ch. Phys., **9**, 492, 1876. 4, Hermann, J. pr. Ch., **46**, 387, 1849. 5, Waltershausen, Vulk. Gest., 292, 1853. 6, Pisani, Dx., N. R., 199, 1867. 7, 8, Gamper, Vh. G. Reichs., 134, 1877. 9, Y. Kitamura, J. Coll. Sc. Japan, **2**, I, 43, 1888. 10, Abich, Pogg., **51**, 519, 1840. Also 5th Ed., p. 339.

| | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | ign. | |
|---|---|---|---|---|---|---|---|---|
| 1. Thiorsà, Iceland | 2·75 | 45·97 | 33·28 | 17·21 | 1·85 | — | — | $Fe_2O_3$ 1·12, gangue 0·69 = 100·12 |
| 2. St. Eustache | | 45·8 | 35·0 | 17·7 | 1·0 | — | — | MgO 0·9 = 100·4 |
| 3. Hammerfest | | 46·80 | 35·20 | 14·70 | 1·76 | | 1·62 | MgO 0·73 = 100·81 |
| 4. Lojo, *Lepolite* | 2·75 | 42·80 | 35·12 | 14·94 | 1·50 | — | 1·56 | $Fe_2O_3$ 1·50, MgO 2·27 = 99·69 |
| 5. Etna, *Cyclopite* | 2·682 | 41·45 | 29·83 | 20·83 | 2·32 | 1·72 | 1·91 | $Fe_2O_3$ 2·20, MgO 0·66 = 100·92 |
| 6. Arendal, *Tankite* | 2·897 | 42·49 | 34·70 | 15·82 | 1·60[a] | 0·63 | 4·80 | $Fe_2O_3$ 0·74, MgO 0·30 = 101·08 |
| 7. Pesmeda Alp, *red* | | 41·08 | 36·04 | 17·91 | 1·03 | 1·05 | 4·79 | = 101·90 |
| 8. " " *white* | | 42·79 | 34·78 | 15·98 | 1·36 | 0·62 | 4·13 | = 99·66 |
| 9. Miyake, Japan | 2·761 | 44·03 | 36·80 | 19·29 | 0·23 | — | 0·12 | MgO 0·20 = 100·67 |
| 10. Mt. Somma | 2·763 | $\frac{2}{2}$ 43·96 | 35·30 | 18·98 | 0·47 | 0·40 | — | $Fe_2O_3$ 0·63, MgO 0·45 = 100·19 |

[a] Incl. $Li_2O$.

**Pyr., etc.**—B.B. fuses at 5 to a colorless glass. Anorthite from Mte. Somma, and indianite from the Carnatic, are decomposed by hydrochloric acid, with separation of gelatinous silica.

**Obs.**—Occurs in some diorytes; occasionally in connection with gabbro and serpentine rocks; in some cases along with corundum; in many volcanic rocks, andesytes, basalts, etc.; as a constituent of some meteorites (Juvenas, Stannern).

Anorthite (*christianite* and *biotine*) occurs at Mount Vesuvius in isolated blocks among the old lavas in the ravines of Monte Somma, associated with sanidine, augite, mica, and vesuvianite; in the Albani Mts.; on the island of Procida near the entrance to the bay of Naples; on the Pesmeda Alp, Monzoni, Tyrol, as a contact mineral; Aranyer Berg, Transylvania, in andesyte; in the Faröer; on Iceland, on the plain of Thiorsâ, Hekla, and elsewhere; near Bogoslovsk in the Ural. In the lava of the island of Miyake, Japan, and also scattered on the lava field in well-defined separate crystals evidently ejected by the volcano; further in the anorthite-basalt of Fusiyama and elsewhere in Japan.

The localities of the special varieties of anorthite have already been mentioned.

*Anorthite* was named in 1823 by Rose from *ανορθός*, *oblique*, the crystallization being triclinic. Bournon's name, *Indianite*, derived from the locality in India, was first published in his Catalogue of the Royal Mineralogical Collection, in the year 1817. The species had been described by him as early as 1802 (l.c.), and his description is remarkably complete for the time, it including, besides physical characters, a chemical analysis by Chenevix, agreeing nearly in essential points with the later by Rose, and quite as well as his, with the true or normal composition of the mineral. Bournon supposed that the grains might be rhombohedral in crystallization; but Brooke, in Phillips' Mineralogy (3d ed.), published in 1823, the year of Rose's publication, announced that there were two cleavages, inclined to one another 84° 45′ and 95° 15′, differing not widely from the same angle as ascertained by Rose. Justice seems to require that Bournon's name should be restored to the species. Beudant, in the first edition of his mineralogy, published in 1824, described indianite in full and called it lime-feldspar, mentioning anorthite only in his index.

*Christianite* was named by Monticelli and Covelli after the prince Christian Frederick of Denmark, who explored Vesuvius with them; *Amphodelite* from *αμφί*, *double*, and *ὀδελός*, *spear*, the crystals being often twinned parallel to 010; *Latrobite*, after C. F. Latrobe, the discoverer of the variety.

**Alt.**—Lindsayite already mentioned is a partially altered anorthite; the same is probably true of sundvikite of A. E. Nordenskiöld, Beskr. Finl. Min., 113, 1855; see 5th Ed., p. 340. Rosite and polyargite of Svanberg, Ak. H. Stockh., 1840, are pinite-like pseudomorphs; rosite is from Aker in Södermanland, and polyargite from Tunaberg, Sweden. See 5th Ed., p. 480.

Crystals of anorthite altered to a saussurite-like substance from Franklin Furnace, N. J., have been described by Roepper (Am. J. Sc., **16**, 364, 1878).

**Artif.**—See albite, p. 331.

**Ref.**—[1] Kk., Min. Russl., **4**, 200, 1862. Cf. also Rose, Gilb. Ann., **73**, 197, 1823. [2] Mlr., Min., 376, 1852. Hbg., Min. Not., **1**, 6, 1856. Dx., Min., **1**, 294, 1862. Kk., l. c. Schrauf, Atlas, Tf. XVI, XVII, 1871. Gdt., Index, **2**, 24, 1888. Rath, Pogg., **147**, 22, 1872; Pesmeda Alp, Ber. nied. Ges., July 2, 1877. [3] Dx., tankite, N. R., 195, 1867. [4] Rath, Aranyer Berg, Zs. Kr., **5**, 23, 1881. [5] Twins, Rath, Pogg., **138**, 449, 1869, **147**, 36, 1872; Jb. Min., 689, 1876.

Barsowite *G. Rose*, Pogg., **48**, 567, 1839. Massive; coarse to fine granular. Cleavage in two directions at 90°, extinction parallel to the cleavage. Orthorhombic (or monoclinic). H. = 5·5–6. G. = 2·584 Bauer. Luster more or less pearly. Color white. Optically biaxial.

Composition probably like anorthite, $CaAl_2Si_2O_8$ or $CaO.Al_2O_3.2SiO_2$. Analyses: 1, Varrentrapp, Pogg., **48**, 568. 2, Friederici, Jb. Min., **2**, 71, 1880, after deducting the corundum present.

| | | $SiO_2$ | $Al_2O_3$ | CaO | MgO | Alk. | | |
|---|---|---|---|---|---|---|---|---|
| 1. | $\frac{3}{3}$ | 48·74 | 33·90 | 15·29 | 1·54 | — | = | 99·44 |
| 2. | $\frac{3}{3}$ | 41·54 | 36·59 | 19·82 | — | 2·05 | = | 100 |

B.B. fuses on the edges to a vesicular glass. Gelatinizes readily with hydrochloric acid, especially on heating.

Occurs in boulders in the auriferous sand of Barsovski near Kyshtymsk south of Ekaterinburg in the Ural as the gangue of the blue corundum; the occurrence is similar to that of the indianite which is the gangue of the corundum of the Carnatic. It is often intimately mixed with granular calcite, and incloses also corundum, spinel, and occasionally scales of a yellow mica. Bauer shows that it is chemically identical with anorthite, though apparently different optically and in specific gravity; it may yet prove to be that species, perhaps somewhat altered.

Huronite *Thomson*, Min., **1**, 384, 1836. An impure feldspar approaching anorthite. Occurs in spherical masses in diabase boulders on Drummond Id. in Lake Huron. Structure partly in imperfect folia, and partly granular. H. = 3–3·5; G. = 2·86; luster waxy to pearly: color light yellowish green; subtranslucent. Harrington has examined this mineral and confirmed its relation to anorthite. He gives: H. = 5·5; G. = 2·814; fusibility about 5. An analysis by N. N. Evans gave:

$SiO_2$ 47·07 $Al_2O_3$ 32·49 $Fe_2O_3$ 0·97 CaO 13·30 MgO 0·22 $K_2O$ 2·88 $Na_2O$ 2·03 ign. 2·72 = 101·68

A mineral similar to huronite occurs in place near Sudbury, Ontario; see Harrington, Trans. R. Soc. Canada, 4 (3), 82, 1886.

Mikrotin *G. Tschermak,* Ber. Ak. Wien, 50 (1), 606, 1865. A name proposed for glassy kinds of the plagioclase feldspars, corresponding to the variety sanidine of orthoclase; it is derived from *μικρότης, littleness,* in allusion to the small form in which they commonly appear, as, for example, embedded in volcanic rocks.

Sigterite *C. F. Rammelsberg,* Jb. Min., 2, 71, 1890.

Massive, granular. Cleavage easy, giving a surface with pearly luster; also in traces in a second direction, these regarded as corresponding in position to *c* (001) and *m* (110) of orthoclase. G. = 2·600–2·622. Luster vitreous to pearly. Color gray. Translucent.

Sections parallel to the first direction of cleavage and normal to the second show polysynthetic twinning lamellæ. For the former the angle between the directions of extinction is 7°–9°, i.e., the angle with the edge regarded as corresponding to *c/b* is ± 3½° to 4½°. Sections parallel to the second cleavage show no twinning structure and give an extinction-angle for the edge *c/b* of + 16°. The axial plane is nearly normal to a direction corresponding to *b* and is inclined to *c* in the positive direction (Tenne).

Comp.—$(Na,K)_2Al_2Si_3O_{10}$ or $(Na,K)_2O.Al_2O_3.3SiO_2$. With Na : K = 5 : 1, this requires: Silica 51·5, alumina 29·2, soda 14·8, potash 4·5 = 100.

Anal.—1, Raschig. 2, Rg. Also 3, 4, the same as 1, 2, after deducting, respectively, 3·84 and 6·03 p. c. augite.

| | $SiO_2$ | $Al_2O_3$ | $Na_2O$ | $K_2O$ | |
|---|---|---|---|---|---|
| 1. | 49·71 | 29·54 | 13·31 | 5·00 | FeO 1·34, CaO 0·66, ign. 0·42 = 99·98 |
| 2. | 50·16 | 28·64 | 13·63 | 3·96 | FeO 1·97, CaO 0·98, MgO 0·16, ign. 0·42 = 99·92 |
| 3. | 50·01 | 30·86 | 13·90 | 5·23 | = 100 |
| 4. | 50·54 | 30·64 | 14·58 | 4·24 | = 100 |

Occurs intimately associated with white albite and eudialyte at Sigtesö, in the Langesund-fiord, southern Norway.*

## II. Metasilicates. $RSiO_3$.

Salts of Metasilicic Acid, $H_2SiO_3$; characterized by an oxygen ratio of 2 : 1 for silicon to bases.

The following include all the well-marked groups among the Metasilicates. The Division closes with a number of species, in part of somewhat doubtful composition, forming a transition to the Orthosilicates.

1. **Leucite Group.**
2. **Pyroxene Group.**
3. **Amphibole Group.**
4. **Beryl Group.**
5. **Eudialyte Group.**
6. **Melanocerite Group.**

### 1. Leucite Group. Isometric.

In several respects leucite is allied to the species of the feldspar group, which immediately precede.

321. **Leucite** $KAl(SiO_3)_2$ Isometric at 500°
Pseudo-isometric at ordinary temperatures.

322. **Pollucite** $H_2Cs_4Al_4(SiO_3)_9$ Isometric

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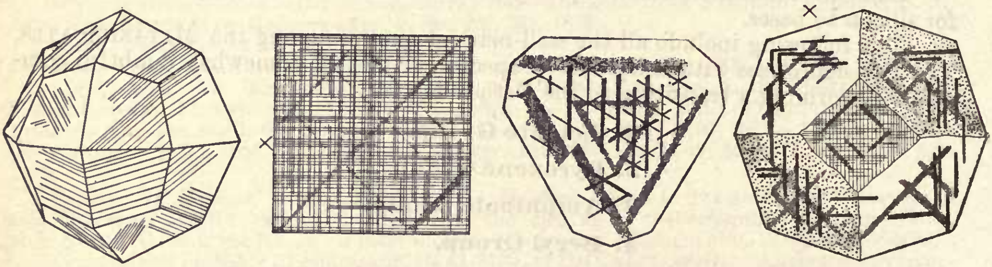
* A later optical investigation by Tenne (Jb. Min., 2, 206, 1891) has shown that the above supposed new species of feldspar is merely an intimate mixture of albite and elæolite. This conclusion finds confirmation in the composition obtained, and is accepted by Rammelsberg. Brögger states further (priv. contr.) that the locality is Sigtesö, not Sigterö.

**321. LEUCITE.** Weisse Granaten, Weisse granat-förmige Schörl-Crystallen (fr. Vesuvius), *J. J. Ferber*, Briefe aus Wälschland, 165, 176, etc., 1773. Basaltes albus polyedrus granatiformis, etc., *v. Born*, Lithoph., **2**, 73. 1775. Schorl blanc *Fr. Trl.* of Ferber. Grenats blancs calcinés (fr. Vesuvius, where called Occhio di Pernice, Rome, etc.) *de Saussure*, J. Phys., **7**, 21, 1776. Œil de Perdrix, Grenats blancs, altérés par une vapeur acide qui ayant dissout le fer a laissé les grénats dans un état de blancheur, *Sage*, Min., **1**, 317, 1777; *de Lisle*, **2**, 330, 1783. Weisse Granaten *Hoffm.*, Bergm. J., 454, 474, 1789. White Garnet. Leucit *Wern.*, Bergm. J., **1**, 489, 1791, Höpfner's Mag. N. Helvet., **4**, 241. Leucite *H.*, J. Mines, **5**, 260, 1799. Amphigène *H.*, Tr., **2**, 1801.

Isometric at 500° C.; pseudo-isometric under ordinary conditions (see below). Commonly in crystals varying in angle but little from the tetragonal trisoctahedron *n* (211, 2-2), with *a* (100, *i-i*), and *d* (110, *i*) sometimes present as subordinate forms. Faces often showing fine striations due to twinning. Also in disseminated grains; rarely massive granular.

Cleavage: *d* (110) very imperfect. Fracture conchoidal. Brittle. H. = 5·5–6. G. = 2·45–2·50. Luster vitreous. Color white, ash-gray or smoke-gray. Streak uncolored. Translucent to opaque. Refractive index: $n_r$ = 1·507 Dx. (1862). Usually shows very feeble double refraction : $\omega = 1·508$, $\epsilon = 1·509$ Dx. (1874).

The anomalous double refraction[1] of leucite was early noted (Brewster, Biot, Dx.) and variously explained. In 1873, Rath, on the basis of careful measurements, referred the seemingly isometric crystals to the tetragonal system; the trapezohedral face 112 being taken as 111, and 211, 121 as 421, 241 respectively; also 101, 011 as 201, 021. Later Weisbach (1880), on the same ground, made them orthorhombic; Mallard, however, referred them (1876), chiefly on optical grounds, to the monoclinic system, and Fouqué and Lévy (1879) to the triclinic. The true symmetry, corresponding to the molecular structure which they possess or tend to possess at ordinary temperatures, is in doubt, but it has been shown (Klein, Pfd.) that at 500° to 600° sections become isotropic; and further (Rosenbusch) that the twinning striations disappear on heating, to reappear again in new position on cooling. Sections ordinarily show twinning lamellæ ‖ *d* (110); in some cases a bisectrix (+) is normal to what corresponds to a cubic face, the axial angle being very small. The structure corresponds in general (Klein) to the interpenetration of three crystals, in twinning position ‖ *d*, which may be equally or unequally developed; or there may be one fundamental individual with inclosed twinning lamellæ (cf. figs. 2–4).



1, Common form, with twinning striations, Rath. 2–4. Sections, showing twinning lamellæ, as seen in polarized light, Klein: 2, section ‖ 001, showing fine tw. lamellæ ‖ 110, also others less numerous and sharp, parallel to two other dodecahedral faces; 3, section ‖ 111, with tw. lamellæ; 4, ‖ cubic face, composite crystal, of three individuals, cf. f. 2.

**Comp.**—A metasilicate of aluminium and potassium, $KAl(SiO_3)_2$ or $K_2O.Al_2O_3.4SiO_2$ = Silica 55·0, alumina 23·5, potash 21·5 = 100.

Soda is present only in small quantities, unless as introduced by alteration; traces of lithium, also of rubidium and cæsium, have been detected.

**Anal.**—1, Rg., Min. Ch., Erg., 151, 1886. 2, Rath, Pogg., **147**, 272, 1872; 3, Id., ibid., Erg., **6**, 209, 1873. 4. Lemberg, Zs. G. Ges., **28**, 537, 1876. 5, E. Scacchi, Rg., l. c., 151, 1886. **6**, Berwerth, Min. Mitth., 66, 1876. 7, Schulze, Jb. Min., **2**, 114, 1880. Also 5th Ed., p. 334.

| | | $SiO_2$ | $Al_2O_3$ | $K_2O$ | $Na_2O$ | CaO | | |
|---|---|---|---|---|---|---|---|---|
| 1. Vesuvius, erupt. 1845 | | 55·28 | 24·08 | 20·79 | 0·60 | — | | = 100·75 |
| 2. " | G. = 2·468 | 55·58 | 23·38 | 19·53 | 1·50 | 0·26 | | = 100·25 |
| 3. " | G. = 2·479 | 55·21 | 23·70 | 19·83 | 1·21 | 0·43 | | = 100·38 |
| 4. " | | 56·04 | 23·38 | 18·90 | 1·41 | 0·20 | $H_2O$ 0·32 | = 100·25 |
| 5. Rocca Monfina | | 55·16 | 22·15 | 21·08 | 0·33 | — | $H_2O$ 1·04 | = 99·76 |
| 6. Acquacetosa | | 55·18 | 23·65 | 19·40 | 0·32 | 0·83 | FeO, MgO *tr.* | = 99·38 |
| 7. Albani Mts | G. = 2·479 | 54·91 | 22·85[a] | 21·48 | 0·41 | — | | = 99·65 |

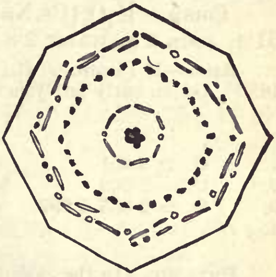
[a] $Fe_2O_3$, *tr.*

Potash, regarded long as an alkali exclusively of the vegetable kingdom, was first found among minerals in this species by Klaproth, whose earliest analysis was made in 1796.

**Pyr., etc.**—B.B. infusible; with cobalt solution gives a blue color (aluminium). Decomposed by hydrochloric acid without gelatinization.

**Obs.**—Leucite belongs peculiarly to the more recent volcanic rocks; thus it occurs in embedded crystals, grains or aggregates of grains, with nephelite in leucite-basalts and leucitytes (leucitophyr or amphigenyte); with nephelite and sanidine in phonolyte, and with plagioclase in leucite-tephrytes. The crystals usually show twinning lamellæ in polarized light, and further are often characterized by the symmetrical arrangement of inclusions (f. 5) of glass, or of microlites of augite, magnetite, etc. Clear glassy crystals occur in ejected volcanic masses or in crevices in lava, as at Mte. Somma.

5.



Section with symmetrical inclusions, Zirkel.

The prominent localities are, first of all, Vesuvius and Mte. Somma, where it is thickly disseminated through the lava in grains, and in large perfect crystals; also in ejected masses. It occurs also near Rome, at Borghetta to the north, and Albano and Frascati to the south; some of the older lavas appear to be almost entirely composed of it. Prominent localities are Capo di Bove, Rocca Monfina, etc. The leucitic lava of the neighborhood of Rome has been used for the last two thousand years, at least, in the formation of mill-stones. Mill-stones of this rock have been discovered in the excavations at Pompeii. Further in leucite-tephryte at Proceno near Lake Bolsena in central Italy. Outside of Italy, it is found about the Laacher See and at several points in the Eifel, as at Olbrück in phonolyte; at Rieden near Andernach; at Meiches in the Vogelsgebirge; in the Kaiserstuhlgebirge; in altered form at several points (see below).

Occurs in Brazil, at Pinhalzinho. At Byrock, near Bourke, and at El Capitan, near Cobar, New South Wales. In basalt on the island Bawean near Java. In leucite-basanyte on the south-east of Mt. Kibo, Kilima-njaro, Equatorial Africa. From the Cerro de las Virgines, Lower California. In the United States it forms a rock in the Green River Basin at the Leucite Hills, Wyoming (Zirkel): also in the Absaroka range, in northwestern Wyoming (Hague, Am. J. Sc., 38, 43, 1889). See also p. 1041.

Named by Werner from λευκός, *white*, in allusion to its color. Haüy's name, *Amphigene*, is of later date, and is from ἄμφι, *both*, and γένος, *kind*, in allusion to the supposed existence of cleavage in two directions, and to his fanciful inference therefrom of two "primitive forms;" it has therefore the best of claims for rejection.

**Alt.**—Feldspar, nephelite, and kaolin occur with the form of leucite, as a result of its alteration. The glassy feldspar pseudomorphs were first announced by Scacchi, and since by Blum. Analcite is also a common alteration-product of leucite. For analyses of altered leucite see Rg., Min. Ch., 443, 1875, also 5th Ed., p. 335.

E. Scacchi has described crystals altered to orthoclase, Rend. Acc. Napoli, Dec., 1884; Sauer, others altered to potash feldspar and muscovite from the Oberwiesenthal in the Erzgebirge, Zs. G. Ges., **37**, 441, 1885. Kunz has described crystals having the form of leucite from Magnet Cove, Ark., and approximating to a potash feldspar in composition, Am. J. Sc., **31**, 74, 1886; these are shown by Williams (cf. p. 426) to consist of orthoclase and elæolite. The phonolyte (tinguayte) of the Serra de Tingua, Brazil, also contains pseudo-crystals of leucite (Hussak, Jb. Min., **1**, 166. 1890).

Lemberg has shown that soda can be readily introduced into the composition of leucite by the action of melting sodium chloride, a soda-leucite (Natronleucit) resulting; while it is possible to change the latter also back to a potash-leucite. Further he has shown that leucite can be resolved into a mixture of sanidine and anorthite or microsommite, or all into andesine. See further Zs. G. Ges., **28**, 611–615, 1876.

**Artif.**—Formed by Fouqué & Lévy, Bull. Soc. Min., **3**. 118, 1880; also an iron leucite by Hautefeuille, C. R., **90**, 313, 378, 1880. Ch. and G. Friedel have obtained leucite in tetragonal forms, optically −, by heating for two days at about 500° a mixture of muscovite with about half its weight of calcined silica and 0·7 of potash; orthoclase and nephelite were obtained at the same time, Bull. Soc. Min., **13**, 134, 182, 1890. See Fouqué-Lévy, Synth. Min., 150–155, 1882.

**Ref.**—[1] Rath, Pogg. Erg., **6**, 198, 1873; Jb. Min., 113, 1873, 281, 403, 1876. Hirschwald, Min. Mitth., 227, 1875; Jb. Min., 519, 733, 1876; Min. Mitth., **1**, 85, 1878. Mallard, Ann. Mines, **10**, 79, 1876. Tschermak, Min. Mitth., 66, 1876. Baumhauer, Zs. Kr., **1**, 257, 1877; Min. Mitth., **1**, 287, 1878. Fouqué-Lévy, Min Micr., 1879. Weisbach, Jb. Min., **1**, 143, 1880. Klein, Nachr. Ges. Göttingen, 421, Nov. 26, 1884; Jb. Min., Beil., **3**, 522, 1885; ibid., **2**, 49, 1884. Penfield, Jb. Min., **2**, 224, 1884. Rath, Ber. nied. Ges., 115, 1883, June 6, 1887. Rosenbusch, Jb. Min., **2**, 59, 234, 1885, and Mikr. Phys., 270, 1885.

**322. POLLUCITE.** Pollux *Breith.*, Pogg., **69**, 439, 1846.

Isometric. Observed forms[1]:

*a* (100, *i-i*); *d* (110, *i*); *e*'(210, *i*-2)?; *n* (211, 2-2

Often in cubes with form *n*, also *d* striated transversely; rarely other forms more or less rounded. Also massive.

Cleavage in traces. Fracture conchoidal. Brittle. H. = 6·5. G. = 2·901 Pisani. Luster vitreous and bright on surface of fracture, but sometimes dull and gum-like externally. Colorless. Transparent. Refractive indices: $n_r = 1·515$, $n_y = 1·517$, $n_{bl} = 1·527$ Dx[2].

**Comp.**—$H_2O.(Cs,Na)_2O.Al_2O_3.5SiO_2$ = Silica 47·0, alumina 16·0, cæsium oxide 31·4, soda 2·8, water 2·8 = 100 Rg. Here Cs : Na = 5 : 2. See further, p. 1044.

**Anal.**—1, Pisani, C. R., **58**, 714, 1864. 2, Rg., Ber. Ak. Berlin, 9, 1878. 3, 4, Id., ib., 669, 1880. On an early analysis by Plattner and its interpretation, 5th Ed., p. 249.

| | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Cs_2O$ | $Na_2O$ | $Li_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | G. = 2·901 | 44·03 | 15·97 | 0·68 | 34·07 | 3·88 | *tr.* | *tr.* | 2·40 | CaO 0·68=101·71 |
| 2. | G. = 2·868 | [48·15] | 16·31 | — | 30·00 | 2·48 | — | 0·47 | 2·59 | = 100 |
| 3. | G. = 2·885–2·897 | 46·48 | 17·24 | — | 30·71 | 2·31 | — | 0·78 | 2·34 | = 99·86 |
| 4. | | — | — | — | 30·53 | 2·19 | — | 0·41 | — | |

**Pyr., etc.**—In the closed tube becomes opaque and yields water, but only at a high temperature. In the forceps whitens, fuses with difficulty, coloring the flame yellow. In hydrochloric acid slowly decomposes, with separation of pulverulent silica.

**Obs.**—Occurs very sparingly in the island of Elba, with petalite (castorite) in cavities in granite. Named from Pollux (the genitive of which is Pollucis), of heathen mythology.

**Ref.**—[1] Corsi, Zs. Kr., **6**, 200, 1881. [2] N. R., 8, 1867.

## 2. Pyroxene Group.

Orthorhombic, Monoclinic, Triclinic.

Composition $RSiO_3$ with R = Ca,Mg,Fe chiefly, also Mn,Zn. Further $RSiO_3$ with $\overset{II}{R}(Fe,Al)_2SiO_6$, less often with $\overset{I}{R}Al(SiO_3)_2$. Rarely including zirconium and titanium, also fluorine.

### α. *Orthorhombic Section.*

| | | | $\breve{a} : \bar{b} : \dot{c}$ | or | $\bar{b} : \breve{a} : \dot{c}$ |
|---|---|---|---|---|---|
| **323.** | **Enstatite** | $MgSiO_3$ | 0·9702 : 1 : 0·5710 | | 1·0307 : 1 : 0·5885 |
| | Bronzite | $(Mg,Fe)SiO_3$ | | | |
| **324.** | **Hypersthene** | $(Fe,Mg)SiO_3$ | 0·9713 : 1 : 0·5704 | | 1·0319 : 1 : 0·5872 |

The second set of axial ratios, with $\breve{a} = 1$, brings out distinctly the similarity of the form to the monoclinic species. This resemblance is exhibited still more clearly if, as suggested by Rath and Tschermak and later adopted by Groth, the monoclinic species are referred to axes having $\beta = 90°$ nearly (see pyroxene); on the other hand this change involves a sacrifice in simplicity of symbols and for other more fundamental reasons is not to be recommended.

### β. *Monoclinic Section.*

| | | | $\grave{a} : \bar{b} : \dot{c}$ | $\beta$ |
|---|---|---|---|---|
| **325.** | **Pyroxene** | | 1·0921 : 1 : 0·5893 | 74° 10′ |
| | DIOPSIDE | $\left\{ \begin{array}{l} CaMg(SiO_3)_2 \\ Ca(Mg,Fe)(SiO_3)_2 \end{array} \right.$ | | |
| | Malacolite, Salite, Diallage, etc. | | | |
| | HEDENBERGITE | $CaFe(SiO_3)_2$ | | |
| | Manganhedenbergite | $Ca(Fe,Mn)(SiO_3)_2$ | | |
| | SCHEFFERITE | $(Ca,Mg)(Fe,Mn)(SiO_3)_2$ | | |
| | Jeffersonite | $(Ca,Mg)(Fe,Mn,Zn)(SiO_3)_2$ | | |
| | AUGITE | $\left\{ \begin{array}{l} Ca(Mg,Fe)(SiO_3)_2 \\ \text{with } (Mg,Fe)(Al,Fe)_2SiO_6 \end{array} \right.$ | | |
| | Leucaugite, Fassaite, Augite. Also some Diallage. | | | |

| | | | $\grave{a} : \overset{1}{b} : \acute{c}$ | $\beta$ |
|---|---|---|---|---|
| 326. | **Acmite** | $Na\overset{III}{Fe}(SiO_3)_2$ | 1·0996 : 1 : 0·6012 | 73° 11′ |
| | Aegirite | | | |
| 327. | **Spodumene** | $LiAl(SiO_3)_2$ | 1·1238 : 1 : 0·6355 | 69° 40′ |
| 328. | **Jadeite** | $NaAl(SiO_3)_2$ | Triclinic? | |

| | | | $\grave{a} : \overset{1}{b} : \acute{c}$ | $\beta$ |
|---|---|---|---|---|
| 329. | **Wollastonite** | $CaSiO_3$ | 1·0531 : 1 : 0·9676 | 84° 30′ |
| 330. | **Pectolite** | $HNaCa_2(SiO_3)_3$ | 1·1140 : 1 : 0·9864 | 84° 40′ |
| 331. | **Rosenbuschite** | $Na_2Ca_3((Si,Zr,Ti)O_3)_4$ | 1·1687 : 1 : 0·9572 | 78° 13′ |
| 332. | **Låvenite** | $(Na_4,Ca_2,Mn_2,Zr)((Si,Zr)O_3)_2$ | 1·0964 : 1 : 0·7152 | 69° 42′ |
| 333. | **Wöhlerite** | $12(Na_2,Ca)(Si,Zr)O_3.RNb_2O_6$ | 1·0549 : 1 : 0·7091 | 70° 45′ |

In låvenite and wöhlerite fluorine also enters, and låvenite like wöhlerite also contains niobium but in smaller amount, and both contain titanium; see further under these species.

### $\gamma$. *Triclinic Section.*

| | | | | $\alpha$ | $\beta$ | $\gamma$ |
|---|---|---|---|---|---|---|
| | | | $\breve{a} : \bar{b} : \acute{c}$ | | | |
| 334. | **Hiortdahlite** | $(Na_2,Ca)Fe((Si,Zr)O_3)_2$ | 0·9984:1:0·3512 | 89°22½′ | 90°37′ | 90°6′ |
| | | | $\bar{a} : b : \acute{c}$ | $\alpha$ | $\beta$ | $\gamma$ |
| | or (p. 377) cf. wöhlerite | | 1·0583:1:0·7048 | 90°29′ | 108°49½′ | 90°8′ |

Hiortdahlite also contains fluorine and titanium in small amount.

| | | | $\bar{a} : \breve{b} : \acute{c}$ | $\alpha$ | $\beta$ | $\gamma$ |
|---|---|---|---|---|---|---|
| 335. | **Rhodonite** | $MnSiO_3$ | 1·0729:1:0·6213 | 103°18′ | 108°44′ | 81°39′ |
| | Pajsbergite, Bustamite | $(Mn,Ca)SiO_3$<br>$(Mn,Fe)SiO_3$ | | | | |
| | Fowlerite | $(Mn,Zn,Fe,Ca)SiO_3$ | | | | |

| | | | $\bar{a} : \breve{b} : \acute{c}$ |
|---|---|---|---|
| 336. | **Babingtonite** | $(Ca,Fe,Mn)SiO_3.Fe_2(SiO_3)_3$ | 1·0691 : 0·6308 |

$\alpha = 104°\ 21\tfrac{1}{2}'$ $\beta = 108°\ 31'$ $\gamma = 83°\ 34'$

The Pyroxene Group embraces a number of species which, while falling in different systems—orthorhombic, monoclinic, and triclinic—are yet closely related in form. Thus all have a fundamental prism with an angle of 93° and 87°, parallel to which there is more or less distinct cleavage. Further, the angles in other zones show a greater or less degree of similarity as exhibited in the descriptions which follow. In composition the metasilicates of calcium, magnesium, and ferrous iron are most prominent, while compounds of the form $\overset{II}{R}(Al,\overset{III}{Fe})_2SiO_6$, $\overset{I}{R}Al(SiO_3)_2$ are also important (Tschermak).

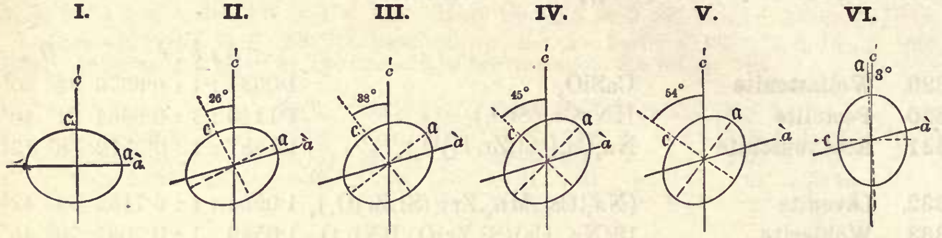
The species of the pyroxene group are closely related in composition to the corresponding species of the amphibole group, which also embraces members in the orthorhombic, monoclinic, and triclinic systems. In a number of cases the same chemical compound appears in each group; furthermore, a change by paramorphism of pyroxene to amphibole is often observed. In form also the two groups are related. Thus we have respectively for the typical monoclinic species:

Pyroxene $\grave{a} : \overset{1}{b} : \acute{c} = 1·0921 : 1 : 0·5893$ $\beta = 74°\ 10'$

Amphibole $\grave{a} : \tfrac{1}{2}\overset{1}{b} : \acute{c} = 1·1022 : 1 : 0·5875$ $\beta = 73°\ 58'$

The relation is further shown in the parallel growth of crystals of monoclinic amphibole upon or about those of pyroxene. This and other related points are illustrated in the pages which follow.

The relation of the prominent members of the Pyroxene Group optically, especially as regards the connection between the position of the axes of light-elasticity and the crystallographic axes is exemplified in the following figures (from Cross, Am. J. Sc., **39**, 359, 1890). A corresponding exhibition of the prominent amphiboles is given under that group.



I, Enstatite, etc. II, Spodumene. III, Diopside, etc. IV, Hedenbergite, Augite. V, Augite. VI, Ægirite (p. 366).

### *α. Orthorhombic Section.*

**323. ENSTATITE.** Diallage métalloïde pt. *H.*, Tr., 1801. Bronzit *Karst.*, Klapr., Gehlen's J., **4**, 151, 1807; *Karst.*, Tab., 40, 91, 1808; *Klapr.*, Beitr., **5**, 34, 1810. Blättriger Anthophyllit *Wern.*, 1808, Hausm. Entw., 1809. Bronzite. Broncit. Chladnite *Shep.*, Am. J. Sc., **2**, 381, 1846; Shepardite *Rose*, Beschr. Meteor., 29, 1864. Enstatit *Kenng.*, Ber. Ak. Wien, **16**, 162, 1855. Protobastit *A. Streng.*, Zs. G. Ges., **13**, 71, 1861. Victorite *Meunier*, Ber. Ak. Wien, **61** (2), 26, 1870.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}97020 : 1 : 0{\cdot}57097$ Lang[1].
$100 \wedge 110 = {}^*44^\circ\ 8'$, $001 \wedge 101 = 30^\circ\ 28\frac{2}{3}'$, $001 \wedge 011 = 29^\circ\ 43\frac{1}{2}'$.

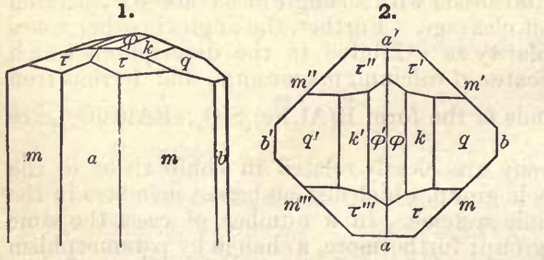
**Forms**[1]:
$a$ (100, $i\text{-}\bar{i}$)
$b$ (010, $i\text{-}\breve{i}$)
$c$ (001, $O$)
$\mu$ (310, $i\text{-}\bar{3}$)
$\delta$ (520, $i\text{-}\bar{\frac{5}{2}}$)
$z$ (210, $i\text{-}\bar{2}$)

$m$ (110, $I$)
$d$ (350, $i\text{-}\breve{\frac{5}{3}}$)
$n$ (120, $i\text{-}\breve{2}$)
$\lambda$ (250, $i\text{-}\breve{\frac{5}{2}}$)
$f$ (140, $i\text{-}\breve{4}$)
$r$ (201, $2\text{-}\bar{i}$)
$s$ (502, $\frac{5}{2}\text{-}\bar{i}$)

$\phi$ (016, $\frac{1}{6}\text{-}\breve{i}$)[2]
$h$ (014, $\frac{1}{4}\text{-}\breve{i}$)[3]
$\gamma$ (027, $\frac{2}{7}\text{-}\breve{i}$)[2]
$k$ (012, $\frac{1}{2}\text{-}\breve{i}$)
$q$ (023, $\frac{2}{3}\text{-}\breve{i}$)[2]
$t$ (011, $1\text{-}\breve{i}$)
$\beta$ (021, $2\text{-}\breve{i}$)
$\omega$ (031, $3\text{-}\breve{i}$)

$\tau$ (223, $\frac{2}{3}$)[2]
$o$ (111, 1)
$x$ (221, 2)
$g$ (412, $2\text{-}\bar{4}$)
$\rho$ (623, $2\text{-}\bar{3}$)
$e$ (212, $1\text{-}\bar{2}$)
$i$ (211, $2\text{-}2$)

$y$ (421, $4\text{-}\bar{2}$)
$\zeta$ (321, $3\text{-}\bar{\frac{3}{2}}$)
$\psi$ (432, $2\text{-}\bar{\frac{4}{3}}$)
$\epsilon$ (343, $\frac{4}{3}\text{-}\breve{\frac{4}{3}}$)[2]
$u$ (232, $\frac{3}{2}\text{-}\breve{\frac{3}{2}}$)
$v$ (121, $2\text{-}\breve{2}$)
$w$ (252, $\frac{5}{2}\text{-}\breve{\frac{5}{2}}$)



Figs. 1, 2, Bamle, Rath.

$zz''' = 51^\circ\ 45'$
$mm''' = 88^\circ\ 16'$
$nn' = 54^\circ\ 32'$
$rr' = 99^\circ\ 18'$
$\phi\phi' = 10^\circ\ 52'$
$kk' = {}^*31^\circ\ 52'$
$qq' = 41^\circ\ 41'$
$m\tau = 61^\circ\ 20'$
$mo = 50^\circ\ 39'$
$mx = 31^\circ\ 22\frac{1}{2}'$
$ce = 33^\circ\ 11'$
$ci = 52^\circ\ 36'$

$cu = 55^\circ\ 31'$
$\tau\tau' = 40^\circ\ 16\frac{1}{2}'$
$oo' = 54^\circ\ 8'$
$xx' = 75^\circ\ 35'$
$ee' = 59^\circ\ 1'$
$ii' = 91^\circ\ 15'$
$uu' = 48^\circ\ 10'$
$\tau\tau''' = 39^\circ\ 1\frac{1}{2}'$
$oo''' = 52^\circ\ 24'$
$xx''' = 72^\circ\ 57'$
$ee''' = 27^\circ\ 39'$
$ii''' = 20^\circ\ 35'$
$uu''' = 72^\circ\ 52'$

Twins rare: tw. pl.[4] *h* (014), forming twinning lamellæ; also tw. pl. 101 as stellate twins crossing at angles of nearly 60°, sometimes six-rayed (Becke) analogous to the pyroxene twins with tw. pl. 122. Distinct crystals rare, habit prismatic. Usually massive, fibrous or lamellar.

Cleavage: *m* easy. Parting ∥ *b*; also *a*. Fracture uneven. Brittle. H. = 5·5. G. = 3·1–3·3. Luster a little pearly on cleavage-surfaces to vitreous; often metalloidal in the bronzite variety. Color grayish white, yellowish white, greenish white, to olive-green and brown. Pleochroism weak, more marked in varieties relatively rich in iron. Streak uncolored, grayish. Translucent to nearly opaque.

Optically +. Ax.-pl. ∥ *b*. Bx ⊥ *c*. Dispersion $\rho < v$ weak. Axial angle large and variable, increasing with the amount of iron, usually about 90° for FeO = 10 p. c. Axial angles and FeO percentage[5].

| | Aloysthal | Leiperville | Greenland | Balsfiord | Kraubat | Lauterbach |
|---|---|---|---|---|---|---|
| $2H_o$ | 133° 8′ | 123° 38′ | 114° 15′ | 112° 30′ | 106° 51′ | 101° 30′ |
| Fe(Mn)O | 2·76 | 5·77 | 11·14 | 8 42 | 9·80 | 10·62 |

Also, Lévy-Lcx. $\alpha_y = 1·665$ $\beta_y = 1·669$ $\gamma_y = 1·674$ Offret 2V = 70°

**Comp., Var.**—$MgSiO_3$ or $MgO.SiO_2$ = Silica 60, magnesia 40 = 100. Also $(Mg,Fe)SiO_3$ with Mg : Fe = 8 : 1, 6 : 1, 3 : 1, etc.

**Var.**—1. *With little or no iron; Enstatite.* Color white, yellowish, grayish, or greenish white; luster vitreous to pearly; G. = 3·10–3·13. *Chladnite,* Shepardite of Rose, which makes up 90 p. c. of the Bishopville meteorite, belongs here and is the purest kind. *Victorite,* occurring in the Deesa meteoric iron in rosettes of acicular crystals, is similar.

2. *Ferriferous; Bronzite.* Color grayish green to olive-green and brown. Luster of cleavage-surface often adamantine-pearly to submetallic or bronze-like; this, however, is usually of secondary origin and is not essential.

With the increase of iron (above 12 to 14 p. c.) bronzite passes to hypersthene, the optic axial angle changing so that in the latter $\mathfrak{a} = Bx_a$ and $Bx_a \perp a$.

**Anal.**—1, Hauer, Ber. Ak. Wien, **16**, 165, 1855. 2, Rath, Zs. Kr., **1**, 23, 1877; also Krafft. 3, Koenig, Proc. Acad. Philad., 198, 1877. 4, Maskelyne and Flight, Q. J. G. Soc., **30**, 411, 1874. 5, Lorenzen, Medd-Grönland, **7**, 1884 ("Kupfferite"), cf. Ussing, Zs. Kr., **15**, 614, 1889. 6, Pisani, Dx. Min., **1**, 537, 1862 (Genth says probably from Castle Rock, Delaware Co., Penn.). 7, Knop, Jb. Min., 698, 1877. 8, Farsky, Vh. G. Reichs., 206, 1876. 9, 9*a*, Schrauf, Zs. Kr., **6**, 327, 328, 1882. 10, Rg., Pogg., **141**, 514, 1870. 11, Dmr., Bull. Soc. G. Fr., **19**, 414, 1862. 12, Breidenbaugh, Am. J. Sc., **6**, 211, 1873. 13, Kobell, J. pr. Ch., **36**, 303, 1845. 14, Streng, Zs. G. Ges., **13**, 73, 1861.

15, J. Lawrence Smith, Am. J. Sc., **38**, 225, 1864. 16–18, Maskelyne, Phil. Trans., **160**, 204, 1870. 19, Tschermak, Ber. Ak. Wien, **61** (2), 469, 1870. 20, Maskelyne, Phil. Trans., **161**, 360, 1871. 21, Rath, Ber. Ak. Berlin, 33, 1872. 22, 23, Rg., Ber. Ak. Berlin, 314, 1870, Min. Ch., 383, 1875.

*Enstatite, etc.*

| | G. | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|
| 1. Aloysthal | | 56·91 | 2·50 | 2·76 | — | 35·44 | — | $H_2O$ 1·92 = 99·53 |
| 2. Bamle | 3·153 | 58·00 | 1·35 | 3·16 | — | 36·91 | — | ign. 0·80 = 100·22 |
| 3. Georgia | 3·235 | 57·70 | 0·91 | 4·96 | 0·20 | 35·82 | — | ign. 0·78 = 100·37 |
| 4. Du Toit's Pan, S. A. | | 55·91 | 2·64 | 4·99 | — | 34·91 | 0·46 | $Cr_2O_3$ 0 54, NiO *tr.* = [99·45 |
| 5. Fiskernäs | 3·205 | 55·04 | 3·35 | 5·71 | — | 33·98 | — | ign. 1·78 = 99·86 |
| 6. Leiperville? | | 57·08 | 0·28 | 5·77 | — | 35·59 | — | $H_2O$ 0 90 = 99·62 |
| 7. Lützelberg | | 52·50 | 2·29 | 6·07 | — | 32·23 | 4·35 | insol. 2·00 = 99·44 |
| 8. Kosakow | | 56 23 | 2·62 | 6·67 | 0·23 | 32·37 | 0·96 | $Cr_2O_3$ 0·34, $H_2O$ 0·95 = [100·37 |
| 9. Křemže | 3·315 | 54·87 | 2·16 | 6·97 | — | 35·65 | 0·10 | ign. 0 ·56 = 100·31 |
| 9*a*. " | 3·315 | 54·98 | *tr.* | 9·75 | — | 32·83 | 1·62 | $Cr_2O_3$ 0·71, $H_2O$ 0·58 = [100·47 |
| 10. Dreiser Weiher | 3·308 | 52·33 | 5·23 | 7·17 | — | 30·95 | 3·25 | = 98·93 |
| 11. Lherz | 3·27 | 54·76 | 4·90 | 9·35 | — | 30·22 | — | = 99·23 |
| 12. Brewster, N. Y | 3·29 | § 54·17 | 3·30 | 9·94 | 0·24 | 31·99 | 0·99 | alk. 0·48, ign. 0·13 = [101·24 |
| 13. Greenland | | 58·00 | 1·33 | 10·14 | 1·00 | 29·66 | — | = 100·13 |
| 14. Harzburg | 3·29 | 53·45 | 3·71 | 8·54 | 0·16 | 30·86 | 2·19 | $Cr_2O_3$ 0·89, $H_2O$ 0·87 = [100·67 |

*From Meteorites.*

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | |
|---|---|---|---|---|---|---|---|
| 15. Bishopville | 59·97 | — | 0·40 | — | 39·34 | — | $Na_2O$($K_2O$ *tr.*) 0·74 = [100·45 |
| 16. Busti, *gray* | § 57·58 | — | 0·48 | — | 39·33 | 2·06 | $Na_2O$ 0·67, $K_2O$ 0·57, [$Li_2O$ 0·02 = 100·71 |
| 17. " *white* | 58·44 | — | 1·18 | — | 38·94 | 1·68 | $Na_2O$ 0·36, $K_2O$ 0·33 = [100·92 |
| 18. " *dark gray* | 57·60 | — | 1·44 | — | 40·64 | — | $Na_2O$ 0·91, $K_2O$ 0·39 = [100·98 |

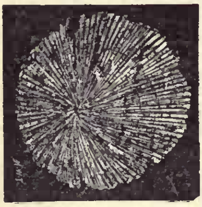
| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|
| 19. Lodran | 3·313 | 55·35 | 0·60 | — | 12·13 | 32·85 | 0·58 | = 101·51 |
| 20. Breitenbach | 3·238 | $\frac{2}{2}$ 56·05 | — | — | 13·44 | 30·85 | — | = 100·34 |
| 21. Ibbenbühren | 3·426 | 54·51 | 1·26 | 0·29 | 17·53 | 26·43 | 1·04 | = 101·06 |
| 22. Hainholz | | 53·05 | 3·19 | — | 15·63 | 25·40 | 2·73 | = 100 |
| 23. Shalka | | 55·70 | — | — | 20·54 | 22·80 | 1·32 | = 100·36 |

Some of those in this last group properly belong under hypersthene.

**Pyr., etc.**—B.B. almost infusible, being only slightly rounded on the thin edges; F. = 6. Insoluble in hydrochloric acid.

**Obs.**—Enstatite (incl. bronzite) is a common constituent of peridotytes and the serpentines derived from them; it also occurs in crystalline schists. It is often associated in parallel growth with a monoclinic pyroxene, e.g. diallage. A common mineral in meteoric stones often occurring in chondrules with eccentric radiated structure (f. 3). Also obtained in somewhat similar forms from deep-sea dredgings by the "Challenger."

3.



Enstatite Chondrule from the Knyahinya Meteorite.

Occurs near Aloysthal in Moravia, in serpentine; at the W. base of Mt. Bresouars in the Vosges, olive-green, in serpentine; at Kupferberg in Bavaria; at Baste in the Harz (*protobastite*); in the so-called olivine bombs of the Dreiser Weiher in the Eifel; at Grödlitzberg near Liegnitz, Silesia; Ultenthal, Tyrol; also at the other localities mentioned. In immense crystals at the apatite deposits of Kjörrestad near Bamle, Norway, in part altered to a steatic mineral. In the peridotyte associated with the diamond deposits of South Africa.

In the U. S., in New York at the Tilly Foster magnetite mine, Brewster, Putnam Co., with chondrodite. In Penn., at Texas and Castle Rock (?), Delaware Co. At Edwards, N. Y., extensively, more or less completely altered to talc, forming the fibrous mineral which has been called *agalite* (see talc).

Named from ἐνστάτης, an *opponent*, because so refractory. The name *bronzite* has priority, but a bronze luster is not essential, and is far from universal.

**Alt.**—*Bastite* or *Schiller spar* (see p. 351), the original from Baste in the Harz, is an altered bronzite. G. Rose long since pronounced it a result of the alteration of some mineral of the pyroxene group. Enstatite occurs altered to talc as at Edwards, N. Y.; the Bamle mineral approximates to this. At Brewster it occurs altered to serpentine.

**Artif.**—Artificial crystals have been obtained by Daubrée by fusion, also by Fouqué-Lévy, although the monoclinic magnesium silicate (pyroxene) seems to be formed more readily. Cf. Fouqué Lévy, Synth. Min., 110, 1882.

**Ref.**—[1] From the meteorite of Breitenbach, Ber. Ak. Wien, **59** (2), 848, 1869; these crystals gave all the planes in the list except those marked [2] and [3]; see also Weisbach, on bronzite from the Rittersgrün meteorite, Jb. Min., **2**, 253, 1882. It is obvious that no sharp line can be drawn between enstatite and hypersthene. The so-called Breitenbach enstatite (or bronzite) is midway between the two species and perhaps should be regarded as a hypersthene, since it contains 13·6 p. c. of FeO (anal. 20) and is optically *negative*, although the dispersion is $\rho < v$. Dx. gives $2H_{a.r} = 98° 32'$, $2H_{a.y} = 98° 52'$, $2H_{a.gr} = 99° 43'$, Min., **2**, xiv, 1874. Accurate measurements of a true enstatite are thus far wanting; Dx. gives for white artificial crystals, probably pure magnesium silicate (probably a pyroxene?, Fouqué-Lévy), $mm''' = 87° 31'$; also for the victorite of Meunier, $mm''' = 88° 40'$.

[2] Rath, large coarse crystals, in part distorted and monoclinic in symmetry, from Bamle, Norway, Zs. Kr., **1**, 18, 1877. [3] Bkg., bronzite from the Ultenthal, Tyrol, Zs. Kr., **7**, 502, 1883. [4] Becke, Min. Mitth., **7**, 93, 107. [5] Cf. Rosenbusch, Mikr. Phys., 394, 1885.

**324. HYPERSTHENE.** Labradorische Hornblende (fr. I. St. Paul) *Wern.*, Bergm. J., 376, 391, 1789. Diallage métalloïde pt. *H.*, Tr. 1801. Hypersthène *H.*, Ann. Mus., **2**, 17, 1803. Labrador Hornblende; Metalloidal Diallage pt. Paulit *Wern.*, 1812, Hoffm. Min., **2**, 143, 1815. Amblystegite *Rath*, Pogg., **138**, 531, 1869. Szaboite *Koch*, Min. Mitth., **1**, 79, 1878; *Lasaulx*, Zs. Kr., **3**, 288, 1879; *Krenner*, ib., **9**, 255, 1884.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·97133 : 1 : 0·57037$ Rath[1].
$100 \wedge 110 = {}^*44° 10'$, $001 \wedge 101 = 30° 25\frac{1}{3}'$, $001 \wedge 011 = 29° 42'$.

**Forms**[1]:
*a* (100, $i\text{-}\bar{i}$)
*b* (010, $i\text{-}\breve{i}$)
*c* (001, *O*)

*z* (210, $i\text{-}\bar{2}$)
*m* (110, *I*)
*n* (120, $i\text{-}\breve{2}$)

*h* (014, $\frac{1}{4}\text{-}\breve{i}$)
*k* (012, $\frac{1}{2}\text{-}\breve{i}$)
*χ* (045, $\frac{4}{5}\text{-}\breve{i}$)
*l* (011, $1\text{-}\breve{i}$)[2]

*d* (021, $2\text{-}\breve{i}$)
*o* (111, 1)
*ξ* (412, $2\text{-}\bar{4}$)

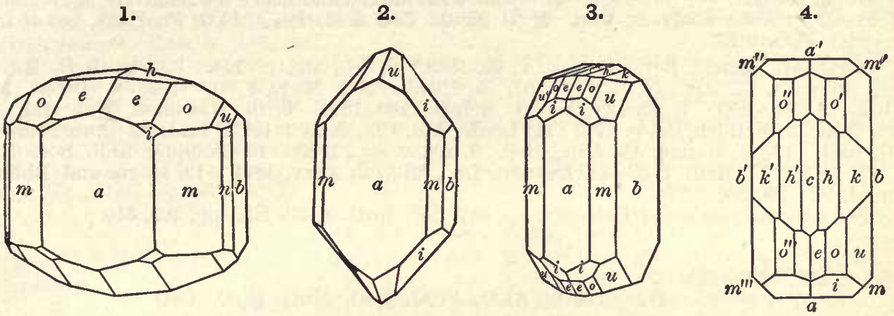
*e* (212, $1\text{-}\bar{2}$)
*i* (211, $2\text{-}\bar{2}$)
*y* (432, $2\text{-}\bar{\frac{4}{3}}$)
*u* (232, $\frac{3}{2}\text{-}\frac{3}{2}$)

$zz''' = 51° 48\frac{1}{2}'$
$mm''' = 88° 20'$
$nn' = 54° 28\frac{1}{2}'$
$hh' = 16° 14'$
$kk' = 31° 50'$

$ll' = 59° 24'$
$co = 39° 18'$
$ce = 33° 8'$
$ci = 52° 33'$
$cu = 46° 3\frac{1}{2}'$

$oo' = 54° 3'$
$ee' = 58° 54\frac{1}{2}'$
$ii' = 91° 8\frac{1}{2}'$
$uu' = 48° 5\frac{1}{2}'$

$oo''' = 52° 23'$
$ee''' = 27° 38'$
$ii''' = 40° 35'$
$uu''' = 72° 50'$
$m'''i = *74° 18'$



Figs. 1, *Amblystegite,* Laach, Rath. 2, Málnás, Schmidt. 3, 4, Capucin, Mt. Dore, Rath.

Crystals rare, habit prismatic, often tabular ∥ *a*, less often ∥ *b*. Usually foliated massive; sometimes in embedded spherical forms. Twins, see enstatite, p. 346.

Cleavage: *b* perfect; *m* and *a* distinct but interrupted. Fracture uneven. Brittle. H. = 5–6. G. = 3·40–3·50. Luster somewhat pearly on a cleavage-surface, and sometimes metalloidal. Color dark brownish green, grayish black, greenish black, pinchbeck-brown. Streak grayish, brownish gray. Translucent to nearly opaque. Pleochroism often strong, especially in the kinds with high iron percentage; thus ∥ 𝔞 or *ă* brownish red, 𝔟 or *b̄* reddish yellow, 𝔠 or *ċ* green.

Optically —. Ax. pl. ∥ *b*. Bx ⊥ *a*. Dispersion $\rho > v$. Axial angle rather large and variable, diminishing with increase of iron, cf. enstatite, p. 347, and the following from Dx.[4]:

| | Farsund | Finland | Labrador | | | | Mt. Dore |
|---|---|---|---|---|---|---|---|
| $2H_{a.r}$ | 98° 22′ | 92° 10′ | 87° 38′ | 85° 39′ | 77° 29′ | 69° 59′ | 59° 20′ |
| Fe(Mn)O | 15·14 | | | 22·59 | | | 33·6 |

Further, Dx.:

Labrador $2H_{a.r} = 85° 39'$  $\beta_r = 1·69$  ∴ $2V_r = 72° 16'$  $2E_r = 170° 27'$  $[2H_{a.y} = 84° 9'$

Mt. Dore $2E_r = 101° 47'$  $2E_y = 101° 7'$  $2E_{gr} = 100° 58'$

Bodenmais, Becke:

$2H_{a.r} = 86° 36'$  $2H_{a.y} = 85° 48'$  $2H_{a.gr} = 84° 30'$

Labrador, Lévy-Lcx.:

$\alpha = 1·692$  $\beta = 1·702$  $\gamma = 1·705$  $2V = 50°$

Hypersthene often encloses minute tabular scales, usually of a brown color, arranged mostly parallel to the basal plane, also less frequently vertical or inclined 30° to *ċ*; they may be brookite (göthite, hematite), but their true nature is doubtful (cf. Kosmann[3]). They are the cause of the peculiar metalloidal luster or schiller, and are often of secondary origin, being developed along the so-called "solution-planes" of Judd.

**Comp., Var.**—$(Fe,Mg)SiO_3$ with Fe : Mg = 1 : 3 (FeO = 16·7 p. c.), 1 : 2 (FeO = 21·7 p. c.) to nearly 1 : 1 (FeO = 31·0 p. c.). Alumina is sometimes present (up to 10 p. c.) and the composition then approximates to the aluminous pyroxenes.

Of the orthorhombic magnesium-iron metasilicates those with FeO > 12 to 15 p. c. are usually to be classed with hypersthene, which is further characterized by being optically negative and having dispersion $\rho > v$.

**Var.**—*Ordinary.*—In lamellar masses, usually exhibiting the characteristic schiller (see above); less often in distinct crystals.

*Amblystegite* from the Laacher See, first described as an independent species, was shown by Rath to be identical with hypersthene after the form of the latter had been determined by Lang. Judd has proposed to retain the name for those kinds which lack the characters of the original typical hypersthene (Geol. Mag., 2, 173, 1885).

*Szaboite* occurs in thin tabular crystals (‖ *b*); it was first described as triclinic and a relation to babingtonite suggested, but its identity with hypersthene was later fixed by Lasaulx (l.c.) and Fr. Koch, Zs. Kr., 10, 100, 1884. It is somewhat altered and hence the relatively large amount of $Fe_2O_3$ in some analyses; thus: MgO 22·82, FeO 8·46, $Fe_2O_3$ 12·69 Fr. Koch, but of fresh material FeO 19·70.

**Anal.**—1, Remelé, Ber. Ch. Ges., 1, 30, 1868. 2, Id., ib., p. 145. 3, Pisani, C. R., 86, 1419, 1878. 4, Id., Dx., N. R., 66, 1867. 5, Heddle, Min. Mag., 5, 10, 1882. 6, Becke, Min. Mitth., 3, 60, 1881. 7, Farsky, Vh. G. Reichs., 206, 1876. 8, 10, Hiortdahl, Nyt Mag., 24, 138, 1879. 9, Meinich, ib., p. 133. 11, Leeds, Am. Ch., March, 1877. 12, Dmr., Ann. Mines, 5, 157, 1844. 13-15, Merian, Jb. Min., Beil., 3, 296 *et seq.*, 1885. 16, Fouqué, Bull. Soc. Min., 1, 47, 1878. 17, Rath, l. c. 18, Laurent, Dx., Min., 2, xxxv, 1874. 19, Hague and Iddings, Am. J. Sc., 26, 230, 1883.

See also analyses under Enstatite, pp. 347, 348; further, 5th Ed., pp. 209, 210.

*Hypersthene, etc.*

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO |
|---|---|---|---|---|---|---|---|---|
| 1. Farsund | 3·386 | 47·81 | 10·47 | 3·94 | 10·04 | *tr.* | 25·31 | 2·12 = 99·69 |
| 2. St. Paul Is. | 3·402 | 49·85 | 6·47 | 2·25 | 14·11 | 0·67 | 24·27 | 2·37 = 99·99 |
| 3. Arvieu | 3·33 | 51·00 | 5·65 | — | 13·60 | — | 28·20 | — $H_2O$ 0·20 = 98·65 |
| 4. Farsund | 3·351 | 48·40 | 9·11 | — | 15·14 | — | 25·79 | 1·90 ign. 0·60 = 100·94 |
| 5. Banffshire | 3·32 | 51·46 | — | 4·02 | 12·67 | 0·69 | 24·23 | 5·30 $Na_2O$ 0·74, $K_2O$ 0·25, $H_2O$ 0·52 = 99·88 |
| 6. Bodenmais | 3·439 | 51·23 | 2·02 | 5·04 | 13·02 | 5·58 | 22·08 | 1·03 = 100 |
| 7. Kosakow | | 53·29 | 2·77 | — | 15·43 | — | 27·01 | 1·19 $H_2O$ 0·35 = 100·04 |
| 8. Romsås | 3·37 | 53·14 | 1·02 | — | 17·84 | 0·38 | 24·85 | 2·69 = 99·92 |
| 9. " | 3·145 | 54·24 | 3·32 | — | 17·40 | 0·40 | 23·15 | 0·82 ign. 0·36 = 99·69 |
| 10. " | | 51·76 | 2·99 | — | 19·73 | — | 23·24 | 2·35 = 100·07 |
| 11. Mt. Marcy | 3·459 | 50·33 | 3·36 | 1·03 | 19·40 | 0·71 | 21·40 | 2·77 $TiO_2$ 0·07, $H_2O$ 1·14 = 100·21 |
| 12. Labrador | 3·392 | 51·36 | 0·37 | — | 21·27 | 1·32 | 21·31 | 3·09 = 98·72 |
| 13. Campo Maior | 3·500 | 52·37 | 2·74 | 2·34 | 17·08 | — | 22·15 | 4·04 $TiO_2$ 0·35 = 101·07 |
| 14. Singalang, Sumatra | 3·487 | 52·23 | 1·08 | 0·56 | 19·84 | — | 22·37 | 1·90 $TiO_2$ 0·37 = 98·35 |
| 15. Waldheim | 3·531 | 50·57 | 2·97 | 0·83 | 26·93 | — | 13·93 | 3·14 $TiO_2$ 0·38, $Na_2O$ 0·62, $K_2O$ 0·57 = 99·94 |
| 16. Santorin | 3·485 | 49·8 | 2·3 | 0·8 | 25·0 | — | 11·2 | 10·8 $Na_2O$ 0·05 = 100·4 |
| 17. Laach, *Amblystegite* | 3·454 | 49·8 | 5·05 | — | 25·6 | — | 17·7 | 0·15 = 98·30 |
| 18. Mt. Dore | | [48·2] | — | — | 28·4 | 5·2 | 16·7 | 1·5 = 100 |
| 19. Mt. Shasta | | 50·33 | 0·97 | — | 22·00 | 0·64 | 23·29 | 1·88 = 99·11 |

**Pyr., etc.**—B.B. fuses to a black enamel, and on charcoal yields a magnetic mass; fuses more easily with increasing amount of iron. Partially decomposed by hydrochloric acid.

**Obs.**—Hypersthene, associated with a triclinic feldspar (labradorite), is common in certain granular eruptive rocks, as noryte, hyperyte, gabbro, also in some andesytes (*hypersthene-andesyte*) a rock recently shown to occur rather extensively in widely separated regions.

It occurs at Isle St. Paul, Labrador; at Chateau Richer and St. Adèle, Mille Isles, Canada, grayish black and brown, with the laminæ curved; at the Isle of Skye; in Greenland; at Farsund and elsewhere in Norway; Elfdalen in Sweden; at Romsås in spherical form in the "Kugelgabbro;" Penig in Saxony; Ronsberg in Bohemia; the Tyrol; Neurode in Silesia; in Thuringia; the Fichtelgebirge; Voigtland; Bodenmais, Bavaria (Becke). In the trachyte of Demavend, Persia (Blaas).

*Amblystegite* is from the Laacher See. *Szaboite* occurs with pseudobrookite and tridymite, in cavities in the andesyte of the Aranyer Berg, Transylvania; also on Mte. Calvario (Etna), near Biancaville, Sicily; also Riveau-Grand, Monte Dore, Puy-de-Dôme. Named after Prof. J. Szabó, of Budapest. *Ficinite* of Kenngott (not the original ficinite) is hypersthene from Bodenmais (Becke).

In the norytes of the Cortlandt region on the Hudson River, N. Y. (G. H. Williams, Am. J. Sc., 33, 137, 1887). Also common with labradorite in the Adirondack Archæan region of northern New York and northward in Canada. In the hypersthene-andesytes of Mt. Shasta, California; Buffalo Peaks, Colorado, and other points.

*Germarite* Breithaupt is a slightly altered hypersthene, Dx., N. R., 61, 1867.

*Hypersthene* is named from ὑπέρ and σθένος, *very strong*, or *tough*. *Amblystegite* is named from ἀμβλύς, *blunt*, στέγη, *roof*, in allusion to the form of the crystals (f. 1).

**Ref.**—[1] From Laach, amblystegite, Pogg., 138, 529, 1869, 152, 27, 1874. Crystals from the Capucin rocks, Mont Dore, gave similar results, Dx., Min., 2, xv, 1874. [2] Becke, Bodenmais, Min. Mitth., 3, 60, 1880. Cf. also Blaas, Persia, Min. Mitth., 3, 479, 1881; Oebbeke, Mt. Dore, Bull. Soc. Min., **8**, 50, 1885; Schmidt, Málnás, Zs. Kr., **10**, 210, 1885, and Mt. Pokhausz, near Schemnitz, Hungary, ib., **12**, 97, 1886; Busz, Mt. Dore, Zs. Kr., **17**, 554, 1890. Cf. also enstatite (p. 346), since the two species can hardly be sharply separated. [3] Kosmann, Jb. Min., 532, 1869, 501, 1871. [4] Dx., N. R., 63, 1867; Min., **2**, xv, 1874.

The following are alteration products of enstatite-hypersthene.

**DIACLASITE.** Gelber Schillerspath *Freiesleben*, Schill. Foss. Baste, 13, 1794. Talkartiger Hornblende, *Hausm.*, Nordd. Beitr. B. H., **1**, 15, 1806. Diaklas *Breith.*, Char., 58, 1823. Diaklasit *Hausm.*, Handb., 498, 1847.

A partially altered enstatite (bronzite) in which the optic axial plane has become ‖ *a* instead of ‖ *b*; it contains several per cent of water. Form and cleavage like enstatite. H. = 3·5–4. G. = 2·8; 3·054 Köhler. Luster pearly and metalloidal on a cleavage-face. Color brass-yellow, greenish gray. Streak greenish gray or nearly uncolored. Transparent in thin laminæ, translucent. Feel somewhat greasy.

Analyses.—1, Köhler, Pogg., **13**, 101, 1828. 2, A. Streng, B. H. Ztg., **23**, 54, 1864. 3, Sander, Rg., Min. Ch., 385, 1875.

| | | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Baste | G. = 3·054 | 53·74 | 1·34 | 11·51 | 0·23 | 25·09 | 4·73 | 3·76 = 100·40 | [= 101·73 |
| 2. Harzburg | | 53·31 | 7·49 | 8·14 | — | 25·37 | 3·56 | 1·55 alk. 0·58, | $Cr_2O_3$ 0·29 |
| 3. Wurlitz | | 52·81 | 1·54 | 12·63 | — | 27·41 | 1·07 | 4·44 = 99·90 | |

In crystals or foliated masses embedded in serpentine rock at Baste near Harzburg; also from the gneiss mountains of Guadarrama, Spain.

**BASTITE, or SCHILLER SPAR.** Talkart *v. Trebra*, Erfahr. Inn. Gebirge, 97, 1785. Schillerspath (fr. Baste) *Heyer*, Crell's Ann., 1786, **1**, 335, **2**, 147. Schillerstein *Wern.*, 1800, Ludw., 50, 1803. Diallage pt. *H.*, Tr., 1801. Metalloidal diallage pt. Bastit *Haid.*, Handb., 523, 1845.

An altered enstatite (or bronzite) having approximately the composition of serpentine. It occurs in foliated form in certain granular eruptive rocks and is characterized by a bronze-like metalloidal luster or schiller on the chief cleavage-face (*b*), which "schillerization" (Judd, cf. Q. J. G. Soc., **41**, 408, 1865, and Min. Mag., **7**, 81, 1886) is undoubtedly of secondary origin. H. = 3·5–4. G. = 2·5–2·7. Color leek-green to olive- and pistachio-green, and pinchbeck-brown. Pleochroism not marked. Optically −. Double refraction weak. Ax. pl. ‖ *a* (hence normal to that of enstatite). Bx ⊥ *b*. Dispersion $\rho > v$.

The original bastite was from Baste near Harzburg in the Harz; also from Todtmoos in the Schwarzwald.

Anal.—1, 2, Köhler, Pogg., **11**, 192, 1827. 3, W. Hetzer C. E. Weiss, Pogg., **119**, 446, 1863.

| | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Baste, *cryst.* | ⅔ 43·90 | 1·50 | 13·16[a] | 0·55 | 26·00 | 2·70 | 12·43 = 100·24 | |
| 2. " *massive* | 42·36 | 2·18 | 13·27[b] | 0·85 | 28·90 | 0·63 | 12·07 = 100·26 | [100·40 |
| 3. Todtmoos | ⅔ 43·77 | 6·10 | 7·14 | — | 30·92 | 1·17 | 8·51 1·67 $CO_2$, 1·12 org. subst. = | |

[a] With 2·37 $Cr_2O_3$ [b] With some $Cr_2O_3$.

In the closed tube affords water. B.B. becomes brown and is slightly rounded on the thin edges. With borax reactions of iron. Imperfectly decomposed by hydrochloric acid, completely so by sulphuric acid. A mineral resembling schiller spar occurs in serpentine in Middletown, Delaware Co., Pa. Some altered monoclinic pyroxene may be included in what is called schiller spar.

**PHÄSTINE.** Phästin *Breith.*, Char., 29, 180, 1823, 115, 1832. Resembles somewhat schiller spar, and, according to Breithaupt, is altered bronzite. It is foliated, but the cleavage is not very easy; H. = 1–1½; G. = 2·825; luster pearly; color yellowish gray; feel greasy, talc-like. It is from Kupferberg in the Fichtelgebirge, and occurs distributed through serpentine.

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**PECKHAMITE** *J. L. Smith*, Am. J. Sc., **19**, 462, **20**, 136, 1880.

Occurs in rounded nodules. Cleavage distinct. G. = 3·23. Luster greasy, opalescent. Color light greenish yellow. Composition, $2(Mg,Fe)SiO_3.(Mg,Fe)SiO_4$. Anal.—1, on 0·1 gr., 2, on 0·35 gr.

| | $SiO_2$ | FeO | MgO |
|---|---|---|---|
| 1. | 49·50 | 15·88 | 33·01 = 98·39 |
| 2. | 49·59 | 17·01 | 32·51 = 99·11 |

From the meteorite of Estherville, Emmet Co., Iowa, which fell May 10, 1879. Also from the Logrono and Sierra de Chaco meteorites (Meunier). Named after Prof. S. F. Peckham.

Whether peckhamite is to be regarded as an independent species, or the result of a mixture of enstatite and chrysolite as has been urged, is uncertain.

## *β. Monoclinic Section.*

**325. PYROXENE.** Corneus pt. *Wall.*, 138, 1847. Basaltes pt. *Cronst.*, 68, 1758. Schorl noir *de Lisle*, Crist., 265, 1772; Schorl noir en prisme à huit pans terminé par une pyramide dièdre, etc. (fr. volc. Vivarais) *Faujas*, Volc. Viv., 89, fig. D, 1778. Schorl oct. obliquangle tronqué [made a distinct species] *Démeste*, Lett., 1, 382, 1779. Schorl opaque rhomboidal pt., Schorl opaque qui paroissent deriver d'un octaèdre rhomboidal (fr. volc. Auvergne, Vesuv., Viv., Etna), *de Lisle*, Crist., 2, 396, 407, 415, figs. 12, 13, 14 (twin), 17, 18, pl. v, 1783. Augit (fr. volc.) *Wern.*, Freiesleben in Bergm. J., 243, 1792. Volcanite *Delameth.*, Sciagr., 2, 401, 1792. Pyroxene (fr. Etna, Arendal, etc.) *H.*, J. Mines, **5**, 269, 1799; Tr., **3**, 1801. Pentaklasit *Hausm.*, Handb., 687, 1813. Pirosseno, Piroxena, *Ital.*

**Diopside.** Malacolit *Abildgaard*, Ann. Ch., **32**, 1800; Delameth., J. Phys., **51**, 249, 1800. Alalite, Mussite *Bonvoisin*, ib , 409, May, 1806. Diopside *H.*, J. Mines, **20**, 65, 1806. Traversellit *Scheerer*, Pogg., **93**. 109, 1854.

Lavrovite. Lawrowit, Vanadin-Augit, *Koksharov*, Bull. Ac. St. Pet., **11**, 78, 1866. Lavroffite.

SALITE. Sahlit *d'Andrada*, Scherer's J., **4**, 31, 1800; J. Phys., **51**, 241, 1800. Sahlite. Baicalit *Renovanz*, Crell's Ann., **2**, 21, 1793; Baikalit *Karst.*, Tab. 34, 74, 1800. Funkite, Dufr., Min., **3**, 761, 1847. Violan *Breithaupt*, J. pr. Ch., **15**, 321, 1838. Anthocoite *L. J. Igelström*, Jb. Min., **2**, 36, 1889. Coccolit *d'Andrada*, Scherer's J., **4**, 1800. Protheite *Ure*. Canaanite *Alger*, Min., 89, 1844.

DIALLAGE *H.*, Tr., 89, 1801. Hudsonite *Beck*, Min. N. Y., 405, 1842. Omphacite. Omphazit *Wern.*, Hoffm. Min., **2**, 2, 302, 1812; *Breithaupt*, ib., **4**, 2, 125, 1817.

**Hedenbergite.** Hedenbergit *Berz.*, Nouv. Syst. Min., 206, 269, 1819; Hedenberg, Afh., **2**, 169. Lotalite *Severgin*, before 1814. Bolopherit *Breith.*, Handb., 582, 1847. Kalkeisenaugit *Germ.* Manganhedenbergite *Weibull*, G. För. Förh., **6**, 505, 1883. Asteroite *L. J. Igelström*, B. H. Ztg., Min., **29**, 8, 1870.

**Schefferite.** Schefferit *J. A. Michaelson*, J. pr. Ch., **90**, 107, 1863. Eisenschefferit *Flink*, Zs. Kr., **11**, 495, 501, 1886.

JEFFERSONITE *Keating & Vanuxem*, J. Ac. Philad., **2**, 194, 1822.

**Augite.** Leucaugite, *Dana*, 216, 1868. FASSAITE, Fassait *Wern.*, Hoffm., Min., **4**, 2, 110, 1817. AUGITE. Basaltische Hornblende pt. *Wern.*, Bergm. J., 1792; Basaltine *Kirw.*, Min., **1**, 219, 1794. Maclureite *Nuttall*, Am. J. Sc., **5**, 246, 1822 = Amphibole *H. Seybert*, J. Ac. Philad., **2**, 139, 1821. Pyrgom *Breith.*, Char., 140, 1832.

Monoclinic and hemihedral. Axes $\grave{a} : \bar{b} : \grave{c} = 1{\cdot}09213 : 1 : 0{\cdot}58932$; $\beta = 74^\circ\ 10'\ 9'' = 001 \wedge 100$ Rath[1].

$100 \wedge 110 = 46^\circ\ 24'\ 59''$, $001 \wedge 101 = 24^\circ\ 20'\ 53''$, $001 \wedge 011 = 29^\circ\ 33'\ 6''$.

**Forms**[2]:
*a* (100, *i*-ī)
*b* (010, *i*-ì)
*c* (001, *O*)
*χ* (510, *i*-5̄)
*Ψ* (920, *i*-$\bar{\frac{9}{2}}$)[5]
*f* (310, *i*-3̄)
*g* (210, *i*-2̄)
*m* (110, *I*)
*Ω* (350, *i*-$\grave{\frac{5}{3}}$)[6]
*ω* (120, *i*-2̀)
*i* (130, *i*-3̀)
*∇* (150, *i*-5̀)[4]
*L* (170, *i*-7̀)[4]
*y* (101, – 1-ī)
*F* (201, – 2-ī)[4]
*J* (702, – $\frac{7}{2}$-ī)[5]
*ς* (301, – 3-ī)

*M* (401, – 4-ī)[3]
*ψ* (501, – 5-ī)
*n* (1̄02, $\frac{1}{2}$-ī)
*p* (1̄01, 1-ī)
*H* (4̄03, $\frac{4}{3}$-ī)[4]
*Π* (3̄02, $\frac{3}{2}$-ī)[7]
*G* (2̄01, 2-ī)[5]
*q* (3̄01, 3-ī)
*X* (015, $\frac{1}{5}$-ì)[4]
*e* (011, 1-ì)
*z* (021, 2-ì)
*π* (041, 4-ì)
*δ* (061, 6-ì)
*S* (119, – $\frac{1}{9}$)[4]
*T* (117, – $\frac{1}{7}$)[2]
*σ* (112, – $\frac{1}{2}$)
*u* (111, – 1)

*v* (221, – 2)
*r* (552, – $\frac{5}{2}$)
*w* (331, – 3)
*h* (441, – 4)
*O* (1̄13, $\frac{1}{3}$)[2]
*τ* (1̄12, $\frac{1}{2}$)
*ξ* (3̄35, $\frac{3}{5}$)
*ν* (2̄23, $\frac{2}{3}$)[2]
*s* (1̄11, 1)
*ρ* (3̄32, $\frac{3}{2}$)
*β* (8̄85, $\frac{8}{5}$)
*o* (2̄21, 2)
*λ* (3̄31, 3)
*κ* (711, – 7-7̄)
*D* (922, – $\frac{9}{2}$-$\bar{\frac{9}{2}}$)[3]
*B* (411, – 4-4̄)[3]
*α* (312, – $\frac{3}{2}$-3̄)

*Γ* (311, – 3-3̄)
*E* (10·4·1, – 10-$\bar{\frac{5}{2}}$)[3]
𝔤 (732, – $\frac{7}{2}$-$\bar{\frac{7}{3}}$)[5]
*A* (211, – 2-2)[3]
*η* (421, – 4-2̄)
*Λ* (433, – $\frac{4}{3}$-$\bar{\frac{4}{3}}$)[5]
*K* (4̄14, 1-4̄)[7]
*Θ* (3̄13, 1-3̄)
*k* (3̄12, $\frac{3}{2}$-3̄)
*Δ* (3̄11, 3-3̄)
*ι* (2̄11, 2-2)
*x* (461, – 6-$\frac{3}{2}$)
*t* (351, – 5-$\grave{\frac{5}{3}}$)
*Σ* (243, – $\frac{4}{3}$-2̀)[2]
*μ* (121, – 2-2̀)
*Q* (136, – $\frac{1}{2}$-3̀)[5]
*P* (134, – $\frac{3}{4}$-3̀)[5]

*N* (132, – $\frac{3}{2}$-3̀)
*l* (241, – 4-2̀)
*d* (131, – 3-3̀)
*φ* (152, – $\frac{5}{2}$-5̀)
𝔢 (3̄47, $\frac{4}{7}$-$\bar{\frac{4}{3}}$)[5]
𝔡 (6̄87, $\frac{8}{7}$-$\bar{\frac{4}{3}}$)[5]
𝔟 (2̄35, $\frac{3}{5}$-$\grave{\frac{3}{2}}$)[5]
𝔞 (4̄65, $\frac{6}{5}$-$\grave{\frac{3}{2}}$)[5]
𝔠 (3̄54, $\frac{5}{4}$-$\grave{\frac{5}{3}}$)[5]
*Ξ* (1̄·2·10, $\frac{1}{5}$-2̀)[7]
*W* (1̄22, 1-2̀), **tw.pl.**
*ϵ* (1̄21, 2-2̀)
*ζ* (4̄83, $\frac{8}{3}$-2̀)
*R* (1̄32, $\frac{3}{2}$-3̀)[3]
*ϑ* (1̄42, 2-4̀)
*U* (1̄52, $\frac{5}{2}$-5̀)[5]
*γ* (1̄51, 5-5)

Also, reported by Götz[8] from Ala, 15·4·0, 15·0·4, 15 4·4.

$\chi\chi''' = 23°\ 44'$
$ff''' = 38°\ 36'$
$gg''' = 55°\ 26'$
$mm''' = 92°\ 50'$
$\mu\mu' = 50°\ 54'$
$ii' = 35°\ 12\tfrac{1}{2}'$

$cy = 24°\ 21'$
$c\varsigma = 47°\ 13'$
$c\psi = 56°\ 13\tfrac{1}{2}'$
$cn = 15°\ 39'$
$cp = 31°\ 20'$
$a'p = {}^{*}74°\ 30'$
$cG = 55°\ 48'$
$cq = 70°\ 16\tfrac{1}{2}'$

$ee' = 59°\ 6'$
$zz' = 97°\ 11'$
$xx' = 132°\ 25'$
$\delta\delta' = 147°\ 14'$

$c\sigma = 19°\ 42'$
$cu = 33°\ 49\tfrac{1}{2}'$
$cv = 49°\ 54'$
$cw = 57°\ 59\tfrac{1}{2}'$
$cm = 79°\ 9\tfrac{1}{2}'$
$cO = 15°\ 5'$
$c\tau = 22°\ 32'$
$cs = 42°\ 2'$
$co = 65°\ 21'$
$c\lambda = 76°\ 23'$

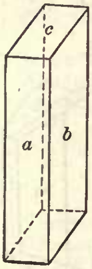
$cd = 57°\ 10\tfrac{1}{2}'$
$cW = 33°\ 57'$
$c\Delta = 71°\ 23'$
$ck = 46°\ 46'$

$au = 53°\ 58'$
$av = 47°\ 43\tfrac{1}{2}'$
$a's = 76°\ 34'$
$a'o = 61°\ 32'$
$a'\lambda = 55°\ 26\tfrac{1}{2}'$
$ae = 76°\ 16'$
$az = 79°\ 36'$
$a'k = 61°\ 51'$
$a'\Delta = 39°\ 50'$

$a'W = 90°\ 9$

$uu' = 48°\ 29'$
$vv' = 68°\ 42'$
$ww' = 77°\ 25'$
$ps = {}^{*}29°\ 35\tfrac{1}{2}'$
$ss' = 59°\ 11'$
$oo' = 84°\ 11'$
$\lambda\lambda' = 91°\ 35'$
$kk' = 28°\ 52'$
$\Delta\Delta' = 37°\ 50'$
$m'p = {}^{*}79°\ 23'$
$dd' = 106°\ 58'$
$bW = 59°\ 29'$

1.



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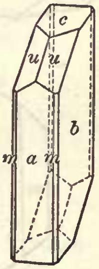

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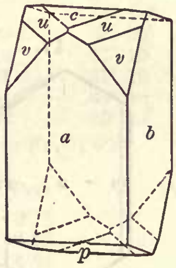

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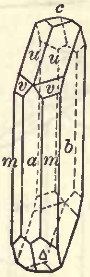

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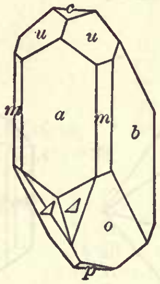

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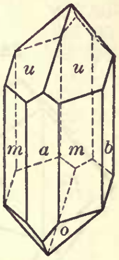

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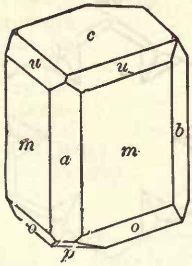

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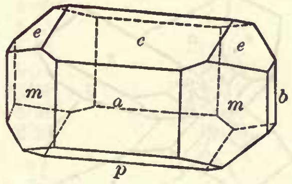

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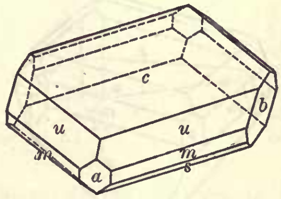
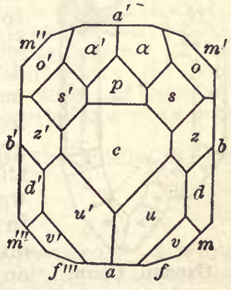


Figs 1, 2, Russell, N. Y. 3, Pierrepont, N. Y. 4, Gouverneur, N. Y. 5, 7, *Diopside*, De Kalb, N. Y. 6, Rossie, N. Y. 1–7, Pfd. 8, Monroe, N. Y. 9, Warwick, N. Y.

Twins[10]: tw. pl. (1) *a*, contact-twins, common (fig. 18), sometimes polysynthetic. (2) *c*, as twinning lamellæ producing striations and pseudo-cleavage or parting ∥ *c*; very common, often of unquestioned secondary origin; also capable of being produced artificially. (3) *y* (101) cruciform-twins, not common, f. 20. (4) *W* ($\bar{1}22$) contact-twins or penetration- and cruciform-twins, the vertical axes crossing at angles of nearly 60° ($bW = 59°\ 29'$, and since $a'W = 90°\ 9'$, the faces *a* and $\underline{a}$ fall nearly in a plane; sometimes repeated as a six-rayed star (f. 21).

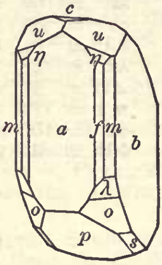
10.



Crystals usually prismatic in habit, often short and thick, and either a square prism (*a*, *b* prominent), or nearly square (93°, 87°) with *m* predominating; sometimes a nearly symmetrical 8-sided prism with *a*, *b*, *m*. Often coarsely lamellar, ∥ *c* or *a*. Also granular, coarse or fine; rarely fibrous or columnar.

Occasionally hemihedral, only the planes at an extremity of the vertical axis being present, and the habit then apparently hemimorphic as in f. 22 and f. 19, the latter a twin. Cf. G. H. Williams[8].

11.



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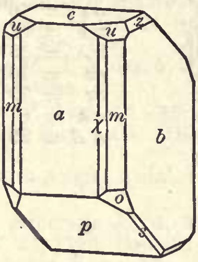

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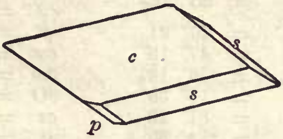

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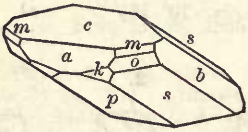

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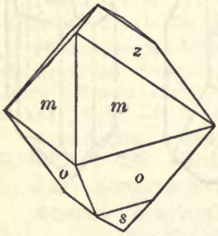

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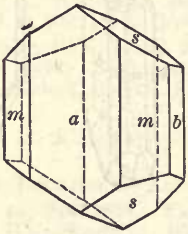
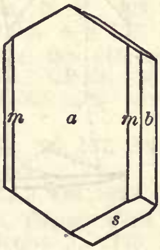


17.



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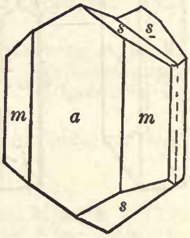

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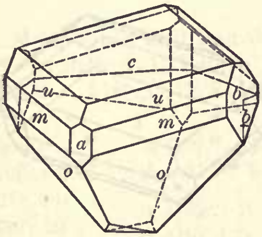

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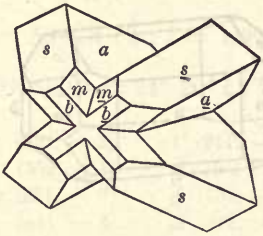

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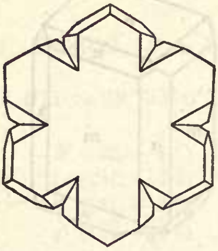
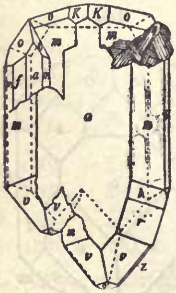


11, Ala, after Götz. 12, Nordmark. 13, 14, *Schefferite*, Långban, Flink. 15, *Fassaite*, 16–18, *Augite*. 19, Orange Co., N. Y., G. H. Williams. 20, Schönhof, Zeph. 21, Sasbach.

22.



Canaan, Conn.

Cleavage: *m* sometimes rather perfect, but interrupted, often only observed in thin sections ⊥ *c*. Parting ∥ *c*, due to twinning, often very prominent, especially in large crystals and lamellar masses; also ∥ *a* less distinct and not so common. Fracture uneven to conchoidal. Brittle. H. = 5–6. G. ≒ 3·2 –3·6, varying with the composition. Luster vitreous inclining to resinous; often dull; sometimes pearly ∥ *c* in kinds showing parting. Color usually green of various dull shades, varying from nearly colorless, white, or grayish white to brown and black; rarely bright green, as in kinds containing chromium. Streak white to gray and grayish green. Transparent to opaque. Pleochroism usually weak, even in dark colored varieties; sometimes marked, especially in violet-brown kinds containing titanium. Pyro-electrically + on *a* (cooling), and − on *b* for Ala crystals, but − on *a* and + on *b* for Tyrol; an indistinct opposite polarity between the extremities of the vertical axis was noted in one case, Hankel.

Optically +. Double refraction strong. Ax. pl. ∥ *b*. $Bx_a \wedge \dot{c} = \mathfrak{c} \wedge \dot{c} = +36°$ to $+52°$, or $c\mathfrak{c} = 20°$ to $36°$, the angle in general increasing with amount of iron (see below). Axial angles for diopside from Ala, Dx.:

$$\alpha_y = 1{\cdot}6727 \quad \beta_y = 1{\cdot}6798 \quad \gamma_y = 1{\cdot}7026 \quad \therefore 2V_y = 58° 59' \quad 2E_y = 111° 34'$$

Measured, $2E_r = 111° 40'$ $2E_y = 111° 20'$ $2E_{bl} = 110° 51'$

Refractive indices, Heusser:

$$\beta_r = 1{\cdot}67810 \qquad \beta_y = 1{\cdot}68135 \qquad \beta_{gr} = 1{\cdot}68567 \qquad \beta_{bl} = 1{\cdot}69372$$

See also beyond under diopside, etc.

The connection between the position of the axes of elasticity and the composition (see further analyses beyond) is exhibited in the following tables, chiefly from Doelter, also Wiik.

| | FeO | $Bx_a \wedge \dot{c}$ | | FeO | $Bx_a \wedge \dot{c}$ |
|---|---|---|---|---|---|
| Ala | 2·91 | + 36° 5′ | Tavastby | 5·52 | 41° |
| Zillerthal, *light* | 3·29 | 36° 15′ | Taberg | 2·94[b] | 41° 24′ |
| " *dark* | 3·09[a] | 36° 50′ | Stansvik | 10·38 | 42° 30′ |
| L. Baikal | 3·49 | 37° 10′ | Nordmark | 17·34 | 46° 45′ |
| Achmatovsk | 3·81 | 37° 10′ | Stansvik | 20·44 | 46° |
| Arendal | 4·5 | 39° 10′ | Lojo, *blk.* | 27·50 | 48° |
| Lojo | 4·97 | 39° 30′ | Tunaberg, *Hedenb.* | 26·29 | 47° 50′ |

[a] Also $Fe_2O_3$ 0·89. [b] Also $Fe_2O_3$ 0·88.

| | FeO | $FeO + Fe_2O_3$ | $FeO + Fe_2O_3 + Al_2O_3$ | $Bx_a \wedge \dot{c}$ |
|---|---|---|---|---|
| Vesuvius, *green* | 3·16 | 6·67 | 11·51 | + 41° |
| Greenwood Furnace | 2·55 | 7·6 | 12·69 | 42° 20′ |
| Agnas Caldeiras | 4·81 | 8·32 | 16·21 | 43° 35′ |
| P. Molar | 5·43 | 11·61 | 17·28 | 45° 45′ |
| S. Vincent | 5·20 | 10·45 | 18·60 | 46° 45′ |
| Vesuvius, *black* | 4·09 | 8·56 | 18·31 | 46° 45′ |
| Vesuvius, *yellow* | 6·78 | 7·87 | 13·94 | 46° 57′ |
| Bufaure | 7·74 | 11·51 | 16·60 | 47° |
| Pesmeda | 2·09 | 7·10 | 17·2 | 47° 10′ |
| Sarza | 5·43 | 10·38 | 20·04 | 47° 55′ |
| Cuglieri | 5·05 | 11·37 | 19·98 | 48° |
| Siderao | 9·14 | 18·43 | 31·51 | 50° |
| Arendal | 15·59 | 16·19 | 33·36 | 50° 35′ |
| R. d. Patas | 5·95 | 13·44 | 28·08 | 51° |
| Pico da Cruz | 2·23 | 17·60 | 34·57 | 52° |

**Comp., Var.**—For the most part a normal metasilicate, $RSiO_3$, of various bivalent or less frequently univalent metals, chiefly calcium and magnesium, also iron, less often manganese and zinc. The alkali metals potassium and sodium present rarely, except in very small amount. Also in certain varieties containing the trivalent metals aluminium, ferric iron, and manganese. These varieties may be most simply considered as molecular compounds of $Ca(Mg,Fe)Si_2O_6$ and $(Mg,Fe)(Al,Fe)_2SiO_6$, as suggested by Tschermak. Chromium is sometimes present in small amount; also titanium replacing silicon.

The name *Pyroxene* is from πῦρ, *fire*, and ξένος, *stranger*, and records Haüy's idea that the mineral was, as he expresses it, "a stranger in the domain of fire," whereas, in fact, it is, next to the feldspars, the most universal constituent of igneous rocks. This error, however, was more than counterbalanced by Haüy's discovery of the true crystallographic distinction of the species, which led him to bring together, under this one name, what Werner and others had regarded as distinct species. The name, therefore, is properly the name of the species as a whole, while *Augite* is only entitled to be used for one of its varieties.

The varieties are numerous and depend upon variations in composition chiefly; the more prominent of the varieties properly rank as sub-species.

## I. *Containing little or no Aluminium.*

DIOPSIDE. Malacolite, Alalite. *Calcium-magnesium pyroxene.* Formula $CaMg(SiO_3)_2$ = Silica 55·6, lime 25·9, magnesia 18·5 = 100. Color white, yellowish, grayish white to pale green, and finally to dark green and nearly black; sometimes transparent and colorless. In prismatic crystals, often slender; also granular and columnar to lamellar massive. G. = 3·2–3·38. $Bx_a \wedge \dot{c} = +36°$ and upwards. Iron is present usually in small amount as noted below, and the amount increases as it graduates toward true hedenbergite, see further below.

Flink gives for the five varieties of diopside from Nordmark the following optical constants; see analyses 10–15 beyond, and for the axial ratios see Ref.[1].

| $Bx_a \wedge \dot{c}$ | $2V_r$ | $2V_y$ | $2V_{gr}$ | $\beta_r$ | $\beta_y$ | $\beta_{gr}$ |
|---|---|---|---|---|---|---|
| +38° 3½′ | 59° 9′ | 58° 52′ | 58° 40′ | 1·68978 | 1·69359 | 1·69869 |
| 38° 45′ | 59° 9′ | 58° 57′ | 58° 46′ | 1·69133 | 1·69593 | 1·69781 |
| 39° 1′ | 59° 6½′ | 58° 56½′ | 58° 47′ | 1·68889 | 1·69588 | 1·70029 |
| 41° 41′ | 59° 18′ | 59° 11′ | 59° 6′ | 1·70055 | 1·70467 | 1·71062 |
| 44° 38½′ | 60° 44½′ | 60° 36′ | 60° 29′ | 1·71655 | 1·72428 | 1·72983 |

The following belong here:

*Chrome-diopside*, a variety containing chromium in small amount, often of a bright green; from the localities mentioned under analyses 33–40.

*Malacolite*, as originally used, included a bluish gray, grayish green, and whitish translucent variety from Sala, Sweden.

*Alalite* occurs in broad right-angled prisms, colorless to faint greenish or clear green, usually striated longitudinally, and came originally from the Mussa Alp in the Ala valley, Piedmont. *Mussite* is white, grayish white, and apple-green (according to Bonvolsin's original description), and occurs in prismatic implanted crystals, and also in masses made up of aggregated crystals. Named from the same locality, the Mussa Alp.

*Traversellite*, from Traversella, is in similar long glassy crystals, usually rectangular (*a*, *b*), much striated longitudinally, often clear green at one end and colorless at the other; prismatic cleavage perfect.

*Canaanite* is a grayish white or bluish white pyroxene rock occurring with dolomite at Canaan, Conn.; it has been referred to scapolite. Pyroxene in large white crystals is common in the region (f. 22); their composition, according to an analysis by M. D. Munn (priv. contr.) is: ⅔ $SiO_2$ 55·05, CaO 31·35, MgO 12·53, $Al_2O_3,Fe_2O_3$ 1·07 = 100; G. = 3·33. Cf. 5th Ed., p. 803.

*Lavrovite* is a pyroxene, colored green by vanadium, from the neighborhood of Lake Baikal in eastern Siberia. In coarse granular masses with quartz, and also in small imperfect crystals. Cleavage affords the prism 87° 7′; and there is the usual lamination from compound structure parallel to *c*. The color is fine emerald-green. Cf. anal. 50, and Kk., Min. Russl., 6, 206.

*Diopside* is named from *δις*, *twice* or *double*, and *ὄψις*, *appearance*. *Malacolite* is from *μαλακός*, *soft*, because softer than feldspar, with which it was associated.

HEDENBERGITE. *Calcium-iron pyroxene*. Formula $CaFe(SiO_3)_2$ = Silica 48·4, iron protoxide 29·4, lime 22·2 = 100. Color black. In crystals, and also lamellar massive. G. = 3·5–3·58. $Bx_a \wedge \dot{c} = +48°$. Manganese is present in *manganhedenbergite* to 6·5 p. c., see anal. 45, below. Color grayish green. G. = 3·55. Named after the Swedish chemist, Ludwig Hedenberg, who first analyzed and described the mineral.

Between the two extremes, diopside and hedenbergite, there are numerous transitions conforming to the formula $Ca(Mg,Fe)Si_2O_6$. As the amount of iron increases the color changes from light to dark green to nearly black, the specific gravity increases from 3·2 to 3·6, and the angle $Bx_a \wedge \dot{c}$ also from 36° to 48°.

The following are varieties, coming under these two sub-species, based in part upon structure, in part on peculiarities of composition.

SALITE. Sahlite. Color grayish green to deep green and black; sometimes grayish and yellowish white. In crystals; also cleavable and granular massive. G. = 3·25–3·4. Named from Sala in Sweden, one of its localities, where the mineral occurs in masses of a grayish green color, having a perfect parting ‖ *c*.

*Baikalite* is a dark dingy green variety, in crystals, with parting like the preceding. Named from Lake Baikal, in Siberia, near which it occurs.

*Protheite* is somber-green, in crystals, and approaches fassaite; from the Zillerthal in Tyrol.

*Funkite* is dark olive-green coccolite from Boksäter in Göthland, having a larger percentage of Fe than Mg.

*Lotalite* from Lotala, Finland, in black lamellar masses, is near hedenbergite.

VIOLAN *Breithaupt*, J. pr. Ch., 15. 321, 1838. Occasionally in prismatic crystals, affording (Dx , Min., 1, 66, 1862, N. R., 183, 1867) the angles and the planes (in the prismatic zone) of pyroxene, also the prismatic cleavage. Usually lamellar massive, sometimes fibrous. H. = 6. G. = 3·233.

Luster waxy. Color dark violet-blue. Translucent, but in thin plates transparent. Optically +, and $Bx_o$ inclined to *a* as in diopside. Anal.—1, Damour, Dx., Min., **1**, 66, 1862 (impure material ?). 2, Pisani, Dx., N. R., 184, 1867. 3, Schluttig, Inaug. Diss., Leipzig, Groitzsch, 17, 1884, as recalc. by Grünhut, Zs. Kr., **13**, 74, 1887.

| | | $SiO_2$ | $Al_2O_3$ | FeO | MnO | CaO | MgO | $Na_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | G. = 3·233 | 56·11 | 9·04 | 2·46 | 2·54 | 13·62 | 10·40 | 5·63 | = 99·80 |
| 2. | G. = 3·21 | 50·30 | 2·31 | 4·15 | 0·76 | 22·35 | 14·80 | 5·03 | $H_2O$ 0·30 = 100 |
| 3. | G. = 3·231 | ⅔ 52·02 | 2·60 | 1·19[a] | 2·87 | 22·94 | 15·18 | 5·69[b] | = 102·49 |

[a] Incl. (Ni,Co)O 0·39. [b] Incl. $K_2O$ 0·75.

Occurs in small seams with white quartz, white fibrous tremolite spotted violet with manganese, greenovite and manganesian epidote, in the braunite of St. Marcel, in the valley of Aosta, Piedmont. Named from its color.

ANTHOCHROITE *L. J. Igelström*, Jb. Min., **2**, 36, 1889. Probably identical with violan. Occurs in grains embedded in limestone and in thin veins. H. = 5–6. Color rose-red to pale violet. Analysis gave: $SiO_2$ 51·6, MnO 3·4, MgO 13·5, CaO 23·3, $Al_2O_3$,$Fe_2O_3$ 1·4, alk. [6·8] = 100. Occurs associated with braunite, manganesian garnet, epidote, vesuvianite at Jakobsberg, Wermland, Sweden. Named from ανθος, *flower*, and χροα, *color*.

*Asteroite* L. J. Igelström, B. H. Ztg., **29**, 8, 1870, is a stellate radiated pyroxene, from Nordmark, in Sweden. Color ash-gray to white; luster silky; opaque, becoming bronze color on exposure. Anal.—$SiO_2$ 48·48, FeO 22·24, MnO 4·12, CaO 17·00, MgO 4·18, ign. 2·83 = 98·85.

COCCOLITE. A granular variety, sometimes as indistinct crystals embedded in calcite, also forming loosely coherent to compact granular aggregates. Color varying from white to pale green to dark green, and then containing considerable iron; the latter the original coccolite. Named from κόκκος, a *grain*.

DIALLAGE. Lamellar or thin-foliated pyroxene, characterized by a fine lamellar structure and parting ‖ *a*, with also parting ‖ *b*, and less often ‖ *c*. Also a fibrous structure ‖ $\dot{c}$. Twinning ‖ *a*, often polysynthetic; interlamination with an orthorhombic pyroxene common. Color grayish green to bright grass-green, and deep green; also brown. Luster of surface *a* often pearly, sometimes metalloidal or exhibiting schiller and resembling bronzite, from the presence of microscopic inclusions of secondary origin (cf. Judd, ref. see bastite, p. 351). $Bx_a \wedge \dot{c} =$ +39 to 40°. H = 4; G. = 3·2–3·35. In composition near diopside, but often containing alumina and sometimes in considerable amount, then properly to be classed with the augites (cf. anal. 51–65). Often changed to amphibole; see smaragdite, p. 389, and uralite, p. 390.

Named from διαλλαγή, *difference*, in allusion to the dissimilar cleavages or planes of fracture. This is the characteristic pyroxene of gabbro, and other related rocks.

*Hudsonite* is a lamellar massive kind, color black, often with a bronze tarnish. G. = 3·5, Beck; 3·43–3·46, Brewer. Contains lime and ferrous iron, with but little magnesia. Named from the Hudson river, in the vicinity of which it occurs, in Cornwall, Orange Co., N. Y.

OMPHACITE. Omphazit [fr. Baireuth] *Wern.*. Hoffm. Min., **2**, 2, 302, 1812; *Breith.*, ib., **4**, 2. 125, 1817, Handb., 612, 1841, B. H. Ztg., **24**, 365, 397, 1865. The granular to foliated pyroxenic constituent of the garnet-rock called eclogyte, often interlaminated with amphibole (smaragdite); cleavage as with pyroxene. H. = 5–6. G. = 3·2–3·3. Luster vitreous to silky. Color grass-green. Anal.—1–5, J. Fikenscher, B. H. Ztg., **24**, 397, 1865. 6, Luedecke, Zs. G. Ges., **28**, 259, 1876.

| | G. | $SiO_2$ | $Al_2O_3$ | FeO | MgO | CaO | $Na_2O$ | $K_2O$ | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Ober-Pferdt | 3·263 | 52·57 | 9·12 | 5·32 | 13·75 | 17·41 | 1·11 | 0·28 | 0·32 | = 99·98 |
| 2. Wustuben | 3·270 | 52·35 | 9·69 | 4·08 | 12·85 | 18·05 | 1·73 | 0·32 | 0·62 | = 99·69 |
| 3. Silberbach | 3·243 | 52·77 | 9·19 | 4·81 | 13·60 | 18·11 | 1·22 | — | 0·41 | = 100·11 |
| 4. Stumbach | 3·201 | 52·16 | 8·71 | 11·63 | 10·77 | 14·16 | 0·87 | 0·14 | 0·50 | = 99·94 |
| 5. Pacher, Styria | | 50·29 | 6·67 | 3·26 | 15·22 | 21·50 | 0·88 | 0·88 | 0·45 | $Cr_2O_3$ 2·07 = |
| 6. Syra | | 52·53 | 4·60 | 11·80 | 16·10 | 12·80 | — | — | 1·69 | = 99·52[100·64 |

Occurs near Hof in Bavaria; at Pacher in Styria. Also a similar mineral (diallage) in the glaucoplane schists of the island Syra (Luedecke). Schrauf gives the name to the "chromdiopsid" of anal. 36, beyond. The name *Omphacite* is from ὄμφαξ, *an unripe grape*, alluding to the color; it is among the names of green stones mentioned by Pliny.

SCHEFFERITE. A manganese pyroxene, sometimes also containing much iron (iron-schefferite, Eisenschefferit *Flink*). Flink gives the composition of the Långban mineral (anal. 46) as corresponding to $6CaMgSi_2O_6.MgFeSi_2O_6.Mn_2Si_2O_6$.

In crystals, sometimes tabular ‖ *c* (f. 13), also with *p* ($\bar{1}01$) prominent, more often elongated in the direction of the zone *b* : *p* ($\bar{1}01$), as in f. 14; very rarely prismatic, ‖ $\dot{c}$. Twins, with *a* as tw. pl., very common. Axial ratio as given beyond, Ref. [1]. Also crystalline, massive. Cleavage prismatic, very distinct. Color yellowish brown to reddish brown. Optically +. $Bx_a \wedge \dot{c} = \mathfrak{c} \wedge \dot{c} = 44° 25\frac{1}{2}'$. $2V_y = 65° 3'$. Named after the Swedish chemist (1710–1759).

The iron-schefferite from Pajsberg (anal. 47) is black in color and has the axial ratio given beyond. $\mathfrak{c} \wedge \dot{c} = +49°$ to 59° for different zones in the same crystal. The brown iron-schefferite from Långban (anal. 48) has $\mathfrak{c} \wedge \dot{c} = 69° 3'$. It resembles garnet in appearance.

**Jeffersonite.** A manganese-zinc pyroxene (see anal. 49). In coarse crystals sometimes very large; they are like ordinary pyroxene in habit. Edges rounded and faces uneven and apparently corroded. G. = 3·63. Color greenish black, on the exposed surface chocolate-brown. $Bx_a \wedge \dot{c} = 53° 32'$. $2H_{a.y} = 84° 32'$ Dx., Min., **2**, XIX, 1874. Named after Mr. Jefferson.

According to the view of R. Fritz Gaertner the zinc shown in the analysis is to be explained as due to enclosed zincite and the manganèse to franklinite, but this needs confirmation; Pisani's analysis (49) was made on the crystals examined optically by Dx.

## II. *Aluminous.*

**Augite.** *Aluminous pyroxene.* Composition chiefly $CaMgSi_2O_6$ with $(Mg,Fe)(Al,Fe)_2SiO_6$, and occasionally also containing alkalies. Here belong:

*a.* **Leucaugite.** Color white or grayish. Contains alumina, with lime and magnesia, and little or no iron. Looks like diopside. H. = 6·5; G. = 3·19, Hunt. Named from λευκός, *white.*

*b.* **Fassaite,** or *Pyrgom.* Includes the pale to dark, sometimes deep-green crystals, or pistachio-green and then resembling epidote. The aluminous kinds of diallage also belong here. Named from the locality in the Fassathal, Tyrol. *Pyrgom* is from πύργωμα, *a tower.*

*c.* **Augite.** Includes the greenish or brownish black and black kinds, occurring mostly in eruptive rocks. It is usually in short prismatic crystals, thick and stout, or tabular ‖ *a*; often twins. Ferric iron is here present, in relatively large amount, and the angle $Bx_a \wedge \dot{c}$ becomes + 50° to 52°. Named from αὐγή, *luster.*

The *Augite* of Werner (and volcanite *Delameth.*) included only the black mineral of igneous rocks—the *volcanic schorl* of earlier authors.

*Titaniferous augite.* Containing 0·5 to 4·5 p. c. titanium dioxide; cf. anals. 103 to 121.

**Alkali-augite.** Here belong varieties of augite characterized by the presence of alkalies, especially soda; cf. anals., 103 to 121; they hence approximate to acmite and ægirite. They are known chiefly from rocks rich in alkalies, as elæolite-syenite, phonolyte, leucityte, etc. A pyroxene intermediate between diopside and ægirite has been described by Brögger from the elæolite-syenite of southern Norway, which has $\mathfrak{c} \wedge \dot{c} = +52°$, Zs. Kr., **16**, 655, 1890. Cf. also Cross, Am. J. Sc., **39**, 359, 1890.

**Anal.**—The following are analyses, chiefly recent, of the typical varieties; for other analyses see 5th Ed., pp. 217 to 219; also Rg., Min. Ch., pp. 386–392, 1875, and Erg., 20–31, 1886, further Heddle, Trans. R. Soc. Edinburgh, **28**, 1878, and many papers on pyroxene in rocks in Jb. Min., and elsewhere.

1–7, Doelter, Min. Mitth., 288 1877, Min. Mitth., **1**, 49, 1878. 8, E. S. Sperry, priv. contr. 9, A. E. Nordenskiöld, G. För. Förh., **12**, 353, 1890. 10–13, Flink, Zs. Kr., **11**, 449, 1886. 14, Doelter, l. c. 15, Sjögren, G. För. Förh., **4**, 378, 1879. 16–21, quoted by Wiik, Finsk. Vet.-Soc. Förh., **24**, 1882; 16, Moberg; 17, Castren; 18, Hjelmman; 19, Hjelt; 20, 21, Castren. 22, Maskelyne, Phil. Trans., **160**, 202, 1870. 23, Streng, Jb. Min., **1**, 238, 1885. 24, Bamberger, Min. Mitth., 23, 1877. 25, Nauckhoff, G. För. Förh., **1**, 167, 1873. 26, Haushofer, J. pr. Ch., **102**, 35, 1867. 27, Freda [Gazz. Ch. Ital., **13**, 498], JB. Ch., p. 1889, 1883. 28, Suchsdorff, Zs. Kr., **2**, 498, 1878. 29, Renqvist, ibid. 30, Rath, Pogg., **144**, 387, 1871. 31, Lepéz, quoted by Zepharovich, Lotos, 1885. 32, Hawes, Am. J. Sc., **16**, 397, 1878.

33, Pisani, Bull. Soc. Min., **5**, 281, 1882. 34, A. Knop, Jr., Jb. Min., **2**, 97 ref., 1890. 35, Scharizer, Jb. G. Reichs., 707, 1884. 36, Schrauf, Zs. Kr., **6**, 329, 1882. 37, Knop, Jb. Min., 698, 1877. 38, Oebbeke, ib., p. 845. 39, Dmr., Bull. G. Soc. Tr., **19**, 414, 1862. 40, Rg., Pogg., **141**, 516, 1870.

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### DIOPSIDE.

| | | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Val d'Ala, *colorless* | | 54·28 | 0·51 | 0·98 | 1·91 | — | 17·30 | 25·04 | = 100·02 |
| 2. | " *dark green* | | $\frac{2}{2}$ 54·74 | — | — | 2·91 | — | 17·02 | 26·03 | = 100·70 |
| 3. | Achmatovsk, *light green* | 3·169 | 54·45 | 0·99 | 0·55 | 3·81 | — | 15·65 | 24·89 | = 100·34 |
| 4. | Zillerthal, *colorless* | | 54·85 | 0·25 | 0·15 | 3·29 | — | 16·02 | 24·99 | = 99·55 |
| | " *dark green* | 3·192 | 54·23 | 1·22 | 0·89 | 3·09 | — | 16·38 | 24·69 | = 100·50 |
| 5. | L. Baikal, *Baikalite* | 3·242 | $\frac{2}{2}$ 53·95 | 0·78 | 0·97 | 3·49 | — | 16·40 | 25·14 | = 100·73 |
| 6. | Arendal | 3·242 | 53·28 | 1·37 | 1·08 | 4·50 | — | 15·63 | 24·29 | = 100·15 |
| 7. | New York State | 3·201 | 52·79 | 1·45 | 0·62 | 5·02 | — | 16·09 | 24·91 | = 100·88 |
| 8. | De Kalb, N. Y. | 3·287 | 55·12 | 0·40 | — | 1·12 | — | 18·15 | 25·04 | $Na_2O$ 0·45, [$K_2O$ 0·02, ign. 0·17 = 100·47 |
| 9. | Taberg | | 53·71 | 0·40 | 0·88 | 2·94 | 0·20 | 15·67 | 25·09 | ign. 0·30 = [99·19 |
| 10. | Nordmark, *white* | | 54·59 | — | 0·11 | 2·49 | 0·14 | 17·42 | 25·70 | = 100·45 |
| 11. | " *yellow-green* | | 54·09 | 0·28 | 0·19 | 3·36 | 0·26 | 17·12 | 25·41 | = 100·71 |
| 12. | " *grass-green* | | 54·26 | 0·33 | 0·48 | 3·51 | 0·45 | 16·04 | 24·82 | = 99·89 |
| 13. | " *dark green* | | 53·03 | 0·75 | 0·32 | 7·34 | 1·13 | 13·65 | 22·98 | = 99·20 |
| 14. | " *black* | 3·311 | 50·91 | 0·17 | 0·76 | 17·34 | 0·21 | 7·21 | 22 93 | = 99 53 |
| 15. | " *black* | 3·367 | 51·05 | 1·10 | 0 95 | 17·31 | 0·60 | 5·92 | 22·44 | = 99·37 |
| 16. | Karis Lojo, *gray-green* | | 52·49 | 2·17 | — | 2·68 | 0·63 | 17·20 | 24·34 | = 99·51 |
| 17. | Ithis, *green* | | 50·31 | 6·46 | — | 4·81 | — | 14·48 | 24·87 | = 100·93 |
| 18. | Pälkäne, *green* | | 52·6 | 4·8 | — | 4·0 | — | 14·2 | 25·8 | = 101·4 |
| 19. | Hermala Lojo, *green* | | 53 03 | — | — | 4·97 | 0·22 | 15·88 | 25·48 | = 99·58 |
| 20. | Stansvik, *green* | | 52·76 | — | — | 10·38 | 1·34 | 9·95 | 23·90 | ign. 0·27 = [98·60 |
| 21. | Ojama, Lojo, *dark green* | | 46·37 | 4·15 | — | 27·50 | 0·14 | 3·00 | 20·58 | = 101·74 |
| 22. | Busti Meteorite | | 55·49 | — | 0·55 | — | — | 23·33 | 19·98 | $Na_2O$ 0·55 = [99·83 |
| 23. | Zermatt | 3·11 | 54·22 | — | — | 1·84 | — | 18·25 | 24·80 | ign. 0·41 = [99·52 |
| 24. | Albrechtsberg | 3·167 | 55 60 | 0·16 | — | 0·56 | — | 18·34 | 26·77 | = 101·43 |
| 25. | Nordmarksberg | | 53·20 | 0·08 | — | 2·33 | 0·20 | 16·89 | 24·06 | $Na_2O$ 0·34, [ign. 1·26 = 98·36 |
| 26. | Gefrees | 3·285 | 54·00 | 0·62 | — | 3·78 | 0·27 | 15·31 | 25·46 | = 99·44 |
| 27. | Mt. Somma | 3·19 | 42·73 | 1·06 | — | 4·22 | 0·94[a] | 17·80 | 24·18 | = 100·93 |
| 28. | Wampula, Finl. | | 51·88 | 1·19 | — | 4·32 | 0·89 | 17·09 | 23·88 | = 99·25 |
| 29. | Tavastby, " | 3·045 | 52·80 | 6·10 | — | 5·52 | — | 18·31 | 19 08 | = 101·81 |
| 30. | Valpellina | 3·329 | 54 02 | 0·20 | — | 8·07 | — | 13·52 | 24·88 | = 100·69 |
| 31. | Kriml | 3·381 | 52·08 | 1·36 | 2·56 | 8·93 | 0·49 | 10·61 | 21·59 | $Na_2O$ 2 06 = [99·68 |
| 32. | Edenville | | 51·05 | 2·02 | 1·30 | 12·28 | 0·12 | 10·02 | 22·07 | ign. 0·34 = [99·10 |

[a] CuO

### *Chrome-diopside.*

| | | G. | $SiO_2$ | $Al_2O_3$ | $Cr_2O_3$ | FeO | MnO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|---|---|
| 33. | Diamond Fields, S. A., *green* | 3·26 | 52·4 | 0·6 | 2·8 | 6·5 | — | 15·5 | 20·5 | $H_2O$ 1·5 = [99·8 |
| 34. | " (Jagerfontein) | | 54·97 | 1·50 | 2·08 | 4·71 | — | 14·30 | 21·52 | = 99·08 |
| 35. | Jan Mayen | 3·313 | 51·86 | 1·56 | 0·73 | 3·46 | *tr.* | 17·40 | 22·15 | $Fe_2O_3$ 2·44, [ign. 0·12 = 99·72 |
| 36. | Křemže | 3·259 | 53·67 | 2·45 | 1·49 | 3·84 | *tr.* | 13·57 | 20·34 | $Fe_2O_3$ 2·07, [$K_2O$ 1·48, $Na_2O$ 1·29 = 100·20 |
| 37. | Kaiserstuhl | | 51·89 | 4·76 | 1·09 | 4·40 | 0·54 | 15·47 | 19·73 | insol. 2·30 = [100·18 |
| 38. | Schw. Stein, Nassau | 3·202 | 50·44 | 5·10 | 1·40 | 9·70 | — | 17·42 | 14·63 | = 98·69 |
| 39. | Lherz | 3·28 | 53·63 | 4·07 | 1·30 | 8·52 | — | 12·48 | 20·37 | = 100·37 |
| 40. | Dreiser Weiher | 3·28 | 49·71 | 7·42 | 2·61 | 5·03 | — | 17·84 | 17·39 | = 100·0 |

### HEDENBERGITE, *also above.*

| | | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|---|---|
| 41. | Shergotty Meteorite | 3·466 | 52·34 | 0·25 | — | 23·19 | — | 14·29 | 10·49 | = 100·56 |
| 42. | Dognacska | 3·557 | 48·38 | 0·68 | 3·23 | 15·88 | 7·94 | 2·22 | 22·10 | alk. 0·28 = [100·71 |
| 43. | " | 3·588 | 49·00 | 0·91 | 2·85 | 17·24 | 8·52 | 1·34 | 21·30 | = 101·16 |
| 44. | Tunaberg | 3·492 | 47·62 | 1·88 | 0·10 | 26·29 | — | 2·76 | 21·53 | = 100·18 |
| 45. | Vester Silfberg | 3·55 | 48·29 | — | — | 24·01 | 6·47 | 2·83 | 17·69 | alk. 0·22 = [99 51 |

| | SCHEFFERITE. | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|---|---|
| 46. | Långban | | 52·28 | — | — | 3·83 | 8·32 | 15·17 | 19·62 | = 99·22 |
| 47. | Pajsberg | | 50·88 | 1·97 | — | 17·48 | 6·67 | 9·08 | 12·72 | = 98·80 |
| 48. | Långban, *Eisenschefferit, brn.* | | 52·19 | 0·88 | — | 14·98 | 6·20 | 10·93 | 14·57 | = 99·75 |
| | *Jeffersonite.* | | | | | | | | | |
| 49. | Franklin Furnace, N. J. | 3·63 | 45·95 | 0·85 | — | 8·91 | 10·20 | 3·61 | 21·55 | ZnO 10·15, ign. 0·35 = 101·57 |
| 50. | *Lavrovite* | 3·04 | 53·65 | 2·25 | — | — | 2·48 | 16·00 | 23·05 | $V_2O_3$ 2·57 = 100 |

*Diallage.*

| | | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 51. | Le Prese, Veltlin | 3·271 | 51·46 | 1·31 | — | 15·94 | — | 10·13 | 21·14 | — | = 99·98 |
| 52. | Buchberg, Silesia | | 51·23 | 1·21 | — | 11·57 | 1·26 | 16·11 | 17·07 | 1·31 | = 99·76 |
| 53. | Balta Is., Scotland | 2·965 | 50·23 | 5·85 | — | 5·22 | — | 21·59 | 11·23 | 4·17 | $K_2O$ 1·20, $Na_2O$ 0·58 = 100·07 |
| 54. | Dun Mt., N. Zealand | | 52·23 | 4·71 | — | 3·48 | — | 16·85 | 20·15 | 2·53 | = 99·95 |
| 55. | Ehrsberg | 3·178 | 51·27 | 6·24 | — | 5·60 | — | 14·18 | 21·08 | 0·65 | = 99·02 |
| 56. | Elba | 3·135 | 49·60 | 5·05 | — | 6·73 | — | 16·49 | 20·34 | 1·49 | $Cr_2O_3$ 0·55 = 100·25 |
| 57. | Wildschönau | 3·337 | 50·41 | 4·05 | 0·11 | 6·57 | — | 15·33 | 21 34 | 0·37 | $TiO_2$ 0·88, $Cr_2O_3$ 0·60, $Na_2O$ 1·55, $K_2O$ 0·42 = 101·63 |
| 58. | " | 3·343 | 49·25 | 5·60 | 0·45 | 7·15 | — | 14·41 | 21·31 | 0·30 | $TiO_2$ 0·70, $Cr_2O_3$ 0·20, $Na_2O$ 1·86, $K_2O$ 0·82 = 102·05 |
| 59. | Ehrsberg | 3·178 | 51 34 | 5·35 | 0·48 | 4·42 | — | 14·08 | 21·12 | 0·70 | $TiO_2$ 0 58, $Cr_2O_3$ 0·43, $Na_2O$ 0·84, $K_2O$ 0·15 = 99·49 |
| 60. | Syra | | 52·53 | 4·60 | — | 11·80 | — | 16·10 | 12·80 | 1 69 | = 99·52 |
| 61. | Mt. Marcy | 3·386 | 46·28 | 7·38 | 2·21 | 14·80 | — | 8·91 | 18·78 | 1·12 | $TiO_2$ 0·59 = 100·07 |
| 62. | Gaddbo | | 50·20 | 6·53 | 4·04 | 4·35 | — | 11·75 | 19·04 | 1·26 | alk., 1·05 = 98·22 |
| 63. | Åkerö | | 47·10 | 4·55 | — | 15·20 | 0·17 | 18·65 | 11·33 | 1·33 | insol. 0·34 = 98 67 |
| 64. | Kyrkjö | 3·010 | 44·12 | 11·90 | 6·45 | 4·04 | 0·26 | 20·34 | 8·73 | 4·72 | = 100·56 |
| 65. | " | 3·162 | 43·22 | 12·98 | 5·21 | 7·92 | 0·36 | 16·17 | 9·70 | 3·98 | = 99·54 |

| | AUGITE. | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|---|
| 66. | Amity, *Leucaugite* | 3·26 | 50·05 | 7·16 | 0·56 | — | 14·48 | 25·63 | $H_2O$ 1·66 = 99·54 |
| 66*a*. | Grenville, Q. | 3·35 | 51·27 | 4·00 | 0·10 | — | 17·46 | 25·27 | Alk 0·76 ign 1·63 = 100·49 |
| 67. | Vesuvius, *yellow* | 3·233 | 53·2 | 1·5 | — | 2·3 | 19·3 | 23·4 | ign. 0·2 = 99·9 |
| 68. | " *green* | 3·252 | 48·4 | 5·6 | — | 9·5 | 13·7 | 22·9 | ign. 0·26 = 100·36 |
| 69. | Monzoni | 3·317 | 49·60 | 4·16 | — | 9 82 | 14·42 | 21·86 | = 99·86 |
| 70. | Vogelsgebirge | | 50·12 | 6·25 | 4·95 | 3·46 | 14·41 | 21·43 | = 100·62 |
| 71 | Kircheip | 3·347 | 48·07 | 6·65 | 8·60 | 4·28 | 10·47 | 21·44 | = 99·51 |
| 72. | Naurod | 3·379 | 48·49 | 6·91 | 9·20 | 4·17 | 11·81 | 20·57 | = 101·15 |
| 73. | Etna | 2·935 | 48·48 | 7·02 | — | 13·52 | 11·08 | 19·08 | ign. 0·17 = 99·35 |
| 74 | Amherst Co., Va. | 3·420 | 42·50 | 15·39 | 11·32 | — | 7·50 | 22·67 | = 99·38 |
| 75. | Rossberg | 3 434 | 49·18 | 2·15 | 4·96 | 9·04 | 13·07 | 20·30 | $Na_2O$ 1·89, $K_2O$ 0·30, $TiO_2$, MnO *tr.* = 100·89 |
| 76. | Vesuvius, *black* | 3·275 | 46·95 | 9·75 | 4·47 | 4·09 | 16·04 | 19 02 | = 100·32 |
| 77. | " *dark green* | 3 203 | 51·01 | 4·84 | 3·51 | 3·16 | 16·58 | 20·80 | = 99·90 |
| 78. | " *yellow* | 3·298 | 50·41 | 6·07 | 1·09 | 6·78 | 12·92 | 22·75 | = 100·02 |
| 79. | Lipari | 3·225 | 48·45 | 6·68 | 3·57 | 6·94 | 14·35 | 20·30 | = 100·29 |
| 80. | Cuglieri, Sardinia | 3·299 | 45·65 | 8·61 | 6·32 | 5·05 | 13·60 | 21·09 | = 100·32 |
| 81. | Greenwood Furnace | 3·295 | 49·18 | 5·09 | 5·05 | 2·55 | 16·83 | 20·62 | = 99·32 |
| 82. | Mt. Bufaure, Tyrol | 3·299 | 49·01 | 5·09 | 3·77 | 7·74 | 14·55 | 20·01 | = 100·17 |
| | *Fassaite.* | | | | | | | | |
| 83. | Fassathal, *Fassaite* | 2·979 | 44·76 | 10·10 | 5·01 | 2·09 | 13·65 | 24·90 | = 100·51 |
| 84. | Toal della Foja, *cryst.* | | 43·81 | 9·97 | 7·01 | 1·52 | 12·51 | 25·10 | $H_2O$ 0·51 = 100·43 |
| 85. | " *gran.-cryst.* | 2·965 | 44·06 | 10·43 | 5·91 | 1·67 | 13·10 | 25·20 | $H_2O$ 0·15 = 100·52 |
| 86. | Mal Inferno, *cryst. green* | | 41·97 | 10 63 | 7·36 | 0·55 | 10·29 | 26·60 | $H_2O$ 2·70 = 100·10 |
| 87. | Arendal | 3·291 | 45·50 | 7·17 | 0·60 | 15·59 | 8·45 | 22·25 | = 99·56 |

*Augite.*

| | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $Na_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 88. | Rib. das Patas | 40·81 | 14·24 | 7·89 | 5·95 | 14·35 | 16·01 | 0·61 | = 99·86 |
| 89. | Pico da Cruz | 36·79 | 16·97 | 15·37 | 2·23 | 8·99 | 18·90 | 0·60 | $TiO_2$ *tr.* = 99·85 |
| 90. | Garza valley | 44·11 | 9·66 | 4·95 | 5·43 | 14·06 | 21·92 | *tr.* | = 100·13 |
| 91. | Aguas das Caldeiras | 45·79 | 7 89 | 3·51 | 4·81 | 14·81 | 21·60 | 1·55 | = 99·96 |
| 92. | St. Vincent | 45·14 | 8·15 | 5·25 | 5·20 | 14·76 | 19·57 | 1·46 | = 99·53 |
| 93. | Siderao | 38·22 | 13·08 | 9·29 | 9·14 | 11·73 | 14 80 | 4·32 | = 100·58 |
| 94. | " | 41·76 | 17·81 | 2·01 | 7·47 | 8·01 | 19·47 | 3·72 | = 100·25 |
| 95. | Praya, *large cryst.* | 43·99 | 14·01 | 2·09 | 8·84 | 10·88 | 19·42 | 1·09 | MnO 0·30 = 100·62 |
| 96. | " *small cryst.* | 38·15 | 25·96 | 11·08 | 6·17 | 1·99 | 4·53 | 7·91 | MnO 4·97 = 100·76 |
| 97. | Pico da Cruz | 37·20 | 16·93 | 15·07 | 3·55 | 6·89 | 14·81 | 5·06 | = 99·51 |
| 98. | Picos valley | 42·15 | 21·51 | 3·79 | 9·43 | 7·55 | 12·28 | 2·98 | = 99·69 |
| 99. | St. Vincent | 41·08 | 9·11 | 17·18 | 15·99 | 2·29 | 6·09 | 8·70 | = 100·44 |
| 100. | " " | 47·99 | 13·30 | 11·32 | 10·39 | 6·16 | 5·14 | 6·60 | = 100·90 |
| 101. | Pedra Molar | 46·94 | 5·67 | 6·18 | 5·43 | 14·18 | 17·83 | 1·83 | = 98·06 |
| 102. | St. Vincent | 45·14 | 8·15 | 5·25 | 5·20 | 14·76 | 19·57 | 1·46 | = 99·53 |

| | | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|---|
| 103. | Sasbach | 44·15 | 4·57 | 6·90 | 6 02 | 3·49 | 12·28 | 22·79 | = 100·20 |
| 104. | Burkheim | 45·83 | 3·57 | 7·47 | 4·90 | 4·11 | 10·92 | 22·83 | = 99·63 |
| 105. | Horberig | 46·54 | 2·85 | 8·20 | 3 72 | 4·32 | 13·19 | 21·29 | = 100·11 |
| 106. | Amoltern | 47·20 | 2·70 | 5·80 | 3·17 | 4·76 | 12·79 | 23·02 | = 99·44 |
| 107. | Oberschaffhausen | 49·75 | 1·45 | 0·53 | 13·23 | 9·66 | 4·55 | 16·72 | MnO 1·09, $Na_2O$ 2·26 [= 99·24 |
| 109. | Lützelberg | 51·37 | 0·94 | 2·43 | 4·14 | 4·46 | 13·55 | 22·72 | $Na_2O$ 0·44, $K_2O$ 0·61 [= 100·66 |
| 110. | Badloch | 52·09 | 0·95 | 1·18 | 1·59 | 1·57 | 18·10 | 23·56 | $Na_2O$ 0·48, $K_2O$ 0·48 [= 100 |

| | | G. | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $Na_2O$ | $K_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 111. | Laveline, Vosges | 3·372 | 50·63 | 0·79 | 0·87 | 3·33 | 8·39 | 13·01 | 21·30 | 1·02 | 0·50 | = 99.84 |
| 112. | Laurvik | 3·401 | 50·33 | 0·66 | 0·30 | — | 12·37 | 10·98 | 22·01 | 2·14 | 0·94 | = 99·73 |
| 113. | Serra Monchique | 3·473 | 42·27 | 0·92 | 8·67 | 13·93 | 6·24[a] | 10·95 | 12·32 | 3·66 | 2·12 | =101·08 |
| 114. | Rieden | 3·489 | 45·80 | 0·52 | 2·80 | 11·11 | 7·68[b] | 6·63 | 20·06 | 2·88 | 1·00 | = 98·48 |
| 115. | Löbau | 3·425 | 45·18 | 0·79 | 8·48 | 6·21 | 5·75[a] | 11·63 | 23·26 | 1·20 | *tr.* | =102·50 |
| 116. | Sasbach | 3·411 | 44·65 | 2·93 | 6·62 | 5·02 | 3·87[a] | 14·76 | 20·32 | 1·29 | 0·49 | = 99·95 |
| 117. | Halleberg | 3·448 | 50·25 | 0·45 | 1·25 | 5·86 | 17·40[a] | 15·72 | 8·73 | 0·82 | 0·47 | =100·95 |
| 118. | Hohentwiel | 3·359 | 42·15 | *tr.* | 5·17 | 16·86 | 8·54 | 3·56 | 10·39 | 10·69 | 2·64 | =100 |
| 119. | Elfdalen | 3·465 | 49·32 | 1 25 | 4·88 | 16·28 | 5·65 | 4·28 | 9·39 | 8·68 | 0·68 | =100·41 |
| 120. | Rieden | 3·456 | 46·47 | 0·73 | 4·28 | 5·95 | 12·17 | 7·24 | 19·23 | 2·61 | 0·74 | = 99·42 |
| 121. | Melfi | 3·416 | 44·55 | 1·36 | 7·27 | 6·06 | 5·91 | 10·44 | 22·83 | 1·47 | 0·52 | =100·41 |

[a] Incl. some MnO. [b] Incl. 0·27 MnO.

**Pyr., etc.**—Varying widely, owing to the wide variations in composition in the different varieties, and often by insensible gradations. Fusibility, 3·75 in diopside; 3·5 in salite, baikalite, and omphacite; 3 in jeffersonite and augite; 2·5 in hedenbergite. Varieties rich in iron afford a magnetic globule when fused on charcoal, and in general their fusibility varies with the amount of iron. Jeffersonite gives with soda on charcoal a reaction for zinc, and in O.F. on platinum wire for manganese; many others also give with the fluxes reactions for manganese. Most varieties are unacted upon by acids.

**Obs.**—Pyroxene is a common mineral in crystalline limestone and dolomite, in serpentine and in volcanic rocks; and occurs also, but less abundantly, in connection with granitic rocks and metamorphic schists; sometimes forms large beds or veins, especially in Archæan rocks. It occurs also in meteorites. The pyroxene of limestone is mostly white and light green or gray in color, falling under *diopside* (including malacolite, salite, coccolite); that of most other metamorphic rocks is sometimes white or colorless, but usually green of different shades, from pale green to greenish black, and occasionally black; that of serpentine is sometimes in fine crystals, but often of the foliated green kind called *diallage;* that of eruptive rocks is usually the black to greenish black *augite.*

In limestone the associations are often amphibole, scapolite, vesuvianite, garnet, orthoclase, titanite, apatite, phlogopite, and sometimes brown tourmaline, chlorite, talc, zircon, spinel, rutile, etc.; and in other metamorphic rocks mostly the same. In eruptive rocks it may be in distinct embedded crystals, or in grains without external crystalline form; it often occurs with similarly disseminated chrysolite (olivine), crystals of orthoclase, sanidine, labradorite, leucite, etc.; also with a rhombic pyroxene, amphibole, etc.

Pyroxene, as an essential rock-making mineral, is especially common in basic eruptive rocks. Thus, as augite, with a triclinic feldspar (usually labradorite), magnetite, often chrysolite, in basalt and basaltic lavas, diabase; in andesyte; also in trachyte; in peridotyte and pikryte; with nephelite in phonolyte. Further with elæolite, orthoclase, etc., in elæolite-syenite and augite-syenite, also as diallage in gabbro, in many peridotytes and the serpentines formed from them; as diopside (malacolite) in crystalline schists. In limburgyte, augityte, and pyroxenyte, pyroxene is present as the most prominent constituent, while feldspar is absent; it may also form rock masses alone nearly free from associated minerals.

Some of the more prominent foreign localities of pyroxene in its various forms are the following; many others have been noted in connection with the descriptions of varieties and analyses already given:

*Diopside* (alalite, mussite) occurs in fine crystals on the Mussa alp in the Ala valley in Piedmont, associated with garnets (hessonite) and talc in veins traversing serpentine; in fine crystals also at Traversella; at Zermatt in Switzerland; Schwarzenstein in the Zillerthal; Ober-Sulzbachthal and elsewhere in Tyrol and the Salzburg Alps; Reichenstein; Rezbanya, Hungary; Achmatovsk in the Ural with almandite, clinochlore; L. Baikal (*baikalite*) in eastern Siberia; Pargas, Orijärvi, and elsewhere in Finland. At Nordmark, Sweden, in fine crystals of varied type of form (cf. Flink, l. c.), but often with *a, b, c, p* prominent, and varying in composition from a diopside nearly free from iron to one containing iron in large amount, approximating to hedenbergite.

*Hedenbergite* was originally described from Tunaberg, Sweden; also from Arendal. Manganhedenbergite is from Vester Silfberg. *Schefferite* is from Långban, Wermland, Sweden, where it occurs embedded in calcite, also enclosing hematite and richterite; rhodonite and hedyphane occur in the neighborhood. Also from the Harstig mine at Pajsberg, with crystallized rhodonite (pajsbergite).

*Augite* (incl. fassaite) on the Pesmeda alp, Mt. Monzoni, and elsewhere in the Fassathal, as a contact formation; Traversella, Piedmont; the Laacher See and the Eifel; Sasbach in the Kaiserstuhl; Vesuvius, white rare, green, brown, yellow to black; Frascati; Etna; the Azores and Cape Verde Islands; the Sandwich Islands, as at the base of the cinder cones at the summit of Haleakala on Maui, where deposits of perfect crystals are found with chrysolite grains and glassy crystals of labradorite. Also in Japan, as on Bonin island (cf. Y. Kikuchi, J. Coll. Sc., Japan, 3, 67, 1889, for an account of some forms).

In N. America, occurs in *Maine*, at Raymond and Rumford, diopside, salite, etc.; at Deer Isle, diallage in serpentine. In *Vermont*, at Thetford, black augite, with chrysolite, in boulders of basalt. In *Mass.*, in Berkshire, white crystals abundant; at the Bolton quarries, same, good; Westfield and Blanford, diallage in serpentine. In *Conn.*, at Canaan, white cryst. 2–3 in. long by 1–2 in. broad, often externally changed by uralitization to tremolite, in dolomite; also the pyroxenic rock, called *canaanite;* in Trumbull, large green cryst. in limestone; in Reading, on the turnpike near the line of Danbury, small transp. cryst., and granular; at Watertown, near the Naugatuck, white diopside. In *N. York*, in N. Y. Co., white cryst. in dolomite; at Warwick, fine cryst.; in Westchester Co., white, at the Sing-Sing quarries; in Orange Co., in Monroe, at Two Ponds, cryst., often large, with scapolite, titanite, etc., in limestone; 3 m. S.E. of Greenwood furnace, salite with coccolite; ½ m. E. of same, in cryst. with mica in limestone; 1 m. W. of Coffee's Hotel in Monroe, black coccolite; 2½ m. N. of Edenville, gray cryst.; 1 m. N.W. of Edenville, black cryst. in limestone; in Cornwall, the var. *hudsonite;* near Amity and Fort Montgomery, good; in Forest-of-Dean, lamellar, green, and bronze-colored, with black coccolite; in Putnam Co., near Patterson, grayish white cryst., abundant; at Rogers' Rock, L. George, massive and granular (coccolite), gray, green, brown; near Oxbow, on Vrooman Lake; in Lewis Co., at Diana, white and black cryst.; in St. Lawrence Co., at Fine, in large cryst.; at De Kalb, fine diopside; also at Gouverneur, Rossie, Russell, Pitcairn; in Essex Co., near Long Pond, cryst., also beautiful green coccolite; at Willsboro', green coccolite with titanite and wollastonite; at Moriah, coccolite, in limestone mostly changed to serpentine forming a useful marble.

In *N. Jersey*, Franklin Furnace, Sussex Co., good cryst., also *jeffersonite*. In *Penn.*, near Attleboro', cryst. and granular; in Pennsbury, at Burnett's quarry, diopside; at the French Creek mines, Chester Co., chiefly altered to fibrous amphibole; at Bailey's quarry, East Marlborough. In *Maryland*, Harford Co., at Cooptown, diallage. In *Delaware*, at Wilmington, a hypersthene-like variety, Nuttal's *Maclureite*. In *Tennessee*, at the Ducktown mines.

In *Canada*, at Calumet I., grayish green cryst. in limestone with phlogopite; at the High Falls of the Madawaska, large crystals, having cryst. of hornblende attached; in Kildau as a rock; in Bathurst, colorless or white cryst.; near Ottawa, in large subtrp. cryst., in limestone; at Grenville, dark green cryst., and granular; at Montreal, Rougemont and Montarvelli Mts., black in doleryte; Burgess, Lanark Co.; Renfrew Co., with apatite, titanite, etc.; Orford, Sherbrooke Co., white crystals, also of a chrome-green color with chrome garnet; at Hull and Wakefield, white crystals with nearly colorless garnets, honey-yellow vesuvianite, etc. At many other points in the Archæan of Quebec and Ontario, especially in connection with the apatite deposits.

**Alt.**—Pyroxene undergoes alteration in different ways. A change of molecular constitution without essential change of composition, i.e., by *paramorphism* (using the word rather broadly), may result in the formation of some variety of amphibole. Thus, the white pyroxene crystals of Canaan, Conn., are often changed on the exterior to tremolite; similarly with other varieties at many localities. See URALITE, p. 390.

Further there may be alteration with chemical change in many ways, as has been explained by Bischof, and many species have been instituted on the material in different stages of change. In the simplest, there is only a taking up of water, producing a "hydrous augite." The water often found in analyses may be from this source. In many cases a loss of silica appears to attend this hydration; and often, also, a loss of one or more of the bases (of which the lime and iron are the first to go), through the dissolving agency of waters holding carbon dioxide, or carbonates, in solution. A complete removal of the lime and iron produces *steatite* or *talc*, a common material of pseudomorphs. *Rensselaerite* is a variety of steatite, having sometimes the cleavage of pyroxene. Pyrallolite is also in part talc or steatite. *Saponite* and *serpentine* are other results of the same kind of alteration, the latter, especially, very common. *Hortonite* is a steatitic pseudomorph of pyroxene, found in Orange Co., N. Y., with chondrodite. See further under TALC, SERPENTINE. *Epidote* is another mineral resulting from the change involving oxidation of the iron. In the case of the aluminous pyroxene, when all the bases except the alumina are removed and water taken up, there may result *cimolite*, a whitish claylike earth, which has been observed constituting pseudomorphs of augite at Bilin in Bohemia. Under the action of alkaline waters, alkalies may be introduced. Thus the hydrous mineral *glauconite* or *green earth* may result as a constituent of some augite pseudomorphs; or *mica*, which has been observed by Kjerulf as a pseudomorph after augite, in the Eifel.

Some of the substances formed by alteration are further mentioned below.

**Artif.**—Diopside has been observed as a furnace product at the iron-works of Philipsburg, N. Jersey (G. J. Brush. Am. J. Sc., **39**, 132, 1865); and dark-colored pyroxene at Gaspenberg; in an old furnace near Hackenburg; a copper furnace near Dillenburg; at Falun and Oldbury; a manganese-augite at Mägdesprung. Augite in small yellow crystals has been found in old fumaroles at Eiterkopfe, near Andernach (Rath).

Formed in crystals, as diopside, artificially by the action of silicon chloride on magnesia (Daubrée); also, a grayish-white var., by mixing the constituents and exposing to a high heat (Berthier); also, a variety of compounds (Lechartier) by fusing the constituents at a bright red heat with an excess of calcium chloride in a carbon crucible enveloped in one of earthenware. See further, Fouqué & Lévy, Synth. Min., 102–110, 1882. Synthetic experiments have been also made by Doelter, Jb. Min., **2**, 51, 1884; also on the results of fusion, as in reforming pyroxene from the fused mass, by Becker, Zs. G. Ges., **37**, 10, 1885. See also Vogt, Ak. H. Stockh., Bihang, **9**, No. 1., 1884; Arch. Math. Nat., Christ., **30**, 34, *et seq.*, 1889, who describes various pyroxenic minerals formed from fusion in slags, etc., including augite, a monoclinic (or triclinic) $MgSiO_3$, a similarly crystallized $FeSiO_3$, also enstatite, rhodonite, an hexagonal $CaSiO_3$, etc.

**Ref.**—[1] Vesuvian augite, yellow variety, G. = 3·277, anal. 67, l. c. It is noteworthy that the angles vary but little even for a wide variation in composition. For a discussion of the change in form with varying amount of FeO and $(Al,Fe)_2O_3$, see Rath, Pogg., **6**, 345, 1873; Flink, Zs. Kr., **11**, 486, 1886. The following will serve for comparison, the axes being accepted as calculated by Kk., Rath, La Valle, Flink, etc., cf. anals. preceding and ref. below:

| | | $\grave{a}$ : $\bar{b}$ : $\acute{c}$ | $\beta$ |
|---|---|---|---|
| Russian and other pyroxenes, mean value (Kk.) | | 1·09312 : 1 : 0·58946 | 74° 11½′ |
| *Diopside*, Val d'Ala | (cf. anal. 1, 2) | 1·09126 : 1 : 0·58949 | 74° 8⅚′ |
| " Nordmark | ( " 10) | 1·09197 : 1 : 0·58694 | 74° 12⅔′ |
| " " | ( " 11) | 1·09220 : 1 : 0·58689 | 74° 13′ |
| " " | ( " 12) | 1·09186 : 1 : 0·58659 | 74° 16′ |
| " " | ( " 13) | 1·09175 : 1 : 0·58562 | 74° 19¾′ |
| " " | ( " 14,15) | 1·09123 : 1 : 0·58429 | 74° 34¾′ |
| *Schefferite* | ( " 46) | 1·1006 : 1 : 0·59264 | 73° 53′ |
| *Iron-schefferite* | ( " 47) | 1·0990 : 1 : 0·59305 | 73° 58⅚′ |
| *Augite* Vesuv., *dark green* | | 1·09547 : 1 : 0·59035 | 74° 13⅚′ |
| " " *yellow* | ( " 67) | 1·09213 : 1 : 0·58931 | 74° 10⅙′ |

Since in pyroxene the angle *ac* differs but little from the angle *a'p*, it is possible so to select the axes as to make the angle of obliquity, $\beta$, nearly 90°. This method, proposed by Rath and later by Tschermak, and adopted by Groth (Tab. Ueb., p. 130, 1889) has a certain advantage in that it exhibits clearly the morphological similarity between the orthorhombic and monoclinic pyroxenes. It is not to be recommended otherwise, however, since the resulting symbols of the commonly occurring planes are often highly complex; moreover, it is clear that the basal plane in the position of Naumann here, as ordinarily, adopted is naturally a *fundamental* plane since it is parallel to it that the common twinning lamellæ occur, with the resulting easy parting so often observed. Cf. also Flink, Zs. Kr., **16**, 299, 1890, who notes another objection.

[2] Cf. Kk., Min. Russl., **4**, 258, 1862; Mlr., Min., p. 290, 1852; Dx. Min., **1**, 55 1862; Hbg., Min. Not., **1**, 18, 1856, **5**, 21, 1863; Rath, Pogg., Erg., **6**, 338, 1873, Ber. nied. Ges. (311), July 7, 1886. A list of planes with authorities is given by Götz, Zs. Kr., **11**, 242, 1885; another by La Valle, Mem. Acc. Linc., **3**, 226, 1886; also a critical summary with literature by Gdt., Index, **2**, 523, 1890.

[2] Hj. Sj., Nordmark, G. För. Förh., **4**, 364, 1879. [3] Götz, l. c. [4] Flink, Nordmark, Zs. Kr., **11**, 449 *et seq.*, 1886, and Öfv. Ak. Stockh., **42**, No. 2, 29, 1885. [5] La Valle, Val d'Ala, l. c., also ib., **5**, 389, 1888. [6] Zeph, Ober-Sulzbachthal, Lotos, 1889. [7] Cathrein, Pinzgau, Ann. Mus. Wien, **4**, 181, 1889. [8] Götz, Mitth. Univ. Greifswald, 1886.

[9] *Hemihedrism:* Williams, Am. J. Sc., **34**, 275, 1887, **38**, 115, 1889; cf. also observations by Hbg., Dx. (quoted by Williams), and further, pyro-electrical observations by Hankel, l. c.

[10] *Twins:* Rath, Zs. Kr., **5**, 495, 1881; Zeph., Jb. Min., 59, 1871; Becke, Min. Mitth., **7**, 93,

1885; Mgg., secondary and artificial twinning ‖ *c*, Jb. Min., **1**, 185. 1886, **1**, 238, 1889. La Valle, polysynthetic twins, Val d'Ala, Mem. Accad. Linc., **19**, June 1, 1884. Association with amphibole, with analyses, Rath, Vesuvius, Pogg., Erg., **6**, 229, 337, 1873; also, Hawes, Edenville, Am. J. Sc., **16**, 397, 1878, and Rep. Min. New Hampshire. 63. 1878; see also p. 390.

*Refractive indices*, etc., Dx., Min., **1**, 55 *et seq.*, 1862; Heusser, Pogg., **91**, 498, 1854; Taberg, A. E. Nd., l. c.; also Flink *et al.*, as already quoted. Etching-figures, Baumh., Pogg., **153**, 75, 1874; Greim, Jb. Min., **1**, 252, 1889. *Pyro-electricity*, Hankel, Wied., **1**, 279, 1877. *Piezo-electricity*, P. Czermak, Ber. Ak. Wien, **96** (2), 1217, 1887.

Discussion of the *composition* of the group: Tschermak, Min. Mitth., 17, 1871; Doelter, ib., 65, 1877, **1**, 49, 1878, **2**, 193, 1879. See also Doelter, Knop, Merian, Mann, etc., references quoted under the analyses. On the relation between composition and optical characters, Doelter, Jb. Min., **1**, 43, 1885; Wiik, Öfv. Finsk. Soc., **24**, 1882, **25**, 1883, **26**, 1884, Zs. Kr., **7**, 78, 1882, **11**, 313. 1885; Herwig [Programm Gymn. Saarbrücken 1884]. Zs. Kr., **11**, 67. 1885.

The following are more or less well-defined alteration products of various kinds of pyroxene; see further for analyses, etc., 5th Ed., pp. 220–223.

HECTORITE *S. Herbert Cox*, Trans. N. Z. Inst., **15**, 409, 1882. A hydrated pyroxenic mineral from the serpentine rocks of the Dun Mts., New Zealand. Occurs in radiating groups of thin flexible laminæ. H. = 2–2·5. Color whitish green to dark green. Analysis by W. Skey:

$SiO_2$ 57·89 $Al_2O_3$ 4·74 FeO 18·46 MgO 13·94 CaO 1·99 $H_2O$ 2·98 $Fe_2O_3$,MnO *tr.* = 100

HYDROUS DIALLAGE. Various forms have been described, 5th Ed., p. 221.

MONRADITE *Erdmann*, Ak. H. Stockh., 103, 1842. Probably a slightly altered pyroxene. Described as occurring granular massive, with two unequal cleavages mutually inclined about 50°; with H. = 6, G. = 3·267; color yellowish, honey-yellow, and luster vitreous. From Bergen in Norway. Named after Dr. Monrad.

PICROPHYLL *Svanberg*, Pogg., **50**, 662, 1839. From Sala, where it occurs both massive, with the cleavage of pyroxene, and fibrous, of a greenish gray color, with H. = 2·5 and G. = 2·75. Named from πικρός, *bitter*, and φύλλον, *leaf*, in allusion to the odor when moistened.

PITKÄRANTITE *Scheerer*, Pogg., **93**, 100, 1854. Pikärandite. Has a leek-green or dark green color, and looks like unaltered pyroxene. From Pitkäranta in Finland. Scheerer refers here part of pyrallolite.

PYRALLOLITE *N. Nordenskiöld*, Schw. J., **31**, 389, 1820. From Finland, where it occurs mostly in limestone, with pyroxene and scapolite. A pyrallolite from Sibbo in Finland has been named *Vargasite*, after Count Vargas, Huot Min., **2**, 676, 1841; Wargasit *Germ.* The crystalline structure is that of pyroxene. Named from πῦρ, *fire*, αλλος, *other*.

STRAKONITZITE *Zepharovich*, Jb. G. Reichs., **4**, 695, 1853. Approaches steatite. It occurs in greenish yellow crystals, soft and greasy in feel, with G. = 1·91.

URALITE *Rose*, Pogg., **22**, 321, 329, 1831; **27**, 97, 1833; **31**, 609, 1834. Pyroxene altered to amphibole. See further, p. 390.

**326. ACMITE.** Achmit *Ström*, Ak. H. Stockh., 160, 1821, and *Berz*,, ib., 163. Akmit *Germ.* Acmite.

AEGIRITE. Ægirin *Esmark*, Berzelius, Jb. Min., 184, 1835.

Monoclinic. Axes: $\grave{a} : \bar{b} : \acute{c} = 1·09957 : 1 : 0·60120$; $\beta = 73° 10\frac{5}{6}' = 001 \wedge 100$ Brögger[1].

$100 \wedge 110 = {}^*46° 28'$, $001 \wedge \bar{1}01 = 31° 52\frac{1}{6}'$, $001 \wedge 011 = 29° 55\frac{1}{6}'$.

**Forms**[1]: *f* (310, $i$-$\bar{3}$) *H* ($\bar{3}02$, $\frac{3}{2}$-$\bar{i}$) *O* ($\bar{6}61$, 6) *S* ($\bar{3}11$, 3-$\bar{3}$)
*a* (100, $i$-$\bar{i}$) *L* (730, $i$-$\frac{7}{3}$) *s* ($\bar{1}11$, 1) *Ω* ($\bar{8}81$, 8) *Q* ($\bar{1}61$, 6-$\grave{6}$)
*b* (010, $i$-$\grave{i}$) *m* (110, *I*) *λ* ($\bar{3}31$, 3) *P* (261, − 6-$\grave{3}$) *K* ($\bar{1}91$, 9-9)
*χ* (510, *i* 5) *p* ($\bar{1}01$, 1-$\bar{i}$)

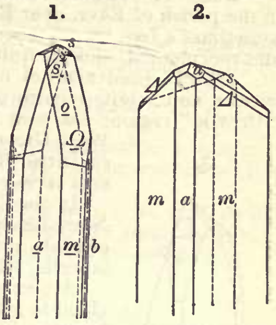
*ff'''* = 38° 40′ *a'H* = 60° 59½′ *a's* = 77° 1′ *ss'* = 60° 17′
*mm'''* = *92° 56′ *m's* = 58° 45½′ *a'S* = *39° 35′ *OO'* = 95° 25½′
*a'p* = 74° 57′ *m'O* = 12° 6½′ *a'O* = 50° 8½′ *SS'* = *38° 20′

On ÆGIRITE: Brögger has observed:

*a, b, c, V* (11·1·0, $i$-$\bar{1}\bar{1}$), *χ, f, W* (16·15·0, $i$-$\bar{\tfrac{16}{15}}$), *m, p, u* (111, − 1), *v* (221, − 2), *s, π* ($\bar{5}51$, 5), *O, Ω, Λ* (451, − 5-$\frac{5}{4}$), *Δ* (592, − $\frac{9}{2}$-$\frac{9}{5}$), *Z* ($\bar{4}$·10·3, $\frac{10}{3}$-$\frac{5}{2}$), *k* ($\bar{3}12$, $\frac{3}{2}$-$\bar{3}$).

The angles are sensibly the same as those of acmite; Brögger measured:

*mm'''* = 92° 49′, *a'p* = 74° 56′, *ss'* = 60° 15′, *uu'* = 48° 41′, *aΔ* = 58° 42′, *mΔ* = 19° 52′, also *ΔΔ'* = 107° 0½′ (calc., Bgr.), *Δ* is a characteristic form.



1, *Acmite;* 2, *Ægirite,* Norway, Brögger.

Twins: tw. pl. *a*, very common, f. 1; crystals often polysynthetic, with enclosed twinning lamellæ. Crystals long prismatic, vertically striated or channeled; the prisms bent, twisted or broken. Acute terminations very characteristic; faces often rough or rounded (*a*, *b*, *p*, *s*). Inclined hemihedrism, like pyroxene, probable.

The above applies to ordinary *acmite*.

For *ægirite*, the crystals are prismatic ‖ $\dot{c}$ with *m* prominent, also *a*, *b*, and usually terminated by *s* ($\bar{1}11$), or *p* ($\bar{1}01$), or with *Δ* (592) and *p* ($\bar{1}01$); again, prismatic by extension of ($\bar{1}11$) with *m* small. Twins not common. Also occurs in groups or tufts of slender acicular to capillary crystals, and in fibrous forms.

Cleavage: *m* distinct; *b* less so. Fracture uneven. Brittle. H. = 6–6·5. G. = 3·50–3·55 Bgr. Luster vitreous, inclining to resinous. Streak pale yellowish gray. Color brownish or reddish brown, green; in the fracture blackish green. Subtransparent to opaque.

Crystals of acmite often show a marked zonal structure, green within and brown on the exterior, particularly ‖ *a*, *b*, *p* ($\bar{1}01$), *s* ($\bar{1}11$). The brown portion (acmite, see below) is feebly pleochroic, the green (ægirite) strongly pleochroic. Both have absorption $\mathfrak{a} > \mathfrak{b} > \mathfrak{c}$, but the former has $\mathfrak{a}$ light brown with tinge of green, $\mathfrak{b}$ greenish yellow with tinge of brown, $\mathfrak{c}$ brownish yellow; the latter has $\mathfrak{a}$ deep grass-green, $\mathfrak{b}$ lighter grass-green, $\mathfrak{c}$ yellowish brown to yellowish.

Optically —. Ax. pl. ‖ *b*. $Bx_a \wedge \dot{c} = \mathfrak{a} \wedge \dot{c} = +2\frac{1}{2}°$ to 6°; for acmite $+5\frac{1}{2}°$ to 6°, for ægirite $+2\frac{1}{2}°$ to $3\frac{1}{2}°$. Axial angles large. For ægirite, Bgr.:

Na $2E = 134° 27'$ $2H_a = 63° 41'$ $2H_o = 117° 18'$. ∴ $2V_a = 63° 28'$ $\beta = 1·753$

Also, Låven, $\beta_y = 1·8084$ Na, Sanger (Rosenbusch).

**Comp., Var.**—Essentially $Na\overset{III}{Fe}(SiO_3)_2$ or $Na_2O.Fe_2O_3.4SiO_2$ = Silica 52·0, iron sesquioxide 34·6, soda 13·4 = 100. Ferrous iron is also present.

The analysis of Doelter as interpreted by him gives, with 89 p. c. of the characteristic $Na\overset{III}{Fe}(SiO_3)_2$, also 6 p. c. of $\overset{II}{Fe}\overset{III}{Fe_2}SiO_6$, 3·7 p. c. of $\overset{II}{Fe}AlSiO_6$ and 1·3 p. c. of $CaMn(SiO_3)_2$. Brögger, however, is inclined to assume the presence, with 85 p. c. of $Na_2Fe_2(SiO_3)_4$, of 15 p. c. of $FeFe_2(SiO_3)_4$.

The essential identity of acmite and ægirite was shown by Tschermak, Min. Mitth., 33, 1871; it had been earlier suggested by Rose. Kryst. Ch., 76, 1852.

Brögger regards the interior green, highly pleochroic, portion of the acmite crystals (noted above) as identical with the characteristic ægirite, while to the acmite proper belongs the feebly pleochroic brown exterior with greater angle of extinction (to + 6°). *Acmite* is characterized by the prevalence of twins, the acute terminations, the common occurrence of *S* ($\bar{3}11$), etc. With *ægirite* simple crystals are the rule and twins rare; the crystals are more often bluntly terminated, with *Δ* (592) prominent; also of quite distinct habit, prismatic ‖ $\bar{1}11$. The color and higher angle of extinction of the acmite indicates greater iron percentage.

**Anal.**—1, Rg., Pogg., **103**, 300, 1858. 2, Doelter, Min. Mitth., **1**, 379, 1878. 3, Id., ib., p. 374. 4, 5, Id., ib., Zs. Kr., **4**, 34, 1879. That these analyses are of ægirite and not arfvedsonite seems to be sufficiently shown by Rg., Min. Ch., Erg., 24, 1886, cf. Lorenzen. 6, Lorenzen, Min. Mag., **5**, 55, 1882. 7, Forsberg, quoted by Ramsay, Fennia, **3**, No 7, 1890 (Geol. Beob. Halbinsel Kola.) 8, J. L. Smith, Am. J. Sc., **10**, 60, 1875.

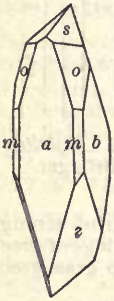
| | G. | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $Na_2O$ | $K_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Acmite.* | | | | | | | | | | | | |
| 1. Rundemyr | 3·53 | | 51·66 | — | 28·28 | 5·23 | 0·69 | — | — | 12·46 | 0·43 | $TiO_2$ 1·11,<br>[ign. 0·39 = 100·25 |
| 2. " | 3·520 | | 51·35 | 1·59 | 32·11 | 2·59 | 0·37 | *tr.* | — | 11 39 | *tr.* | = 99·40 |
| *Ægirite.* | | | | | | | | | | | | |
| 3. Brevik | 3·501 | $\frac{2}{2}$ | 51·74 | 0·47 | 26·17 | 3·48 | 0·46 | 5·07 | 1·79 | 11·02 | 0·34 | = 100·54 |
| 4. Kangerdluarsuk | | | 52·22 | 0·64 | 28·15 | 5·35 | 0·54 | 2·19 | 1·45 | 10·11 | 0·34 | = 100·99 |
| 5. " | | $\frac{2}{2}$ | 49·91 | 1·24 | 22·83 | 13·95 | 0·42 | 1·72 | 0·21 | 9·49 | 0·32 | = 100·09 |
| 6. " | 3·63 | | 49·04 | 1 80 | 29·54 | 4 82 | *tr.* | 2·70 | *tr.* | 13·31 | *tr.* | = 101·21 |
| 7. Kola Peninsula | 3·51 | | 51·82 | 0·60 | 21 02 | 8·14 | 1·00 | 3·01 | 1·47 | 11·87 | 0·85 | ign. 0·50<br>[= 100·28 |
| 8. Hot Springs, Ark. | 3·53 | | 51·41 | 1·82 | 23 30 | 9·45 | — | 2 03 | 0 31 | 11·88 | *tr.* | $TiO_2$ 0·13<br>[= 100·33 |

**Pyr., etc.**—B.B. fuses at 2 to a lustrous black magnetic globule, coloring the flame deep yellow; with the fluxes reacts for iron and sometimes manganese. Slightly acted upon by acids.

**Obs.**—The original *acmite* occurs at Rundemyr, east of the little lake called Rökebergskjern, in the parish of Eker, near Kongsberg, Norway, in a pegmatyte vein; it is in slender crystals, sometimes a foot long, embedded in feldspar and quartz; the crystals are often bent or fractured and recemented, and are quite fragile.

*Ægirite* (and acmite) occurs with leucophanite, cancrinite, elæolite, etc., in the elæolite-syenite and augite-syenite of southern Norway, especially along the Langesund fiord in the "Brevik" region; also near Laurvik, Sande fiord, and Fredriksvärn. Also at Kangerdluarsuk, West Greenland, in a sodalite-syenite with eudialyte, arfvedsonite, etc.; also at Ditró, Transylvania (acmite?), and similarly associated elsewhere; in the acid lavas of San Miguel, one of the Azores.

3.



Schrauf.

In the U. S., in minute crystals in a dike of elæolite-syenite in northwestern New Jersey. At the Hot Springs, Magnet Cove, Arkansas, in fine prismatic crystals, up to 8 inches or more in length, often bent and twisted and with tapering terminations. In Canada, at Montreal and Belœil in elæolite-syenite.

A green pyroxene occurring as an alteration product of a blue amphibole allied to arfvedsonite or riebeckite (see p 400, is referred to ægirite by Cross; it occurs in certain rocks forming dikes in Archæan gneisses in Custer Co., Colorado. Am. J. Sc., **39**, 359, 1890.

Brögger (l.c., p. 330) is inclined to regard the crocidolite of Stavern, Norway, and perhaps also that of S. Africa as a variety of ægirite (*ægirin-asbest*); but see crocidolite, p. 400)

*Acmite* is from *ἀκμή, a point*, in allusion to the pointed extremities of the crystals. *Ægirite* is from Ægir, the Icelandic god of the sea.

**Alt.**—Occurs altered to analcite in Norway (Bgr.). Williams suggests that manganpectolite at Magnet Cove may have been derived from the ægirite.

**Ref.**—[1] Zs. Kr., **16**, 295, 1890; he describes in detail the acmite and ægirite of the islands in the Langesund fiord, Norway, gives the earlier literature for the species, etc. For early observations, see Mitscherlich, Ed. Phil. J., **9**, 55, 1823; Ph., Min., 151, 1837; Rath, Pogg., **111**, 254, 1860; Schrauf, Atlas, Tf. II, 1864.

Note also that the *s* ($\bar{1}11$) of Brögger is *s* (011, T) of Rath, *p* = *c* (001), *S* ($\bar{3}11$) = (211, m), *O* ($\bar{6}61$) = *o* (561), *P* (261) = *z* ($\bar{3}61$); cf. f. 3. This change of position, which better exhibits the relation of form to pyroxene, is probably the reason why most authors have given $Bx_a \wedge \dot{c} = -3°$, while Brögger makes the same angle positive, that is with him the bisectrix ($\mathfrak{a}$) falls in the front obtuse axial angle, instead of in the acute angle.

**327. SPODUMENE.** *D'Andrada*, Scherer's J., **4**, 30, 1800; J. Phys., **51**, 240, 1800. Triphane *Haüy*, Tr., **4**, 1801. Hiddenite *J. L. Smith*, Am. J. Sc., **21**, 128, 1881.

Monoclinic. Axes: $\breve{a} : \bar{b} : \dot{c} = 1{\cdot}1238 : 1 : 0{\cdot}6355$; $\beta = {}^*69° \, 40' = 001 \wedge 100$ J. D. Dana[1].

$100 \wedge 110 = 46° \, 30'$, $001 \wedge \bar{1}01 = 33° \, 25\frac{1}{4}'$, $001 \wedge 011 = 30° \, 47\frac{1}{2}'$.

**Forms**[2]:
*a* (100, *i*-*ī*)
*b* (010, *i*-*ì*)$^3$
*c* (001, *O*)
*l* (320, *i*-$\frac{3}{2}$)
*m* (110, *I*)

*k* (230, *i*-$\frac{3}{2}$)$^4$
*μ* (120, *i*-2̀)
*n* (130, *i*-3̀)
*Z* (150, *i*-5̀)$^4$
*F* (011, 1-*ì*)$^4$
*d* (021, 2-*ì*)

*p* ($\bar{1}11$, 1)
*q* ($\bar{3}32$, $\frac{3}{2}$)$^3$
*r* ($\bar{2}21$, 2)
*s* ($\bar{4}41$, 4)$^3$
*g* (681, − 8-$\frac{4}{3}$)$^3$
*e* (241, − 4-2̀)$^3$

*ξ* (131, − 3-3̀)$^4$
*z* (261, − 6-3̀)$^3$
*φ* ($\bar{3}12$, $\frac{3}{2}$-3̄)$^4$
*f* ($\bar{2}11$, 2-2̄)
*D* ($\bar{4}21$, 4-2)$^4$
*w* ($\bar{3}21$, 3-$\frac{3}{2}$)$^4$

*y* ($\bar{5}61$, 6-$\frac{6}{5}$)$^3$
*v* ($\bar{3}41$, 4-$\frac{4}{3}$)$^4$
*x* ($\bar{2}31$, 3-$\frac{3}{2}$)$^3$
*u* ($\bar{2}43$, $\frac{4}{3}$-2̀)$^3$
*ϵ* ($\bar{2}41$, 4-2̀)$^3$
*t* ($\bar{4}81$, 8-2̀)$^4$

Also in etching-figures[6], Brazil, *v* (101, − 1-*ī*), *w* (201, − 2-*ī*).

*ll'''* = 70° 11′
*mm'''* = *93° 0′
*μμ'* = 50° 46′
*nn'* = 35° 6½′
*FF'* = 61° 35′
*dd'* = 100° 0′

*cd* = *50° 0′
*m'p* = 59° 3′
*m'q* = 44° 21′
*m'r* = 34° 40′
*m's* = 17° 40½′

*mg* = 10° 18′
*me* = 21° 46′
*mp* = 75° 34′
*a'p* = 78° 54′
*a'r* = 62° 40½′

*a'f* = 54° 48½′
*pp'* = 63° 31′
*rr'* = 88° 34′
*ss'* = 96° 23′
*ee'* = 107° 24′

Twins: tw. pl. *a*. Crystals prismatic, often flattened ‖ *a*; the vertical planes striated and furrowed; crystals sometimes very large. Also massive, cleavable.

Cleavage: *m* perfect. A lamellar structure ‖ *a* sometimes very prominent, a crystal then separating into thin plates. Fracture uneven to subconchoidal. Brittle. H. = 6·5–7. G. = 3·13–3·20. Luster vitreous, on cleavage surfaces somewhat pearly. Color greenish white, grayish white, yellowish green, emerald-green, yellow, amethystine purple. Streak white. Transparent to translucent.

Pleochroism strong in deep green varieties. Optically +. Ax. pl. ∥ *b*. Bx$_a$ ∧ ċ = + 26° Dx., = 24° to 25½° Greim. Dispersion $\rho > v$, horizontal. Refractive indices and axial angles:

| | | | | |
|---|---|---|---|---|
| N. Carolina, Na | $\alpha = 1·651$ | $\beta = 1·669$ | $\gamma = 1·677$ | Brazil $\beta_y = 1·669$ Dx.[5] |
| Brazil, red, | $\alpha = 1·660$ | $\beta = 1·666$ | $\gamma = 1·676$ | Lévy-Lcx.[7] |
| Brazil | $2H_{a.r} = 64° 47'$ | $2H_{a.y} = 64° 58\frac{1}{2}'$ | $2H_{a.bl} = 65° 4\frac{1}{2}$ Greim[6]. | |

**Var.**—1. *Ordinary.* Color white or nearly white, yellowish, rarely amethystine; commonly in flattened prismatic crystals, often very large, up to 4 feet or more in length and 12 inches across.

2. *Hiddenite.* Color yellow-green to emerald-green, the latter used as a gem, resembling the emerald but showing more variety of color because of its pleochroism. In small (½ in. to 2 inches long) slender prismatic crystals, surfaces often etched as the result of the action of some natural solvent.

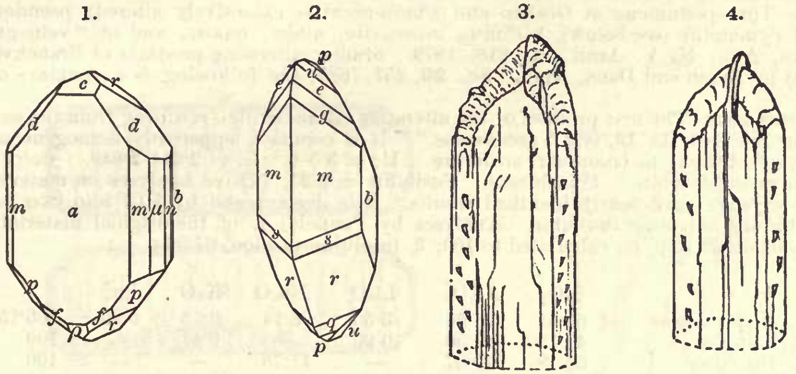


Fig. 1, Norwich, Mass. 2–4, *Hiddenite*, Alexander Co., N. C. 3, 4, Sketches of natural crystals, W. E. Hidden.

**Comp.**—$LiAl(SiO_3)_2$ or $Li_2O.Al_2O_3.4SiO_2$ = Silica 64·5, alumina 27·4, lithia 8·4 = 100. Generally contains a little sodium; the variety hiddenite also chromium, to which the color may be due.

**Anal.**—1, 2, Rg., Pogg. Ann., **85**, 546, 1852. 3, Thomson, Min., **1**, 302. 1836. 4, Pisani, C. R., **84**, 1509, 1877. 5, 6, Doelter, Min. Mitth., **1**, 523, 526, 1878. 7, Jannasch, Jb. Min., **1**, 196, 1888. 8, 9, Julien, Ann. N. Y. Ac. Sc., **1**, 322, 1879. 10, Penfield, Am. J. Sc., **20**, 259, 1880. 11, J. L. Smith, ib., **21**, 128, 1881. 12, Genth, ib., **23**, 68, 1882.

| | G. | $SiO_2$ | $Al_2O_3$ | FeO | CaO | MgO | $Li_2O$ | $K_2O$ | $Na_2O$ | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Utö | 3·133 | 65·02 | 29·14 | *tr.* | 0·50 | 0·15 | 5·47 | 0·14 | 0·46 | — | = 100·88 |
| 2. Tyrol | 3·137 | 65·53 | 29·04 | 1·42 | 0·97 | 0·07 | 4·49 | 0·07 | 0·07 | — | = 101·66 |
| 3. Killiney | | 63·81 | 28·51 | 0·83 | 0·73 | — | 5·60 | — | — | 0·36 | = 99·84 |
| 4. Brazil | 3·16 | 63·80 | 27·93 | 1·17[a] | 0·46 | — | 6·75 | — | 0·89 | — | = 101·00 |
| 5. Huntington | | 63·79 | 27·03 | 0·39 | 0·73 | 0·21 | 7·04 | 0·12 | 1·10 | — | = 101·41 |
| 6. Brazil | | 63·34 | 27·66 | 1·15 | 0·69 | — | 7·09 | — | 0·98 | — | = 100·91 |
| 7. " | 3·174 | 64·32 | 27·79 | 0·67 | 0·17 | — | 7·45 | — | 0·55 | 0·12 | = 101·07 |
| 8. Goshen | 3·19 | 63·27 | 23·73 | 1·17[b] | 0·11 | 2·02 | 6·89 | 1·45 | 0·99 | 0·36 | MnO 0·64 [= 100·63 |
| 9. Chesterfield | 3·196 | 61·86 | 23·43 | 2·73[b] | 0·79 | 1·55 | 6·99 | 1·33 | 0·50 | 0·46 | MnO 1·04 [= 100·68 |
| 10. Branchville | 3·193 | 64·25 | 27·20 | 0·20[b] | — | — | 7·62 | *tr.* | 0·39 | 0·24 | = 99·90 |
| 11. Alex. Co., *Hiddenite* | 3·170 | 64·35 | 28·10 | 0·25[b] | — | — | 7·05 | — | 0·50 | 0·15 | = 100·40 |
| 12. " " " | 3·166 | 63·95 | 26·58 | 1·11 | — | — | 6·82 | 0·07 | 1·54 | — | $Cr_2O_3$ 0·18 [= 100·25 |

[a] Incl. MnO 0·12. [b] $Fe_2O_3$.

The formula, as given above, was first correctly established by Doelter.

**Pyr., etc.**—B.B. becomes white and opaque. swells up, imparts a purple-red color (lithia) to the flame, and fuses at 3·5 to a clear or white glass. The powdered mineral, fused with a mixture of potassium bisulphate and fluorite on platinum wire, gives a more intense lithia reaction. Not acted upon by acids.

**Obs.**—Occurs on the island of Utö in Södermanland, Sweden, with magnetite, quartz, tourmaline, and feldspar; also near Sterzing and Lisens in Tyrol; of a pale green or yellowish color, embedded in granite, at Killiney Bay, near Dublin, and at Peterhead in Scotland; in small transparent crystals of a pale yellow in Brazil, province of Minas Geraës.

In the U. S., in granite at Goshen, Mass., associated at one locality with blue tourmaline and beryl; also at Chesterfield, Chester, Huntington (formerly Norwich), and Sterling, Mass.; at Windham, Maine, with garnet and staurolite; at Peru, with beryl, triphylite, petalite; at Winchester, N. H.; at Brookfield, Ct., a few rods north of Tomlinson's tavern, in small grayish or greenish white individuals looking like feldspar; at Branchville, Ct., in a vein of pegmatyte, with lithiophilite, uraninite, several manganesian phosphates, etc.; the crystals are often of immense size embedded in quartz; near Stony Point, Alexander Co., N. C., the variety *hiddenite* in cavities in a gneissoid rock with beryl (emerald), monazite, rutile, allanite, quartz, mica, etc.; near Ballground, Cherokee Co., Ga.; in South Dakota at the Etta tin mine in Pennington Co., in immense crystals. At Huntington, Mass., it is associated with triphylite, mica, beryl, and albite; one crystal from this locality was 16½ inches long, and 10 inches in girt.

The name spodumene is from σποδιός, *ash-colored.* Named triphane by Haüy from τριφανής, *appearing threefold,* in allusion to his idea that the crystals are divided by three planes with nearly equal ease. *Hiddenite* is named for W. E. Hidden of New York.

**Alt.**—The spodumene at Goshen and Chesterfield is extensively altered; pseudomorphs occur of cymatolite (see below), killinite, muscovite, albite, quartz, and of "vein granite;" cf. Julien, Ann. N. Y. Acad., **1**, 318, 1879. Similar alteration-products at Branchville are described by Brush and Dana, Am. J. Sc., **20**, 257, 1880; the following is a summary of their results:

*β Spodumene.* The first product of the alteration (Branchville), resulting from the exchange of Na for one-half the Li, is "*β spodumene.*" It is compact, apparently homogeneous, with an indistinct fibrous to columnar structure. H. = 5·5–6. G. = 2·644–2·649. Color white, milky, or greenish white. Translucent. Fusibility = 2·25. Three analyses on material from different crystals gave nearly identical results. It is decomposed by HCl into two portions, one soluble and the other insoluble. Analyses by Penfield: 1, of the original material; 2, the soluble portion 32·10 p. c., calculated to 100; 3, insoluble portion, 67·56 p. c.:

| | | $SiO_2$ | $Al_2O_3$ | $Li_2O$ | $Na_2O$ | $K_2O$ | ign. | |
|---|---|---|---|---|---|---|---|---|
| 1. *β spodumene* | $\frac{2}{2}$ | 61·51 | 26·56 | 3·50 | 8·14 | 0·15 | 0·29 | = 100·15 |
| 2. Soluble | | 48·13 | 40·50 | 10·90 | — | 0·47 | — | = 100 |
| 3. Insoluble | | 68·18 | 20·07 | — | 11·75 | — | — | = 100 |

The insoluble portion is albite, the soluble is eucryptite. Examined under the microscope in sections (1) parallel to fibers, the irregular interlacing fibers of eucryptite are seen embedded in albite; (2) transverse to fibers, the eucryptite is in bands with hexagonal outline, surrounded by albite, like quartz in a "graphic granite." See further *Eucryptite,* p. 426.

*Cymatolite.* A second stage in the alteration is the formation of cymatolite (C. U. Shepard, Dana, Min., p. 455, 1868). It has a fibrous to wavy structure, silky luster, white or slightly pinkish color; H. = 1·5–2; G. = 2·69–2·70. The cymatolite from Goshen was earlier (Eng. Mng. J., **22**, 217) called *aglaite* by Julien. Analyses.—1, 2, 3, Julien, l. c. 4, Penfield, l. c.

| | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MnO | MgO | CaO | $Li_2O$ | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Goshen | | 58·51 | 21·80 | 0·85 | 0·29 | 1·44 | 0·84 | 0·19 | 6·88 | 6·68 | 2·40[a] | = 99·88 |
| 2. *Aglaite* | | 58·11 | 24·38 | 1·66 | 0·18 | 0·75 | 0·48 | 0·09 | 2·57 | 8·38 | 3·01[b] | = 99·61 |
| 3. Chesterfield | $\frac{2}{2}$ | 58·58 | 22·28 | 1·77 | 0·15 | 0·45 | 0·93 | 0·10 | 9·08 | 4·48 | 2·08[c] | = 99·90 |
| 4. Branchville | $\frac{2}{2}$ | 60·55 | 26·38 | — | 0·07 | — | — | 0·17 | 8·12 | 3·34 | 1·65 | = 100·28 |

[a] With nitrogenous organic matter 0·44 [b] Do. 0·43. [c] Do. undet.

This corresponds to: $(Na,K,H)AlSi_2O_6$ or $(K,H)AlSiO_4 + NaAlSi_3O_8$. The microscopic examination shows that cymatolite is not, as previously assumed, a simple mineral, but, corresponding to the formula, a very uniform mechanical mixture of *muscovite* and *albite.* In some sections the transitions from β spodumene to cymatolite, i.e. from eucryptite to muscovite, are clearly seen. In other cases the muscovite and albite have each segregated together, so that they are distinct. For example, in figure 2, *s* = unaltered spodumene, *β* = *β* spodumene, *c* = cymatolite, *g* = mica, *a* = albite. Furthermore the successive stages of alteration may be seen in the same crystal, thus as shown in fig. 1, 1*a*, 1*b*, 1*c*, three sections at intervals of 3 to 6 inches in a large crystal 15 inches in length; *s*, *β*, *c* having the same meaning as in fig. 2.

As further steps in the alteration there result: albite, often fibrous, like *β* spodumene; also muscovite, and granular microcline.

*Killinite.* Structure, if any, that of the original spodumene. Compact, crypto-crystalline. H. = 3·5; G. = 2·623–2·652. Luster dull and greasy to vitreous. Color bluish green, greenish gray to olive-green, oil-green, and greenish black. Analyses.—1, Julien. 2, Penfield, prismatic variety, l. c. 3, Dewey, compact, ibid.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | $K_2O$ | $Na_2O$ | $Li_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Chesterfield | 46·80 | 32·52 | — | 2·33 | 0·04 | 0·77 | 7·24 | 0·78 | 0·32 | 7·66 | MgO 0·48, CoO 0·04, organic 1·14 = 100·12 |
| 2. Branchville | 48·93 | 34·72 | 0·54 | 0·33 | 0·64 | — | 9·64 | 0·35 | — | 5·04 | = 100·19 |
| 3. " | 53·47 | 32·36 | 0·79 | 0·42 | 0·72 | 0·17 | 7·68 | 0·44 | 0·04 | 4·07 | = 100·16 |

The original killinite (Thomson, Min., **1**, 330, 1836) was from Killiney Bay, Ireland, where it is also an alteration-product of spodumene, see further 5th Ed., p. 480.

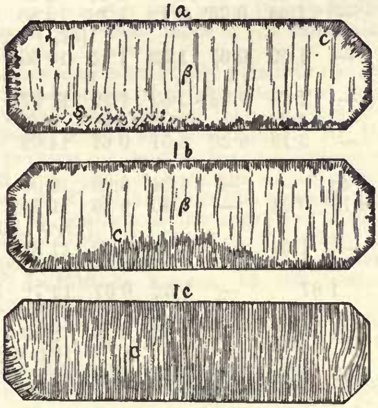
The following scheme explains the above changes of the spodumene, supposing an exchange of the alkali metal:

$$\text{Spodumene } 2[\mathrm{LiAlSi_2O_6}] = [\underset{\text{Eucryptite}}{\mathrm{LiAlSiO_4}} + \underset{\text{Albite}}{\mathrm{NaAlSi_3O_8}}]\ \beta \text{ spodumene}$$

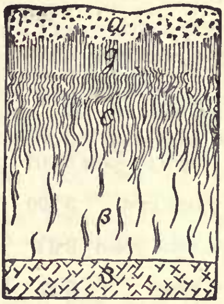
$$= [\underset{\text{Muscovite}}{\mathrm{(K,H)AlSiO_4}} + \underset{\text{Albite}}{\mathrm{NaAlSi_3O_8}}] \text{ cymatolite}$$

$$= \underset{\substack{\text{Muscovite}\\ \text{(or killinite)}}}{\mathrm{(K,H)AlSiO_4}} + \begin{cases} \mathrm{NaAlSi_3O_8} \text{ albite} \\ \text{or } \mathrm{KAlSi_3O_8} \text{ microcline} \end{cases}$$

1.



2.



Experiments showing the effect upon spodumene of solutions of potassium and sodium carbonates, see Lemberg, Zs. G. Ges., **39**, 584, 1887.

**Ref.**—[1] Min., p. 693, 1850, 169, 1852; Rath obtained for Alexander Co., No. Carolina, spodumene, $\breve{a} : \bar{b} : \dot{c} = 1·1283 : 1 : 0·62345$; $\beta = 69° 32\frac{1}{2}'$; the crystals were measured with the help of attached glass plates, Ber. nied. Ges., May 3, 1886. The surface of the crystals of hiddenite are often extensively etched, and some of the planes noted, cf. [3] and [4] below, may be simply corrosion forms. [2] J. D. D., l. c. [3] E. S. D., Alex. Co., Am. J. Sc., **22**, 179, 1881. [4] Rath, l. c. [5] Am. J. Sc., **32**, 204, 1886. [6] Greim, Jb. Min., **1**, 253, 1889. [7] Min. Roches, 266, 1888.

**328. JADEITE.** Nephrite or Jade pt. Jadeite *Damour*, C. R., **56**, 861, 1863. Chloromelanite *Id.*, ibid., **61**, 313, 357, 1865.

Monoclinic (or triclinic)[1], with cleavage and optical characters like pyroxene. Only known massive, with crystalline structure, sometimes granular, also obscurely columnar, fibrous foliated to closely compact.

Cleavage: prismatic, at angles of about 93° and 87°; also orthodiagonal, difficult. Fracture splintery. Extremely tough. H. = 6·5–7. G. = 3·33–3·35. Luster subvitreous, pearly on surfaces of cleavage. Color apple-green to nearly emerald-green, bluish green, leek-green, greenish white, and nearly white; sometimes white with spots of bright green. Optically biaxial, negative. $Bx_a \wedge \dot{c} = 30°$ to 40°, $2H_{a.y} = 82° 48'$ Knr. Streak uncolored. Translucent to subtranslucent.

**Comp.**—Essentially a metasilicate of sodium and aluminium corresponding to spodumene, $NaAl(SiO_3)_2$, or $Na_2O.Al_2O_3.4SiO_2$ = Silica 59·4, alumina 25·2, soda 15·4 = 100

*Chloromelanite* is a dark green to nearly black kind of jadeite, containing iron sesquioxide and not conforming exactly to the above formula. Named from χλωρός, *green*, and μέλας, *black*.

**Anal.**—1, Damour, C. R., **56**, 861, 1863. 2, Id., ibid., **61**, 360, 1865. 3–7, Bull. Soc. Min., **4**, 157, 1881. 8, Fellenberg, Mitth. Ges. Bern, 112, 1865. 9, 10, Id., Vh. Schweiz. Ges., Solothurn, **53**, 88, 1869. 11, Eckstein, quoted by Fischer, p. 375. 12, Frenzel, Jb. Min., **2**, 6 ref., 1885. 13, Dmr., l. c., 1881. 14–17, F. W. Clarke, Proc. U. S. Nat. Mus., **11**, 115, 1888. 18, Dmr., l. c., 1881. 19, 20, Id., l. c., 1865. 21, Id., l. c., 1881. 22, 23, G. W. Hawes, unpubl. contr., 1875. 24, 25, Id., l. c., 1865. 26, Id., l. c., 1881. 27, Fellenberg, quoted by Fischer, l. c., p. 381. 28, Cohen, Jb. Min., **1**, 71, 1884. 29–30, Frenzel, ib., **2**, 6 ref.. 1885. 31–35, 36–40, Dmr., l. c., 1881. 34, 35, Schoetensack, Inaug. Diss., 6, 7, Berlin, 1885.

*Worked Jadeite.*

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $Na_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. China | 3·340 | 59·17 | 22·58 | — | 1·56 | — | 2·68 | 1·15 | 12·93 | = 100·07 |
| 2. " | 3·330 | 59·66 | 22·86 | 0·14$^a$ | 0·42 | — | 2·27 | 2·41 | 12·87 | = 100 63 |
| 3. Asia, *white* | 3·33 | 59·27 | 25·33 | 0·71 | — | — | 0·62 | 0·48 | 13·82 | = 100·23 |
| 4. " *green-gray* | 3·27 | 59 12 | 22·21 | 2·72 | — | — | 1·03 | 0·99 | 13·66 | = 99·73 |
| 5. China, *green spots* | 3·34 | 58·28 | 23·11 | 0·64 | — | — | 1·62 | 0·91 | 13·94 | = 98·50 |
| 6. " *green* | 3·27 | 57·14 | 8·97 | 5·49 | 0·42$^a$ | — | 14·57 | 8·62 | 5·35 | = 100·56 |
| 7. " | 3·32 | 55·34 | 8·40 | 5·60 | 0·66 | — | 14·80 | 8·41 | 6·38 | = 99·59 |
| 8. Swiss Lake-hab. | 3·32 | § 58·89 | 22·40 | — | 1·66 | 0·73$^b$ | 3·12 | 1·28 | 12·86 | $K_2O$ 0·49<br>[$H_2O$ 0·20 = 101·63 |
| 9. China | 3·346 | 60·22 | 22·85 | — | 1·59 | 0·65 | 1·53 | 1·15 | 12·60 | $H_2O$ 0·11<br>[= 100·70 |
| 10. Möhrigen-Steinberg | 3·298 | 58·28 | 21·86 | — | 2·42 | 0·22 | 2·53 | 1·99 | 12·97 | = 100·27 |
| 11. Thibet | 3·25 | 58·28 | 23·00 | — | 4·94 | *tr.* | 3·06 | 1 04 | 9·23 | = 99·55 |
| 12. L. Neuenburg | 3·31 | 57·84 | 22·08 | — | 3·19 | 0·20 | 2·51 | 0·67 | 14·09 | $H_2O$ 0·38<br>[= 100·96 |
| 13. Mexico, *olive-green* | 3·30 | 58·64 | 24·94 | 1·48 | — | — | 1·34 | 0·89 | 13·00 | = 100·29 |
| 14. " *light gr. spots* | 3·007 | 58·88 | 25·93 | 0·12$^a$ | 0·24 | — | 0·40 | 0·36 | 11·64 | $K_2O$ 0·63<br>[$H_2O$ 1·81 = 100·01 |
| 15. " *pale grn.* | 3·190 | 58·18 | 23·53 | — | 1·67 | — | 2·35 | 1·72 | 11·81 | $K_2O$ 0·77<br>[$H_2O$ 0·53 = 100·56 |
| 16. Sardinal, *pale green* | 3·32 | 59·18 | 22·96 | 1·87 | | — | 1·52 | 0·67 | 12·71 | $H_2O$ 0·90<br>[= 99·81 |
| 17. Culebra, *green* | 3·27 | 58·33 | 21·63 | 1·71 | 0·73 | — | 4·92 | 3·09 | 8·13 | $K_2O$ 0·22<br>[$H_2O$ 0·93 = 99·69 |
| 18. Mexico, *emerald-grn.* | 3·26 | 58·20 | 19·54 | 1·97 | 0·34$^a$ | 0·07 | 5·60 | 3·39 | 10·91 | $K_2O$ 0·27<br>[= 100·29 |
| 19. Morbihan | 3·344 | 58·62 | 21·77 | — | 1·86 | 0·28 | 3·85 | 2·23 | 11·64 | = 100·25 |
| 20. Sénart, *grass-green* | 3·352 | 58·92 | 18 98 | — | 0·98 | — | 6·04 | 4·33 | 11·05 | = 100·30 |
| 21. France, *green* | 3·16 | 57·99 | 20·61 | 2·84 | — | — | 4·89 | 3·33 | 9·42 | $K_2O$ 1·50<br>[= 100·58 |
| 22. Mexico | | § 60·99 | 22·20 | — | 0·65 | — | 1·28 | 0·96 | 13·04 | $K_2O$ 0·21<br>[$H_2O$ 0·74 = 100·07 |
| 23. China | | § 58·68 | 21·56 | — | 0·94 | — | 3·37 | 2·49 | 13·09 | $K_2O$ 0·49<br>[= 100·62 |

$^a$ $Cr_2O_3$. $^b$ ZnO.

*Chloromelanite.*

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $Na_2O$ | $K_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 24. Dordogne | 3·413 | 56·40 | 14·76 | 3·27 | 6·06 | 0·66 | 5·49 | 1·82 | 11·20 | *tr.* | = 99·66 |
| 25. Morbihan | 3·410 | 56·12 | 14·96 | 3·34 | 6·54 | 0·47 | 5 17 | 2·79 | 10·99 | *tr.* | $TiO_2$ 0·19<br>[= 100·57 |
| 26. Mexico, *blk.-grn.* | 3·36 | 57·90 | 14·64 | 8·89 | — | 0·76 | 5·16 | 2·21 | 10·77 | *tr.* | = 100·33 |
| 27. Swiss Lake-hab. | 3·40 | 55·88 | 13·64 | — | 10·59 | 0·99 | 4·28 | 3·19 | 11·43 | — | = 100 |

*Unworked jadeite* (Rohjadeit); also (36–40) rocks approaching jadeite in composition.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | CaO | MgO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 28. Thibet | | 59·17 | 22·58 | — | 1·56 | 2·68 | 1·15 | 12·93 | — | — | =100 07 |
| 29. L. Neuenburg | 3·42 | 52·42 | 26·00 | — | 2·02 | 9·05 | 3·56 | 7·44 | — | 0·20 | =100·69 |
| 30. " | 3·36 | 50·30 | 25·68 | — | 2·79 | 11·00 | 4·45 | 6·30 | — | 0·40 | =100·92 |
| 31. Burma | 2·97 | 58·24 | 24·47 | 1·01 | — | 0·69 | 0·45 | 14·70 | 1·55 | — | =101·11 |
| 32. " | 3·06 | 61·51 | 22·53 | — | — | *tr.* | 4·25 | 11·00 | 1·29 | — | =100 58 |
| 33. " | 3·07 | 53·95 | 21·96 | 0·76 | — | 2·42 | 7·17 | 9·37 | 3·70 | — | = 99·33 |
| 34. Burma | 3·138 | 59·70 | 22·77 | — | 0·61 | 2·52 | 1·87 | 13·19 | — | 0·54 | =101·20 |
| 35. Thibet (?) | 3·227 | 59 68 | 22 82 | — | 0·60 | 1·41 | 0·52 | 14·64 | — | 0·24 | = 99 09 |

| | G | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | CaO | MgO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 36. M. Viso, Piedmont | 3·35 | 58·51 | 21·98 | 1·10 | — | 5·05 | 1·70 | 11·84 | *tr.* | — | =100·18 |
| 37. Ouchy, L. Geneva | 3·17 | 56·45 | 17·02 | 7·62 | — | 4·76 | 2·32 | 11·46 | *tr.* | — | = 99·63 |
| 38. St. Marcel | 3·22 | 55·82 | 10·95 | 5·68 | — | 13·42 | 9·05 | 6 74 | *tr.* | — | =101·66 |
| 39. Val d'Aosta | 3·32 | 56·74 | 10·02 | 4·69 | 0·03[a] | 14·00 | 9·10 | ~~5·40~~ | ~~*tr.*~~ | — | = 99·98 |
| 40. Nantes | 3·31 | 54·53 | 14·25 | 3·29 | — | 12·40 | 7·50 | 6·21 | *tr.* | — | = 98·18 |

[a] $Cr_2O_3$.

**Pyr., etc.**—B.B. fuses readily to a transparent blebby glass. Not attacked by acids after fusion, and thus differing from saussurite.

See Lemberg on the results of treatment of jadeite with alkaline carbonates; it is shown that, after fusion, jadeite behaves like fused analcite. Zs. G. Ges., **39**, 586 *et seq.*, 1887.

**Obs.**—Occurs chiefly in Eastern Asia, thus in the Mogoung distr. in Upper Burma, in a valley 25 miles southwest of Meinkhoom; this jadeite is found in rolled masses in a reddish clay, and specimens gave a specific gravity of 3·34, 3·33, 3·24; easily fusible (Mallet[2]). Also in Yungchang, province of Yunnan, southern China (Pumpelly[3]); in Thibet. Much uncertainty prevails, however, as to the exact localities, since jadeite and nephrite have usually been confounded together. May occur also on the American continent, in Mexico and South America; perhaps also in Europe.

Analyses 29, 30 are of rolled masses of jadeite from the shores of L. Neuenburg in Switzerland, which may have come from a local source. Anal. 36–40 are of various soda-bearing rocks, approaching jadeite more or less closely in composition, and also believed to have been of European origin.

Jadeite has long been highly prized in the East, especially in China, where it is worked into ornaments and utensils of great variety and beauty. It is also found with the relics of early man, thus in the remains of the lake dwellers of Switzerland, at various points in France, in Mexico. Greece, Egypt, and Asia Minor. Mr. Pumpelly remarks that the *feitsui* (= kingfisher plumes) is perhaps the most prized of all stones among the Chinese. He also observes that the *chalchihuitl* of the ancient Mexicans, of which he had seen many specimens, is probably the same mineral; but W. P. Blake refers this name to the turquois from the vicinity of Santa Fé. See turquois. The question of the origin and distribution of jadeite is of great interest and has been much discussed. Cf. Fischer, "Nephrit und Jadeit nach ihren mineralogischen Eigenschaften, so wie nach ihrer urgeschichtlichen und ethnographischen Bedeutung," Stuttgart, 1875, 1880. Also Arzruni, Zs. Ethnol., **15**, 163. 1883; Meyer, Mitth. Anthropol. Ges., Wien, **15**, 1885; *et al.*, see further jade, below.

**Ref.**—[1] On the microscopic structure of jadeite, cf. Dx., l. c., 1881; Cohen, l. c.; Krenner, Jb. Min., **2**, 173. 1883; Arzruni, Jb. Min., **2**, 6 ref., 1885; Merrill, Proc. U. S. Mus., **11**, 123, 1888. [2] Min. India, 94, 1887.

[3] Pumpelly, Geol. China, 1866 (Smithson. Contrib., **15**, 118).

JADE. A general term used to include various mineral substances of tough compact texture and nearly white to dark green color used by early man for utensils and ornaments, and still highly valued in the East, especially in China, where it is called *Yu* or *Yu-shih* (yu-stone). It includes properly two species only: *nephrite*, a variety of amphibole (p. 389), either tremolite or actinolite, with G. = 2·95–3·0, and *jadeite*, which is classed with the pyroxene group and in composition is a soda-spodumene, with G. = 3·3–3·35; easily fusible.

The jade of China belongs to both species, so also that of the Swiss lake-habitations and of Mexico. Of the two, however, the former, nephrite, is the more common and makes the jade (ax-stone or Punamu stone) of the Maoris of New Zealand; also found in Alaska.

The name jade is also sometimes loosely used to embrace other minerals of more or less similar characters, and which have been or might be similarly used—thus sillimanite, pectolite, serpentine; also vesuvianite, garnet. Cf. remarks under these species. Bowenite is a jade-like variety of serpentine. The "jade tenace" of de Saussure is now called saussurite.

**329. WOLLASTONITE.** Tafelspath *Stütz*, Neue Einr. Nat. samml. Wien, 144, 1793. Tabular Spar. Schaalstein *Wern.*, 1803, Ludwig's Min. Wern., **2**, 212. 1804, Mohs, Null Kab., **2**, 1, 1804. Wollastonite *H.*, Tr., 1822. Vilnite (fr. Vilna) *Horodeki*, Dx., Min., **1**, 554, 1862.

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c} = 1{\cdot}05312 : 1 : 0{\cdot}96761$; $\beta = 84° 30' = 001 \wedge 100$ Rath[1].

$100 \wedge 110 = {}^*46° 21'$, $001 \wedge \bar{1}01 \doteq 45° 5'$, $001 \wedge 011 = 43° 55\frac{1}{2}'$.

**Forms**[2]:
*a* (100, $i$-$\bar{i}$)
*c* (001, *O*)
*d* (830, $i$-$\frac{8}{3}$)
*z* (320, $i$-$\frac{3}{2}$)
*h* (540, $i$-$\frac{5}{4}$)
*m* (110, *I*)
*q* (340, $i$-$\frac{4}{3}$)
*x* (120, $i$-$\grave{2}$)
*w* (102, $-\frac{1}{2}$-$\bar{i}$)
*v* (101, $-$ 1-$\bar{i}$)
*k* ($\bar{1}$03, $\frac{1}{3}$-$\bar{i}$)
*α* ($\bar{1}$02, $\frac{1}{2}$-$\bar{i}$)
*β* ($\bar{3}$05, $\frac{3}{5}$-$\bar{i}$)
*t* ($\bar{1}$01, 1-$\bar{i}$)
*l* ($\bar{7}$05, $\frac{7}{5}$-$\bar{i}$)
*s* ($\bar{2}$01, 2-$\bar{i}$)
*r* ($\bar{3}$01, 3-$\bar{i}$)
*g* (011, 1-$\grave{i}$)
*f* ($\bar{1}$11, 1)
*n* ($\bar{3}$22, $\frac{3}{2}$-$\frac{3}{2}$)
*ρ* (122, $-$1-$\grave{2}$)
*μ* ($\bar{1}$22, 1-$\grave{2}$)

$dd''' = 42^\circ\ 55'$
$zz''' = 69^\circ\ 54'$
$hh''' = 79^\circ\ 58'$
$mm''' = 92^\circ\ 42'$
$xx' = 51^\circ\ 0'$

$cw = 23^\circ\ 39'$
$cv = 40^\circ\ 3'$
$ck = 17^\circ\ 26'$

$c\alpha = 25^\circ\ 34'$
$c\beta = 30^\circ\ 5'$
$cl = 55^\circ\ 36'$
$cs = 65^\circ\ 45'$
$cr = 74^\circ\ 59'$
$av = 44^\circ\ 27'$
$a't = 50^\circ\ 25'$

$gg' = 87^\circ\ 51'$

$cf = 55^\circ\ 32'$
$cm' = 93^\circ\ 48'$
$m'f = {}^*38^\circ\ 16'$
$cn = 62^\circ\ 37\tfrac{1}{2}'$
$c\rho = 45^\circ\ 36'$
$c\mu = 48^\circ\ 7'$

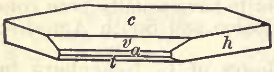
$a'f = {}^*59^\circ\ 17'$

$a'n = 47^\circ\ 12'$
$a'\mu = 75^\circ\ 17\tfrac{1}{2}'$
$a\rho = 68^\circ\ 9\tfrac{1}{2}'$

$ff' = 73^\circ\ 26'$
$nn' = 61^\circ\ 22'$
$\rho\rho' = 80^\circ\ 24'$
$\mu\mu' = 84^\circ\ 32'$

1.

2.



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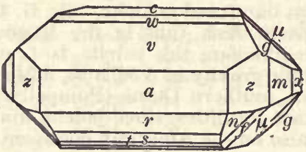

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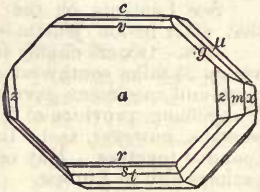


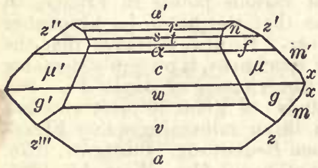
Figs. 1, 2. Diana, N. Y., Pfd. 3, Vesuvius, Rath. 4, Santorin, Hbg.

Twins: tw. pl. *a*. Crystals commonly tabular ∥ *a* or *c*; also short prismatic. Usually cleavable massive to fibrous, fibers parallel or reticulated; also compact.

Cleavage: *a* perfect; also *c*; *t* ($\bar{1}01$) less so. Fracture uneven. Brittle. H. = 4·5–5. G. = 2·8–2·9. Luster vitreous, on cleavage surfaces pearly. Color white, inclining to gray, yellow, red, or brown. Streak white. Subtransparent to translucent. Optically –. $Bx_a \wedge \dot{c} = +37^\circ 40'$. Dispersion $\rho > v$ weak; inclined strong. Ax. pl. ∥ *b*.

$2E_r = 70^\circ 40' \quad 2E_{gr} = 69^\circ \quad 2E_v = 68^\circ 24'$ Dx.

5.



Vesuvius, Rath.

**Comp.**—Calcium metasilicate, $CaSiO_3$ or $CaO.SiO_2$ = Silica 51·7, lime 48·3 = 100.

**Anal.**—1, Rath, Pogg., **144**, 390, 1871. 2, Lemberg, Zs. G. Ges., **24**, 251, 1872. 3, Clemencin (Piquet), Ann. Mines, **1**, 415, 1872. 4, Fouqué, C. R., **80**, 631, 1875; other analyses of less pure material show from 7·2 to 9·5 of $Al_2O_3$. 5, Loczka, Zs. Kr., **10**, 89, 1884. 6, Funaro, Zs. Kr., **9**, 382, 1884. 7, Nikolayev, Min. Russl., **9**, 29, 1884. 8, E. S. Sperry, priv. coutr. See 5th Ed., p. 210; also, Finland, G. För. Förh., **12**, 24, 1890.

| | G. | $SiO_2$ | CaO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|
| 1. Mt. Somma | 2·853 | 51·31 | 45·66 | 0·73 | 0·75 | $Al_2O_3$ 1·37 = 99·82 |
| 2. Orawitza | | 53·53 | 44·08 | — | 1·51 | $(Al,Fe)_2O_3$ 0·46 = 99·58 |
| 3. Merida | 2·80 | 48·36 | 46·41 | 1·30 | 1·11 | $Al_2O_3$ 1·56, $CO_2$ 1·00, $SO_3$ 0·56 = 100·30 |
| 4. Santorin | 2·910 | 46·2 | 41·8 | 1·5 | — | $Al_2O_3$ 7·1, $Fe^5O_3$ 2·9 = 99·5 [= 100·74 |
| 5. Rezbanya | 2·919 | 51·61 | 46·29 | 1·08 | 0·54 | $Al_2O_3$ *tr.*, FeO 0·51, MnO 0·47, alk. 0·24 |
| 6. S. Vito, Sardinia | | 49·78 | 45·12 | 1·20 | 0·60 | FeO 2·20 = 98·90 [= 99·43 |
| 7. Kirghese Steppes | 2·889 | 47·66 | 45·61 | *tr.* | 1·24 | $(Fe,Al)_2O_3$ 0·68, MnO 0·14, insol. 4·10 |
| 8. Bonaparte L., N. Y. | 2·915 | 50·66 | 47·98 | 0·05 | 0·72 | (Fe,Mn)O 0·07, $Na_2O$ 0·46 = 99·94 |

**Pyr., etc.**—In the matrass no change. B.B. fuses easily on the edges; with some soda, a blebby glass; with more, swells up and is infusible. With hydrochloric acid decomposed with separation of silica; most varieties effervesce slightly from the presence of calcite.

**Obs.**—Wollastonite is found especially in granular limestone, and in regions of granite; as a contact formation or in ejected masses in connection with basalt and lavas. It is often associated with a lime garnet, pyroxene, etc.

Occurs in the copper mines of Cziklowa in the Banat; at Orawitza; at Dognaczka and Nagyág; accompanying garnet, fluorite, and native silver, in limestone, at Pargas in Finland, and Kongsberg in Norway; occurs at Perhoniemi and Skräbböle, Finland; at Göckum in Sweden; at Vilna in Lithuania (vilnite); at Harzburg in the Harz; at Auerbach, in granular limestone; in the phonolyte of the Kaiserstuhl; at Vesuvius, rarely in fine crystals: of a greenish white color in lava at Capo di Bove, near Rome; S. Vito, Sarrabus, Sardinia; on Elba; Merida, Portugal; in recent lava on Santorin; in Ireland, at Dunmore Head, Mourne Mts.

In the United States, in *N. York*, at Willsborough, forming the sides of a large vein of garnet, traversing gneiss; at Lewis, 10 m. south of Keeseville, with colophonite, abundant; ½ m. N. of Lewis Corners, with garnet and quartz; at Roger's Rock, near the line between Essex and

Warren Cos., with garnet and feldspar; Diana, Lewis Co., about 1 m. from the Natural Bridge, in abundance, in large white crystals; at Booneville, Oneida Co., in boulders, with garnet and pyroxene; Bonaparte Lake, Lewis Co., in massive forms, fibrous to compact. In *Penn.*, Bucks Co., 3 m. W. of Attleboro', associated with scapolite, pyroxene, and titanite. In *Mich.*, of a red color at the Cliff Mine, Keweenaw Point, Lake Superior, and on Isle Royale, a very tough variety, but now exhausted. In *Canada*, at Grenville, with titanite and green coccolite; at St. Jérôme and Morin, Quebec, with apatite, in large tabular masses of a fibrous structure.

Named after the English chemist, W. H. Wollaston (1766–1828); also called *tabular spar* from its lamellar forms and structure.

The *soda-tabular spar* of Thomson, from near Kilsyth, is pectolite.

**Artif.**—Reported as observed occasionally in furnace slags, also repeatedly stated to have been formed artificially, but the correctness of the observations is doubtful, since in most cases the calcium silicate ($CaSiO_3$) observed does not agree with wollastonite crystallographically, but with the hexagonal compound noted below. For a review of the subject see Bourgeois, Reprod. Min., 113, 1884; Vogt, Arch. Math. Nat. Christiania, **30**, 66, 1889.

**Ref.**—[1]Mt. Somma, Pogg., **138**, 484, 1869. If (as in 5th Ed., p. 210) *α* be made 001, then since *cα* = 69° 56′, the resemblance to pyroxene comes out more clearly; but as urged by Rath the differences in cleavage, etc., are too great to recommend this. With Mlr. and Dx., *a*, *c*, *m*, *e* of Rath-Dana correspond to 001 (*c*), 201 (*u*), 011 (*e*), $\bar{2}21$ (*g*); cf. Hbg., Min. Not., **9**, 28, 1870. [2] See Mlr., Min., 288, 1852; Dx., Min., **1**, 49, 1862; also Rath, Hbg., l. c.

EDELFORSITE Kalksilikat fr. Ædelfors, Kalktrisilikat, *Hisinger*, Ak. H. Stockh., 191, 1838, 1839. Edelforsit *Kbl.*, Grundz., 202, 1838. Ædelforsit *Erdmann*. Forchhammer has shown (Danske Ak. Förh., Ap. 1864) that Hisinger's mineral is an impure wollastonite, containing some quartz and feldspar, with often carbonate of lime and garnet. It occurs compact, part feathery fibrous, and part without any distinct crystalline structure. Color white, grayish white, or with a tinge of yellow. From Ædelfors in Småland, Sweden.

The edelforsite of Gjellebäk (called Gillebäckit by N. Nordenskiöld, Atom. Ch. Min. Syst., 96, 1848) in Norway has also been shown by Forchhammer to be essentially wollastonite. It has the aspect of tremolite. Forchhammer has found "okenite" of N. Greenland (Asbestartig Okenit *Dr. Rink*) to be wollastonite.

HEXAGONAL CALCIUM METASILICATE. An artificial compound having the composition $CaSiO_3$, like wollastonite, but hexagonal in form and sometimes in tabular crystals, optically +, has been repeatedly obtained. Cf. Doelter, Jb. Min., **1**, 119, 1886; Vogt, Arch. Math. Nat., Krist., **30**, 57, 1889; Hussak, Vh. Ver. Rheinl., Corr., 95, 1887.

**330. PECTOLITE.** Pektolith *v. Kobell*, Kastner's Arch., **13**, 385, 1828, **14**, 341. Photolith *Breith.*, Char., 131, 1832. Wollastonite, Stellite, *Thomson*, Min., **1**, 130, 313. Ratholite *some collectors*. Osmelith *Breith.*, Pogg., **9**, 133, 1827. Walkerite *Heddle*, Min. Mag., **4**, 121, 1880.

Manganpektolith *J. Francis Williams*, Zs. Kr., **18**, 386, 1890.

Monoclinic. Axes: $\grave{a} : \bar{b} : \grave{c} = 1{\cdot}1140 : 1 : 0{\cdot}9864$; $\beta$ = *84° 40′ = 001 ∧ 100 E. S. D.[1]

100 ∧ 110 = 47° 57⅚′, 001 ∧ 101 = 39° 10′, 001 ∧ 011 = 44° 29′.

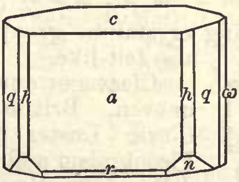
**Forms**[2]: *a* (100, *i*-$\bar{\imath}$), *c* (001, *O*); *h* (540, *i*-$\frac{5}{4}$), *q* (340, *i*-$\frac{4}{3}$), *ω* (140, *i*-$\grave{4}$); *v* (101, − 1-$\bar{\imath}$)[1]; *α* ($\bar{1}02$, $\frac{1}{2}$-$\bar{\imath}$)[1], *t* ($\bar{1}01$, 1-$\bar{\imath}$)[1], *r* ($\bar{3}01$, 3-$\bar{\imath}$); *n* ($\bar{3}22$, $\frac{3}{2}$-$\frac{3}{2}$).

*ah* = *41° 35′ *ωω′* = 25° 24′ *ct* = 43° 51′ *cn* = 61° 59′
*hh‴* = 83° 10′ *av* = *45° 30′ *cr* = 74° 6′ *a′n* = 48° 33′
*qq′* = 68° 8′ *cα* = 24° 41′ *ch* = 86° 1′ *nn′* = 63° 31′

Twins: tw. pl. *a*. Crystals elongated ∥ $\bar{b}$, and usually terminated at one extremity by planes *h*, *ω*, etc.; faces *a* striated. Commonly in close aggregations of acicular crystals. Fibrous massive, radiated to stellate.

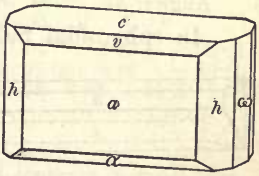
Cleavage: *a* perfect; *c* also perfect. Fracture uneven. Brittle. H. = 5. G. = 2·68–2·78. Luster of the surface of fracture silky or subvitreous. Color whitish or grayish. Subtranslucent to opaque.

1.



1, Ratho, Greg.

2.



2, Bergen Hill.

Optically +. Ax. pl. and $Bx_a \perp b$; $Bx_o$ nearly $\perp a$; $2H_o$ = 143°–145° measured in cleavage plates, Dx.

**Comp., Var.**—$HNaCa_2(SiO_3)_3$ or $H_2O.Na_2O.4CaO.6SiO_2$ = Silica 54·2, lime 33·8, soda 9·3, water 2·7 = 100.

**Var.**—1. *Ordinary.* Almost always columnar or fibrous, and divergent, the fibers often 2 or 3 inches long, and sometimes, as in Ayrshire, Scotland, a yard. *Osmelite*, from Niederkirchen, near Wolfstein, Bavaria, is columnar and radiated; G. = 2·799–2·833, Breith.; color grayish white, yellowish, gray. *Walkerite* varies slightly in composition from ordinary pectolite.

2. *Compact.* Massive, fine-grained and tough, of a pale green color and resembling some jade; used by the Alaska Indians for implements, hammers, etc. Anal. 7.

3. *Manganpectolite.* Contains 4 p. c. MnO. From Magnet Cove, Arkansas, occurring in elæolite-syenite with thomsonite (ozarkite), etc. In crystals with *a*, *c*, *t* ($\bar{1}$01). Measured angles: *ac* = 84° 42′, *ct* = 44° 26′, *a′t* = 50° 55′. H. = 5. G. = 2·845. Cleavage: *c*, *a* both perfect. Axial angle = 15° approx. Dispersion very strong, $\rho > v$, analogous to titanite.

**Anal.**—1, Whitney, J. Soc. N. H. Bost., 36, 1849. 2, 3, Heddle, Phil. Mag., **9**, 248, 1855. 4, Lemberg, Zs. G. Ges., **24**, 252, 1872. 5, E. B. Knerr & E. F. Smith, Am. Ch. J., **6**, 411, 1884. 6, A. H. Chester, Am. J. Sc., **33**, 287, 1887. 7, F. W. Clarke, ib., **28**, 20, 1884. 8, Kbl., Ber. Ak. München, **1**, 296, 1866. 9, Heddle, Min. Mag., **4**, 121, 1880. 10, J. F. Williams, l. c.

| | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. Bergen Hill | | $\frac{3}{3}$ 54·62 | — | 32·94 | 8·96 | — | [2·37] FeO 1·11 = 100 |
| 2. Ratho, *fibrous* | 2·881 | 52·53 | 0·88 | 32·79 | 9·75(with $K_2O$) | | 3·04 = 98·99 |
| 3. " *cryst.* | | 52·58 | 1·46 | 33·75 | 9·26 | — | 2·80 = 98·85 |
| 4. Fassathal | | 54·21 | — | 32·54 | 8·95 | — | 3·01 $Fe_2O_3$ 1·68 = 100·39 |
| 5. Lehigh Co., Penn. | 2·6 | 55·17 | — | 30·00 | 9·02 | 0·37 | 4·63 $Fe_2O_3$ 0·80 = 99·99 |
| 6. Disco Island | | 52·86 | 0·71 | 34·33 | 7·50 | 0·47 | 4·70 = 100·57 [=100·82 |
| 7. Point Barrow, *mass.* | 2·873 | 53·94 | 0·58 | 32·21 | 8·57 | — | 4·09 FeO *tr.*, MgO 1·43 |
| 8. Niederkirchen, *Osmelite* | | 52·63 | — | 34·47 | 8·28 | *tr.* | 2·94 FeO 0·37, MnO 1·75 [= 100·44 |
| 9. Costorphine Hill, *Walkerite* | 2·712 | 52·20 | — | 28·64 | 6·50 | 0·85 | 5·28 FeO 1·33, MgO 5·12 [= 99·92 |
| 10. Magnet Cove, *Manganpectolite* | 2·845 | $\frac{3}{3}$ 53·03 | — | 30·28 | 8·99 | — | 2·43 MnO 4·25, $Fe_2O_3$ [0·10, $CO_2$ 0·82 = 99·90 |

**Pyr., etc.**—In the closed tube yields water. B.B. fuses at 2 to a white enamel. Decomposed partially by hydrochloric acid, gelatinizing. Often gives out light when broken in the dark.

**Obs.**—Occurs mostly in basic eruptive rocks, in cavities or seams; occasionally in metamorphic rocks. Found in Scotland at Ratho Quarry and Castle Rock, near Edinburgh; at Kilsyth, Corstorphine Hill (*walkerite*), Loch End, Girvan, and Knockdolian Hill, in Ayrshire; and at Talisker, etc., I. Skye. Also at Mt. Baldo and Mt. Monzoni in the Tyrol, where first obtained; at an iron mine in Wermland, associated with chlorite and calcite. Disco Is., Greenland (so-called okenite).

Occurs also at Bergen Hill, N. J., in large and beautiful radiations; Lehigh county, Penn.; compact at Isle Royale, L. Superior; at Magnet Cove, Ark., in elæolite-syenite (*manganpectolite*); compact, massive in Alaska, where it is used, like jade, for implements.

**Ref.**—[1] Bergen Hill, angles in zone *ac* not very exact. [2] Cf. Ph., Min., 144, 1837; Greg & Lettsom. Min , 213, 1858. Dx., Min., 1, 129, 547, 1862.

### 331. ROSENBUSCHITE. *W. C. Brögger*, G. För. Förh., **9**, 254, 1887; Zs. Kr., **16**, 378, 1890. Zirkon-pectolith.

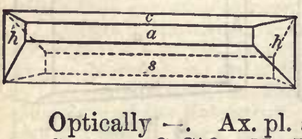
Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c}$ = 1·1687 : 1 : 0·9572; $\beta$ = *78° 13′ = 001 ∧ 100 Brögger.

100 ∧ 110 = 48° 50$\frac{2}{3}$′, 001 ∧ 101 = 34° 29′, 001 ∧ 011 = 43° 8$\frac{1}{4}$′.

**Forms:** *a* (100, *i*-$\bar{i}$), *c* (001, *O*); *h* (540, *i*-$\frac{5}{4}$), *s* ($\bar{2}$01, 2-$\bar{i}$).

Angles: *hh‴* = 84° 56′, *ah* = *42° 28′, *cs* = 67° 28′, *ch* = 81° 20′, *sh′* = *52° 28′.

In spheroidal radiating crystalline groups, rarely showing distinct crystals; also felt-like.



Cleavage: *c* perfect; *a*, *s* rather perfect. Fracture uneven. Brittle. H. = 5–6. G. = 3·30 Bgr.; 3·315 Cleve. Luster vitreous. Color light orange-gray. Pleochroism and absorption weak, $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$.

Optically −. Ax. pl. and $Bx_a \perp b$. $Bx_o \wedge \acute{c} = \mathfrak{c} \wedge \acute{c} = -12°$ to $-14°$.

**Comp.**—$6CaSiO_3.2Na_2ZrO_2F_2.(TiSiO_3.TiO_3)$, Bgr.

**Anal.**—Cleve, Zs. Kr., **16**, 382, 383, 1890.

| | $SiO_2$ | $ZrO_2$ | $TiO_2$ | $Fe_2O_3$ | $La_2O_3$ | MnO | CaO | $Na_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 31·53 | 18·69 | 7·59 | 1·15 | 2·38[a] | 1·85 | 25·38 | 10·15 | ign. 0·20 = 98·92 |
| 2. | 31·36 | 20·10 | 6·85 | 1·00 | 0·33? | 1·39 | 24·87 | 9·93 | F 5·83 = 101·66 |

[a] Including a little $Ce_2O_3$ and a trace of $Di_2O_3$.

**Pyr.**—Fuses easily.

**Obs.**—Occurs very sparingly in the region of the Langesund fiord in southern Norway, exact locality unknown (Barkevik?). It is associated with ægirite, zircon, white feldspar, elæolite, sodalite, tritomite, leucophanite, etc.

Named for Prof. H. Rosenbusch of Heidelberg.

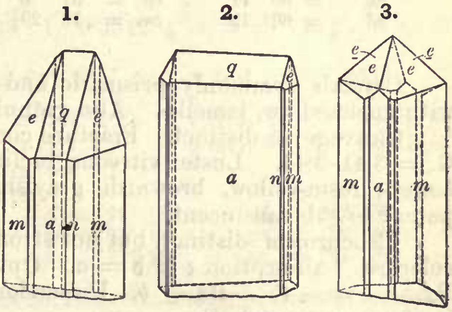
**332. LÅVENITE.** *W. C. Brögger*, G. För. Förh., **7**, 598, 1885, **9**, 252, 1887. *Id.*, Zs. Kr., **16**, 339, 1890. Laavenite. Lovenite.*

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 1{\cdot}09638 : 1 : 0{\cdot}71517$; $\beta = 69° 42\frac{1}{3}' = 001 \wedge 100$ Brögger.

$100 \wedge 110 = {}^*45° 48'$, $001 \wedge 101 = 26° 31'$, $001 \wedge 011 = 33° 51\frac{1}{6}'$.

**Forms:** *a* (100, *i*-ī), *b* (010, *i*-ì); *l* (310, *i*-3̄), *n* (210, *i*-2̄); *m* (110, *I*); *q* (101, −1-ī), *r* (011, 1-ì), *e* (111, − 1).

*ll′′′* = 37° 50½′ *aq* = 43° 11′ *ee′* = 52° 10′ *me* = *39° 29½′
*nn′′′* = 54° 25′ *rr′* = 67° 42′ *ae* = *49° 5½′ *mq* = 59° 27′
*mm′′′* = 91° 36′



Figs. 1–3, Norway, Bgr.

Twins: tw. pl. *a* common; also with enclosed tw. lamellæ. Crystals prismatic with *m* prominent, also tabular ‖ *a*. Also in embedded grains.

Cleavage: *a* rather perfect. Brittle. H.=6. G.=3·51–3·55. Luster vitreous. Color light yellow to nearly colorless; also dark yellow to dark brown. Translucent. Pleochroism rather strong; 𝔠 deep red-brown, 𝔟 yellowish green, 𝔞 wine-yellow. Absorption, 𝔠 > 𝔟 > 𝔞.

Optically −, perhaps in some kinds also +. Double refraction very strong, $\gamma - \alpha = 0{\cdot}03$. Ax. pl. ‖ *b*. $Bx_a \wedge \grave{c} = -19° 25'$ to $-20° 18'$. Axial angles and refractive index:

$2H_a = 90° 16'$ $2H_o = 116° 7'$ ($n = 1{\cdot}4118$) $2V_a = 79° 46'$ $\beta = 1{\cdot}750$

**Comp., Var.**—Essentially $R(Si,Zr)O_3$ with $Zr(SiO_3)_2$ and $RTa_2O_6$; $R = Mn(Fe) : Ca : Na_2 = 7 : 6 : 9$ approx.; $RZr(O_2F_2)$ replaces in part $RZrO_3$.

**Var.**—Occurs in Norway in two varieties, one light yellow to nearly colorless; the other dark reddish brown to blackish brown; the former variety contains more soda and lime and has $Bx_a \wedge \grave{c} = -19° 25'$; the latter has $Bx_a \wedge \grave{c} = -20° 18'$.

**Anal.**—1, Cleve, G. För. Förh., **7**, 598, 1885. 2, Id., ibid, **9**, 252, 1887. 3, Id., Zs. Kr., **16**, 344, 1890.

| | | $SiO_2$ | $ZrO_2$ | $TiO_2$ | $Ta_2O_5$ | $Fe_2O_3$ | FeO | MnO | CaO | $Na_2O$ | F | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | G.=3·51 | 33·71 | 31·65 | — | — | 5·64? | — | 5·06 | 11·00 | 11·32 | | 1·03 | = 99·41 |
| 2. | G.=3·547 | 29·63 | 28·79 | 2·35 | 5·20 | 4·73? | — | 5·59 | 9·70 | 10·77 | | ign. 2·24 | = 99·00 |
| 3. | | 29·17 | 28·90 | 2·00 | 4·13[a] | 0·78 | 3·02 | 7·30 | 6·93 | 11·23 | 3·82 | 0·65 | X[b] 3·08 [= 101·01 |

[a] Incl. $Nb_2O_5$. [b] X = Zircon.

**Obs.**—First found on the little island Låven in the Langesund fiord, southern Norway, associated with catapleiite, eucolite, also mosandrite, tritomite, etc.; also on the island Klein-Arö with

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* The Swedish å is equivalent to the Danish (Norwegian) *aa* and has the sound of the English *o*.

eucolite, cappelenite, etc., and on Arö; it belongs among the rarer minerals of the dikes of elæolite- or augite-syenite. Further noted in the elæolite-syenite, occurring on the southwestern boundary of the provinces of Minas Geraes and São Paulo, also in the Serra de Tingua, Brazil; similarly associated on one of the Los islands, near Sierra Leone, West Africa; in the sanidinyte of São Miguel, Azores.

**Ref.**—L. c., and Zs. Kr., **16**, 339, 1890. The crystals were first described as mosandrite, Zs. Kr., **2**, 275, 1878.

### 333. WÖHLERITE. Wöhlerit *Scheerer*, Pogg., **59**, 327, 1843.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 1{\cdot}0549 : 1 : 0{\cdot}7091$; $\beta = {}^*70° 45' = 001 \wedge 100$ Dx.-Dbr.[1]

$100 \wedge 110 = {}^*44° 53'$, $001 \wedge 101 = 27° 27'$, $001 \wedge 011 = 33° 48'$.

**Forms**[2]:
*a* (100, i-ī)
*b* (010, i-ì)
*c* (001, O)
*l* (720, i-$\frac{7}{2}$)
*n* (210, i-2̄)
*m* (110, *I*)
*g* (120, i-2̀)
*h* (130, i-3̀)
*d* (101, − 1-ī)
*k* (1̄01, 1-ī)
*δ* (2̄01, 2-ī)
*x* (012, ½-ì)
*o* (011, 1-ì)
*f* (021, 2-ì)
*p* (111, − 1)
*s* (1̄11, 1)
*j* (2̄21, 2)?
*u* (311, − 3-3̄)[3]
*ξ* (2̄12, 1-2)?
*π* (2̄11, 2-2̄)
*i* (121, − 2-2)
*φ* (1̄21, 2-2̀)
*ω* (1̄61, 6-6̀)[3]

$nn''' = 52° 56\frac{1}{2}'$
$mm''' = 89° 46'$
$gg' = 53° 19'$
$hh' = 37° 1'$
$ck = 39° 11'$
$c\delta = 66° 19'$
$ad = {}^*43° 18'$
$xx' = 37° 1'$
$oo' = 67° 36'$
$ff' = 106° 29'$
$cp = 37° 3'$
$cm = 76° 29\frac{1}{2}'$
$cs = 49° 50\frac{1}{2}'$
$ci = 50° 30'$
$c\phi = 62° 17'$
$ap = 49° 7'$
$a's = 73° 31'$
$pp' = 51° 52'$
$ss' = 67° 22\frac{1}{2}'$
$ii = 88° 24\frac{1}{2}'$
$\phi\phi' = 106° 15'$
$\xi\xi' = 36° 52'$
$\pi\pi' = 51° 34'$

Crystals commonly prismatic and tabular ∥ *a*; usually twins, tw. pl. *a*; also with enclosed tw. lamellæ. Also granular.

Cleavage: *b* distinct. Fracture conchoidal to splintery. Brittle. H. = 5·5–6. G. = 3·41–3·44. Luster vitreous, inclining to resinous. Color light yellow, wine-, honey-, resin-yellow, brownish, grayish. Streak-powder yellowish white. Transparent to subtranslucent.

Pleochroism distinct, but not strong; $\mathfrak{c}$ wine-yellow, $\mathfrak{b}$ clear yellow, $\mathfrak{a}$ nearly colorless. Absorption $\mathfrak{c} > \mathfrak{b} = \mathfrak{a}$. Optically −. Ax. pl. nearly ∥ *d* (101) and ⊥ *b*. $Bx_a \wedge \grave{c} = -45°$. $Bx_o \perp b$. Dispersion small, $\rho < v$. Axial angles variable even in the same crystal, Dx.

| | | | | | |
|---|---|---|---|---|---|
| 1. | $2H_{a.r} = 89° 34'$ | $2H_{o.r} = 128° 6'$ | ∴ | $2V_r = 76° 10'$ | $\beta_r = 1{\cdot}67$ |
| | $2H_{a.bl} = 90° 54'$ | $2H_{o.bl} = 127° 6'$ | ∴ | $2V_{bl} = 77° 2'$ | $\beta_{bl} = 1{\cdot}69$ |
| 2. | $2H_{a.r} = 85° 41'$ | $2H_{o.r} = 139° 3'$ | ∴ | $2V_r = 71° 56'$ | $\beta_r = 1{\cdot}69$ |
| | $2H_{a.bl} = 86° 12'$ | $2H_{o.bl} = 138° 32'$ | ∴ | $2V_{bl} = 72° 18'$ | $\beta_{bl} = 1{\cdot}71$ |
| 3. | $2H_{a.r} = 86° 24'$ | $2H_{o.r} = 144° 24'$ | ∴ | $2V_r = 71° 26'$ | $\beta_r = 1{\cdot}72$ |
| | $2H_{a.bl} = 87° 30'$ | $2H_{o.bl} = 144° 8'$ | ∴ | $2V_{bl} = 72° 1'$ | $\beta_{bl} = 1{\cdot}74$ |

Also, Brögger, $Bx_a \wedge \grave{c} = -43° 18'$, and axial angles:

| | | | | |
|---|---|---|---|---|
| For Li | $2H_{a.r} = 90° 53'$ | $2H_{o.r} = 122° 9'$ | ∴ | $2V_r = 78° 18'$ |
| " Na | $2H_{a.y} = 91° 18'$ | $2H_{o.y} = 121° 42'$ | ∴ | $2V_y = 78° 37'$ |
| " Tl | $2H_{a.gr} = 91° 57'$ | $2H_{o.gr} = 121° 15'$ | ∴ | $2V_{gr} = 78° 49'$ |

**Comp.**—Essentially $12R(Si,Zr)O_3.RNb_2O_6$; where R = Ca : $Na_2$ = 4 : 1 nearly, also including Fe,Mn in small amount (Rg.). Further (Bgr.) with the metazirconate, $RZrO_3$, in part replaced by $RZr(O_2F_2)$.

**Anal.**—1, Scheerer, l. c. 2, Hermann, Bull. Soc. Moscow, **38**, 467, 1865. 3, Rammelsberg, Pogg., **150**, 211, 1873. 4, Cleve, Zs. Kr., **16**, 360, 1890.

| | | $SiO_2$ | $ZrO_2$ | $TiO_2$ | $Nb_2O_5$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $Na_2O$ | $H_2O$ | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | G. = 3·41 | 30·62 | 15·17 | — | 14·47 | 2·12 | — | 1·55 | 26·19 | 0·40 | 7·78 | 0·24 | — |
| | | | | | | | | | | | | | [= 98·54 |
| 2. | | 29·16 | 22·72 | — | 11·58 | — | 1·28 | 1·52 | 24·98 | 0·71 | 7·63 | 1·33 | — |
| | | | | | | | | | | | | | [= 100·91 |
| 3. | | $\frac{3}{3}$ 28·43 | 19·63 | — | 14·41 | — | 2·50 | | 26·18 | — | 7·78 | — | — |
| | | | | | | | | | | | | | [= 98·93 |
| 4. | G. = 3·442 | 30·12 | 16·11 | 0·42 | 12·85 | 0·48 | 1·26 | 1·00 | 26·95 | 0·12 | 7·50 | 0·74 | 2·98 |
| | | | | | | | | | | | | | X[a] 0·66 = 101·19 |

[a] X = Cerium oxides.

On the absorption spectra, see Krüss and Nilson, Öfv. Ak. Stockh., **44**, 369, 1887.

**Pyr., etc.**—B.B. in a strong heat fuses to a yellowish glass. With the fluxes gives the reactions of manganese, iron, and silica. Dissolves easily when heated in strong hydrochloric acid, with separation of the silica and niobium pentoxide.

**Obs.**—Occurs with elæolite, sodalite (and spreustein), cancrinite, barkevikite, ægirite, etc., in zircon-syenite, on several islands of the Langesund fiord, near Brevik, in Norway, especially on the island Skudesundskjär, near Barkevik; also on Lamöskjär (= Låven) and Stokö; further on the island Risö near Fredriksvärn. Some crystals are nearly an inch long. Named for Prof. Friedrich Wöhler (1800–1883).

**Ref.**—[1] Ann. Ch. Phys., **13**, 425, 1868; and earlier ib., **40**, 76, 1854; Ann. Mines, **16**, 229, 1859; Min., **1**, 162, 1862. See also Dbr., Pogg., **92**, 242, 1854; the system was at first supposed to be orthorhombic. Morton (quoted by Bgr., Zs. Kr., **16**, 355, 1890) gives: $\grave{a} : \bar{b} : \grave{c} = 1·0536 : 1 : 0·70878$; $\beta = 71° 3'$. [2] Cf. Dx., l. c., and Bgr., l. c. [3] Bgr.

## γ. *Triclinic Section.*

**334. HIORTDAHLITE.** *W. C. Brögger*, Nyt Mag., **31**, 232, 1889 (Separate, 1888); Zs. Kr., **16**, 367, 1890.

Triclinic. Axes $\breve{a} : \bar{b} : \grave{c} = 0·99835 : 1 : 0·35123$; $\alpha = 89° 22\frac{1}{2}'$, $\beta = 90° 36\frac{5}{6}'$, $\gamma = 90° 5\frac{5}{6}'$ Brögger.

$100 \wedge 010 = {}^*89° 54\frac{1}{2}'$, $100 \wedge 001 = 89° 23\frac{1}{4}'$, $010 \wedge 001 = 90° 37\frac{1}{2}'$.

**Forms:**
*a* (100, *i*-$\bar{i}$)
*b* (010, *i*-$\breve{i}$)
*l* (210, *i*-$\bar{2}'$)
*m* (110, *I'*)
*g* (120, *i*-$\breve{2}'$)
*h* ($2\bar{1}0$, '*i*-2)
*M* ($1\bar{1}0$, '*I*)
*k* ($1\bar{2}0$, '*i*-$\breve{2}$)
*v* (101, '1-$\bar{i}'$)
*p* (111, 1')
*g* ($\bar{1}\bar{1}1$, 1,)
*e* ($1\bar{1}1$, '1)
*x* (311, 3-$\bar{3}'$)
*y* ($\bar{3}\bar{1}1$, 3-$\bar{3}$,)
*z* ($3\bar{1}1$, '3-3)

*aM* = *44° 59½′
*mM* = 89° 53½′
*av* = 70° 4′
*ap* = 71° 1½′
*ae* = *71° 12′
*ax* = 44° 43′
*a′g* = 72° 11′
*bp* = 72° 14′
*b′e* = 71° 13½′
*Me* = *62° 53′
*pe* = 36° 33′
*ex* = *41° 31′

By inverting the crystals and taking *v* (101) as the base (001), Brögger calculates the following axial ratio and angles, which show the resemblance in form to wöhlerite:

$$\grave{a} : \bar{b} : \grave{c} = 1·0583 : 1 : 0·7048$$

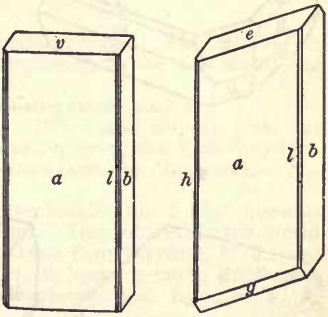
$$\alpha = 90° 29' \quad \beta = 108° 49\frac{1}{2}' \quad \gamma = 90° 8'.$$

Crystals tabular ‖ *a*, and vertically elongated; polysynthetic twins with twinning lamellæ having $\grave{c}$ as tw. ax., tw. pl. ⊥ $\grave{c}$ and comp.-face ‖ *a*.

Cleavage not distinct. Very brittle. H.=5–5·6. G. = 3·267 Bgr. Luster vitreous on crystalline faces; greasy on fracture surfaces. Color light shades of straw-, sulphur- to honey-yellow, less often yellowish brown.

Pleochroism not strongly marked: $\mathfrak{c}$ wine-yellow, $\mathfrak{b}$ bright yellow, $\mathfrak{a}$ nearly colorless. Absorption $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$. Optically +. $Bx_a$ situated in the upper left-hand front octant, oblique to *a*; the optic normal in that behind. Ax. pl. approximately ‖ $1\bar{1}1$. Extinction-angles with $\grave{c}$, on *a* = 25° and 65°, on *b* = 15½° and 74½°.

1. 2.



Norway, Brögger.

**Comp.**—Essentially $(Na_2,Ca)(Si,Zr)O_3$, with also fluorine present (Bgr.) as a fluozirconate $RZrO_2F_2$; nearly corresponding to $4Ca(Si,Zr)O_3.Na_2ZrO_2F_2$.

**Anal.**—Cleve, Zs. Kr., **16**, 374, 1890.

| | $SiO_2$ | $ZrO_2$ | $TiO_2$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $Na_2O$ | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G. = 3·235 | 31·60 | 21·48 | 1·50 | 0·34 | 0·94 | 0·96 | 32·53 | 0·10 | 6·53 | 0·58 | 5·83 | = 102·39 |

**Pyr., etc.**—Fuses easily B.B., to a yellowish white enamel. Gelatinizes with acids.

**Obs.**—Occurs sparingly embedded in feldspar, elæolite, or fluorite in a narrow dike on the island, Mittel-Arö, in the Langesund fiord, southern Norway.

Named after Prof. Th. Hiortdahl of Christiania.

**335. RHODONITE.** Rother Braunstein pt. *Min. of last Cent.;* fr. Kapnik, *Ruprecht,* Phys. Arb. Wien, **1**, 55, 1782; Crell's Ann., **1**, 297, 1790. Rothbraunsteinerz pt. *Wern.* Dichtes Roth-Braunsteinerz (Kapnikker Feldspath) *Karst.*, Tab., 54, 78, 1800 (favoring its being a distinct species, while others (Haüy, Reuss, etc.) supposed it the carbonate mixed with quartz). Rothstein pt., Kieselmangan, Mangankiesel, *Germ.* Manganese Spar pt.; Red Manganese; Bisilicate of Manganese. Rhodonit *Jasche,* Germar, in Schw. J., **26**, 112, 1819. Hydropit *Germar,* ib., 115.

Bustamite (fr. Mexico), Bisilicate de Manganèse et de Chaux, *A. Brongn.*, Ann. Sc. Nat., **8**, 411, 1826. Fowlerite (fr. Hamburg, N. J.) *Sheph.*, Min., 186, 1832, **2**, 25, 1835. Kapnikite *Huot,* **1**, 239, 1841. Paisbergit *Igelström,* Öfv. Ak. Stockh., 143, 1851; J. pr. Ch., **54**, 190, 1851. Mangan-Amphibol *Herm.*, J. pr. Ch., **47**, 7, 1849 = Hermannit *Kenng.*, Min., 71, 1853 = Cummingtonit *Rg.*, Min. Ch., 473, 1860. Järnrhodonit, Eisenrhodonit *Weibull,* Öfv. Ak. Stockh., **41**, No. 9, 29, 1884, Min. Mitth., **7**, 117, 1885. Keatingine (= Fowlerite) *C. U. Shepard,* Contrib. Min. 1876.

Triclinic. Axes $\bar{a} : \breve{b} : \dot{c}$ = 1·07285 : 1 : 0·62127; $\alpha$ = 103° 18′ 7″; $\beta$ = 108° 44′ 8″; $\gamma$ = 81° 39′ 16″ Flink[1].

100 $\wedge$ 010 = *94° 26′, 100 $\wedge$ 001 = *72° 36′ 30″, 010 $\wedge$ 001 = *78° 42′ 30″.

**Forms**[2]:
*a* (100, *i*-$\breve{\imath}$, o Dbr.)
*b* (010, *i*-$\bar{\imath}$, s)
*c* (001, *O*, a)
*m* (110, *I*′, b)
*f* (130, *i*-$\bar{3}$′)
*g* (150, *i*-$\bar{5}$′)

*t* (310, ′*i*-$\breve{3}$)
*d* (210, ′*i*-$\breve{2}$)
*M* (1$\bar{1}$0, ′*I*, c)
*e* (1$\bar{3}$0, ′*i*-$\bar{3}$)
*μ* (401, ′4-$\breve{\imath}$′)
*ρ* ($\bar{2}$01, ,2-$\breve{\imath}$,)[3]
*φ* ($\bar{4}$01, ,4-$\breve{\imath}$,)[3]

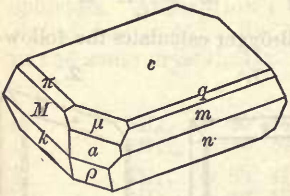
*γ* (041, 4-$\bar{\imath}$′)
*p* (111, 1′)
*q* (221, 2′)
*ϵ* (441, 4′)[3]
*z* (16·2·3, $\frac{16}{3}$-$\breve{8}$′)
*α* (4·1·12, $\frac{1}{3}$-$\breve{4}$′)
**m** ($\bar{1}$11, ,1)

*k* ($\bar{2}$21, ,2)
*i* ($\bar{4}$41, ,4)
*β*. ($\bar{1}\bar{2}$·1·3, ,4-$\overset{\frown}{12}$)
*ω* ($\bar{3}$23, ,1-$\frac{3}{2}$)
*u* ($\bar{2}\bar{2}$3, $\frac{2}{3}$,)
*r* ($\bar{1}\bar{1}$1, 1,)
*l* ($\bar{4}\bar{4}$3, $\frac{4}{3}$,)

*n* ($\bar{2}\bar{2}$1, 2,)
*π* (1$\bar{1}$1, ′1)[4]
*y* (5$\bar{2}$2, ′$\frac{5}{2}$-$\frac{5}{2}$)
*x* (12·$\bar{1}$·1, ′12-$\overset{\frown}{12}$)
*w* (8·$\bar{1}\bar{2}$·3, ′4-$\frac{3}{2}$)
*h* (7·$\bar{2}\bar{8}$·16, ′$\frac{7}{4}$-$\bar{4}$)

Also doubtful[3]: 445, 883, 661.

1.



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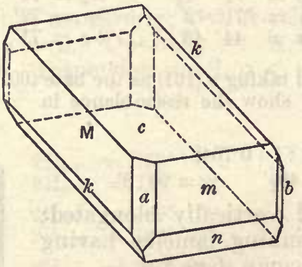
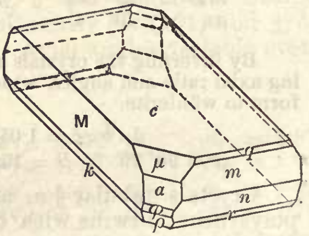
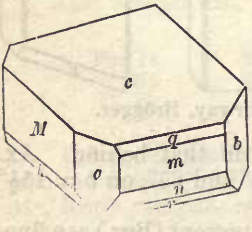


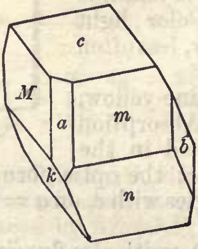
3.



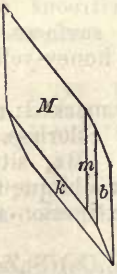
4.



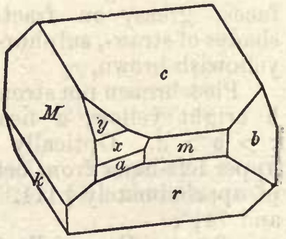
5.



6.



7.



Figs. 1–4, Franklin Furnace, N. J. 2, 3, Pirsson. 5–7, Pajsberg, Flink.

*am* = 48° 33′
*aM* = 43° 55½′
*bm* = 45° 53′
*bf* = 18° 4½′
*bg* = 10° 58′
*b′t* = 66° 54′
*b′d* = 58° 59′
*b′M* = *41° 38½′

*mM* = 92° 28½′
*cμ* = 52° 17′
*cρ* = 58° 45′
*cp* = 29° 49′
*cq* = 43° 8½′
*cm* = 68° 45′
*cM* = 86° 23′

*cm* = 42° 2′
*ck* = 62° 23′
*ci* = 77° 3′
*M′k* = *31° 13½′
*cr* = 45° 57′
*cl* = 57° 51′
*cn* = 73° 52′

*cπ* = 38° 59′
*ap* = 56° 19′
*bm* = 49° 4½′
*mr* = 61° 10′
*b′r* = 69° 46′
*kn* = 86° 5′
*bq* = 53° 1′

The similarity in form between pyroxene and the triclinic species, rhodonite and babingtonite, is shown by their axial ratios and axial angles (pp. 344, 345); also by the following:

| | $110 \wedge 1\bar{1}0$ | $100 \wedge 001$ | $\bar{2}21 \wedge \bar{2}\bar{2}1$ | $221 \wedge 2\bar{2}1$ |
|---|---|---|---|---|
| Pyroxene | *mm‴* = 92° 50′ | *ac* = 74° 10′ | *oo′* = 84° 11′ | *vv′* = 68° 42 |
| Rhodonite | *mM* = 92° 28½′ | *ac* = 72° 36½′ | *kn* = 86° 5′ | |
| Babingtonite | *mM* = 92° 36′ | *ac* = 72° 29′ | | *hd* = 69° 21′ |

Crystals usually large and rough with rounded edges. Commonly tabular ‖ *c*; often elongated in direction of *M*, less often of *m*; also spear-shaped (f. 6); sometimes resembling pyroxene in habit, as in f. 5. Commonly massive, cleavable to compact; also in embedded grains.

Cleavage: *m*, *M* perfect; *c* less perfect. Fracture conchoidal to uneven; very tough when compact. H. = 5·5–6·5. G. = 3·4–3·68. Luster vitreous; on cleavage surfaces somewhat pearly. Color light brownish red, flesh-red, rose-pink; sometimes greenish or yellowish, when impure; often black outside from exposure. Streak white. Transparent to translucent.

Optically −. Extinction-angles on *a* (100), inclined 32° 26′ and 44° 16′ to edges *a*/*m* and *a*/*c* respectively; on *b*, inclined 10° 48′ and 97° 56′ to edges *b*/*a* and *b*/*c*; on *c*, inclined 54° 26½′ and 39° 37′ to edges *c*/*m* and *c*/*M*. Ax. pl. forms angles of 63° and 38½° with the planes *M* and *c*. Plane ⊥ $Bx_a$ inclined 51° 47′ and 51° 40′ to the same planes. Dispersion $\rho < v$. Axial angles, Flink:

$2H_{a.r}$ = 79° 25′ $2H_{o.r}$ = 109° 56′ ∴ $2V_{a.r}$ = 75° 57′ Li
$2H_{a.y}$ = 79° 0′ $2H_{o.y}$ = 108° 25′ ∴ $2V_{a.y}$ = 76° 12′ Na
$2H_{a.gr}$ = 78° 38½′ $2H_{o.gr}$ = 107° 13½′ ∴ $2V_{a.gr}$ = 76° 22′ Tl

**Comp., Var.**—Manganese metasilicate, $MnSiO_3$ or $MnO.SiO_2$ = Silica 45·9, manganese protoxide 54·1 = 100. Iron, calcium, and occasionally zinc replace part of the manganese.

1. *Ordinary*. (*a*) Crystallized. Either in crystals or cleavable masses. The mineral in crystals from Pajsberg, Sweden, was named *paisbergite* (or pajsbergite) under the idea that it was a distinct species. (*b*) Granular massive to compact.

2. *Ferriferous*. Contains sometimes nearly as much iron as manganese, anal. 9.

3. *Calciferous;* BUSTAMITE. Contains 9 to 20 p. c. of lime. Often also impure from the presence of calcium carbonate, which suggests that part of the lime replacing the MnO may have come from partial alteration. Grayish red. Named after M. Bustamente, the discoverer. The original was from Mexico.

4. *Zinciferous;* FOWLERITE. In crystals and foliated, the latter looking much like cleavable red feldspar; the crystals sometimes half an inch to an inch through. This mineral is mentioned by Fowler in Am. J. Sc., **9**, 245, 1825, as *siliceous oxyd of manganese* from Sterling, N. J., and as often containing dysluite (zinciferous spinel). It occurs under the same name in Robinson's Cat. Amer. Min., 298, 1825. It is Thomson's *ferrosilicate of manganese*, Ann. Lyc., N. Y., **3**, 28, 1828. Named after Dr. Samuel Fowler.

**Anal.**—1, Berzelius, Schw. J., **21**, 254, 1817. 2, V. Fino, Att. Acc. Torino, **18**, 39, 1882. 3, H. v. Foullon, Jb. G. Reichs., **38**, 25, 1888. 4, Schlieper, Dana Min., 463, 1850. 5, 6, Ebelmann, C. R., **20**, 1416, 1845. 7, Igelström, l. c. 8, Id., Öfv. Ak. Stockh., **40**, No. 7, 93, 1883. 9, Weibull, after deducting 2·76 p. c. magnetite and calcite, ib., **41**, 9, 39, 1884, and Min. Mitth., **7**, 117, 1885. 10, Rg., Zs. G. Ges., **18**, 34, 1866. 11, Ebelmann, l. c., deducting (Rg.) 12 p. c. $CaCO_3$. 12, Lindström, Öfv. Ak. Stockh., **37**, No. 6, 57, 1880. 13, Sipöcz, Min. Mitth., **31**, 1873. 14, Rg., Min. Ch., 459, 1860. 15, Pirsson, Am. J. Sc., **40**, 484, 1890. Also 5th Ed. p. 226.

| | G. | | $SiO_2$ | MnO | FeO | ZnO | CaO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Långban | | | 48·00 | 49·04 | — | — | 3·12 | 0 22 | — | = 100·38 |
| 2. Viu, Turin | 3·63 | $\frac{2}{2}$ | 44·27 | 48 70 | 1·51 | — | 4·51 | — | 1·24 | = 100·23 |
| 3. Rosenau, Hungary | | $\frac{2}{2}$ | 44·57 | 46·09 | 2·17 | — | 4·22 | 1·47 | 1·00 | = 99·52 |
| 4. Cummington | | | 51·21 | 42 65 | 4·34 | — | 2·93 | *tr.* | — | = 101·13 |
| 5. Algiers | | | 45·49 | 39·46 | 6·42 | — | 4·66 | 2·60 | · | = 98·63 |
| 6. St. Marcel | | | 46 37 | 47·38 | — | — | 5·48 | — | — | = 99·23 |
| 7. Pajsberg, *Paisbergite* | 3·63 | | 46·46 | 41·88 | 3·31 | — | 8·13 | 0·91 | — | = 100·69 |
| 8. Wermland | | | 47·00 | 31·20 | 10·60 | — | 5·70 | 2·50 | 0·80 | = 97·80 |
| 9. Vester Silfberg | 3·672 | | 45 12 | 24·25 | 22·44 | — | 5·62 | 1·20 | — | $Al_2O_3$ 1·38 = 100·01 |
| 10. Mexico, *Bustamite* | | | 47·35 | 42·08 | — | — | 9·60 | — | 0·72 | = 99·75 |
| 11. " " | | | 50 67 | 30·73 | 1 31 | — | 16·45 | 0·73 | — | = 99·89 |
| 12. Långban | 3·40 | | 47·66 | 31 65 | 0·48 | — | 18·16 | 1·18 | — | BaO 0·19, alk. 0·27, gangue 0 52 = 100·11 |
| 13. Rezbánya | | | 47·44 | 23·13 | 6·54 | — | 21·02 | 1·16 | — | $Al_2O_3$ 1·17 = 100·46 |
| 14. Stirling Hill, *Fowlerite* | | | 46 70 | 31·20 | 8·35 | 5·10 | 6·30 | 2 81 | 0·18 | = 100·74 |
| 15. Franklin Furn., " | 3·674 | $\frac{2}{2}$ | 46·06 | 34·28 | 3·63 | 7·33 | 7·04 | 1·30 | — | = 99·64 |

**Pyr., etc.**—B.B. blackens and fuses with slight intumescence at 2·5; with the fluxes gives reactions for manganese; fowlerite gives with soda on charcoal a reaction for zinc. Slightly acted upon by acids. The calciferous varieties often effervesce from mechanical admixture with calcium carbonate. In powder, partly dissolves in hydrochloric acid, and the insoluble part becomes of a white color. Darkens on exposure to the air, and sometimes becomes nearly black.

**Obs.**—Occurs at Långban, Wermland, Sweden, in iron ore beds, in broad cleavage plates, and also granular massive; at the Pajsberg iron mines near Filipstad (*paisbergite*) sometimes in small brilliant crystals; also at Elbingerode, in the Harz; in the district of Ekaterinburg in the Ural massive like marble, whence it is obtained for ornamental purposes; with tetrahedrite at Kapnik and Rezbánya, Hungary; in Cornwall; St. Marcel, also near Viu, Piedmont; Algiers; Tetela di Xonotla, Mexico.

Occurs in Cummington, Mass., and some of the neighboring towns, in boulders; also in Warwick, Mass.; in an extensive bed on Osgood's farm, Blue Hill Bay, Maine; in Irasburg and Coventry, Vt.; near Winchester and Hinsdale, N. H.; at Cumberland, R. I.; *fowlerite* at Mine Hill, Franklin Furnace, and Stirling Hill, near Ogdensburgh, N. J., the two localities only 2 or 3 miles apart, it is usually embedded in calcite and is sometimes in splendid crystallizations.

Named from *ῥόδον, a rose,* in allusion to the color. The name is attributed to Jasche by Germar (1819), but is not in the Kleine Min., Schriften of Jasche (1817).

**Alt.**—There are two prominent methods of alteration, which may act separately or together. (1) Through the strong tendency of manganese protoxide to pass to a higher state of oxidation; in which process the red color changes to brown or black, commencing with the exterior, which becomes a black crust to the mass. Indefinite mixtures thus result, which may be either partly silicate, or wholly one or more oxides of manganese. (2) Through the tendency of the manganese protoxide and other protoxides present to unite with carbonic acid afforded by alkaline carbonated waters, this causing the silicate to be penetrated with manganese carbonate, and often also with carbonate of lime or iron. The color of the result after this latter method is usually grayish red to grayish white, and sometimes brown.

I. *By Oxidation; not Hydrated or Carbonated.*

A. MARCELINE *Berthier,* Ann. Ch. Phys., **51**, 79, 1832. Color grayish black to iron-black; luster submetallic; G. = 3·8; H. = 5·5–6. From St. Marcel in Piedmont. *Heteroclin* Breith. (*Evreinov,* Pogg., **49**, 204, 1840) is from the same locality, and of the same nature, as recognized by Breithaupt.

B. DYSSNITE *v. Kobell,* Grundz., 328, 1838. Thomson's *sesquisilicate of M.,* from Franklin, N. J. (Ann. Lyc. N. York, l. c.), an iron-black ore, with G. = 3·67; it is altered fowlerite. Von Kobell cites Thomson's analysis, and gives no description of his own.

II. *By Oxidation; Hydrated.*

STRATOPEITE, Wittingite, Neotocite, are names of results of this kind of alteration. They are found along with rhodonite. They contain about 35 p. c. of silica. See NEOTOCITE under HYDROUS SILICATES. Opsimose of Beudant and Klipsteinite of v. Kobell (see beyond) are names of a similar hydrous silicate containing about 25 p. c. of silica, with admixed wad.

III. *Carbonated.*

A. ALLAGITE *Jasche,* Germar, Schw. J., **26**, 112, 1819; Grünmanganerz *Jasche,* Kleine Min. Schriften, 10, 1817. From Schebenholze, near Elbingerode in the Harz, is either dull green or reddish brown, and affording du Menil (Gilb. Ann., **61**, 199, 1819) 7·5 p. c. $CO_2$.

B. PHOTICITE *Germar,* Schw. J., **26**, 116, 1819; Photizit *Brandes,* ib., 138. Yellowish white, isabella- and wax-yellow, greenish gray, pearl-gray, to rose-red; G. = 2·8–3, from the same locality with the allagite. It afforded Brandes (ib., 136) 11 to 14 p. c. of carbon dioxide, with some water. Corneous manganese (*Horn-mangan* of Jasche) is of similar nature. it containing 5 to 10 p. c. of carbon dioxide; color brown to gray. And so also the Cummington rhodonite, which afforded Schlieper 10 p. c. or more of carbonates, and which Hermann erroneously made a manganesian amphibole.

Anal.—1, Berthier, l. c. 2, Damour, Ann. Mines, **1**, 400, 1842. 3, Thomson, Lyc. Nat. Hist., N. Y., **3**, 33. 4, 5, du Menil, l. c. 6-8, Brandes, l. c.

| | $SiO_2$ | $Al_2O_3$ | $Mn_2O_3$ | $Fe_2O_3$ | CaO | MgO | $H_2O$ | $CO_2$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. *Marceline* | 26·00 | 3·00 | 67·23 | 1·23 | 1·40 | 1·40 | — | — | = 100·25 |
| 2. *Heteroclin* | 10·24 | — | 76·32 | 11·49 | 1·14 | 0·26 | — | — | = 99·45 |
| 3. *Dyssnite* | 38·39 | — | 51·67 | 9·44 | — | — | — | — | = 99·50 |
| 4. *Allagite, green* | 16·00 | — | — | 73·71 | — | — | — | 7·50 | = 97·21 |
| 5. " *brown* | 16·00 | — | — | 79·00 | *tr.* | — | — | 7·50 | = 98·50 |
| 6. *Photicite, yellowish* | 39·00 | 0·25 | 46·13 | 0·50 | — | — | 3·00 | 11·00 | = 99·88 |
| 7. " *grayish* | 36·00 | 6·00 | 37·33 | 0·50 | — | — | 6·00 | 14·00 | = 99·89 |
| 8. *Horn-manganese* | 35·00 | 0·25 | 57·16 | 0·25 | — | — | 2·50 | 5·00 | = 99·91 |

The ores, as alteration continues, graduate into true oxides of manganese. A kind from Pesillo (called *Pesillite* by Huot, Min., 1841) has lost nearly all of the silica in the change.

A series of alteration products of rhodonite from North Carolina and Rhode Island have been analyzed by W. N. De Regt, cf. Chester, Jb. Min., **1**, 187, 1888.

**Artif.**—Formed by Bourgeois in crystals by fusing equal equivalents of silica and manganese dioxide, Bull. Soc. Min., **6**, 64, 1883. Also by Gorgeu, ibid., **10**, 264, 1887; described by Vogt from the iron-works at Westanfors, Sweden, in Bessemer slags and also with those of spiegeleisen. Ak. H. Stockh., Bihang, **9**, 29, 1884; Arch. Math. Nat., Christ., **30**, 80, 1889.

**Ref.**—[1] Öfv. Ak. Stockh., **42**, No. 6, 159, 1885, and Zs. Kr., **11**, 506, 1886. The position is that suggested by J. D. D. (Min. 225, 1868), which shows the relation to pyroxene; later adopted by Groth, Tab. Ueb., **58**, 102, 1874, and Flink.

[2] Cf. Dbr., Pogg., **94**, 396, 1855; Greg, Phil. Mag., **4**, 196. 1856; Kk., **4**, 174; Dx., Min., **1**, 68, 1862; Sjögren, Pajsberg, G. För. Förh., **5**, 259, 1880; Flink. l. c., who gives many new forms. [3] Pirsson, Franklin Furnace, N. J., Am. J. Sc., **40**, 484, 1890. [4] E. S. D., Franklin.

HYDRORHODONITE. Hydrorodonit *N. Engström*, G. För. Förh., **2**, 468, 1875. Massive; crystalline. Cleavage easy in one direction. H. = 5–6. G. = 2·70. Luster vitreous. Color red-brown Streak brownish white. Translucent, in thin splinters transparent. Analysis, Engström:

$SiO_2$ 44·07 MnO 30·83 FeO 1·04 CaO 3·60 MgO 6·98 $Li_2O$ 1·23 $Na_2O$ 0·39 $H_2O$ 11·84 = 99·98

A second analysis gave similar results. Soluble in hydrochloric acid with the separation of silica. From Långban, Wermland, Sweden. This may be a hydrated rhodonite.

KLIPSTEINITE. Schwarz-Braunsteinerz von Klapperud *Klapr.*, Beitr., **4**, 137, 1807 = Opsimose *Beud.*, Tr., 187, 1832. Vattenhaltigt Manganoxidsilikat *Bahr*, Öfv. Ak. Stockh., **7**, 242, 1850. Klipsteinite *Kbl.*, J. pr. Ch., **97**, 180, 1866.

Amorphous. Compact. H. = 5–5·5. G. = 3·5. Luster dull to submetallic. Color dark liver-brown to black. Streak reddish brown or yellowish brown. Opaque. Analyses: 1, Bahr, l. c. 2, v. Kobell, l. c.:

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ | MnO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Klapperud, *Opsim.* | 23·69 | 0·61 | 9·14 | 56·21 | — | 0·39 | 0·50 | 9·51 | = 100·05 |
| 2. Dillenburg, *Klipst.* | 25·00 | 1·70 | 4·00 | 32·17 | 25·00 | 2·00 | — | 9·00 | = 98·87 |

From Klapperud in Dalecarlia with rhodonite; also from the Bornberg mine at Herborn, near Dillenburg. Beudant's name is from the Greek *ὄψιμος, late;* Klipsteinite is named after Prof. v. Klipstein of Giessen.

Fischer shows the impurity of this supposed mineral, Zs. Kr., **4**, 365, 1880.

### 336. BABINGTONITE. *Lévy*, Ann. Phil., **7**, 275, 1824.

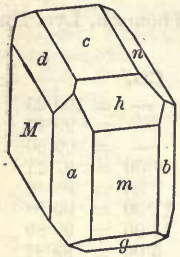
Triclinic. Axes $\bar{a} : \breve{b} : \acute{c} = 1·06906 : 1 : 0·63084$; $\alpha = 104° \, 21\frac{1}{2}'$, $\beta = 108° \, 30\frac{5}{6}'$, $\gamma = 83° \, 34\frac{1}{4}'$ Dauber[1].

$100 \wedge 010 = 92° \, 4\frac{1}{3}'$, $100 \wedge 001 = 72° \, 28\frac{5}{6}'$, $010 \wedge 001 = 76° \, 58\frac{1}{3}'$.

**Forms**[1]:
*a* (100, *i-ĭ*, o Dbr.)
*b* (010, *i-ī*, s)
*c* (001, *O*, a)
*m* (110, *I′*, b)
*M* ($1\bar{1}0$, *′I*, c)
*h* (221, 2′)
*g* ($\bar{1}\bar{1}1$, 1,)
*f* ($\bar{4}\bar{4}3$, $\frac{4}{3}$,)
*d* ($2\bar{2}1$, ′2)

*am* = *47° 23′
*aM* = 45° 13′
*mM* = *92° 36′
*bm* = 44° 41′
*b′M* = 42° 43′
*ch* = 43° 6′
*cm* = *67° 48′
*cg* = *47° 36′
*cd* = 57° 36′
*cM* = *87° 28′
*bh* = 51° 13′
*b′d* = 59° 26′
*dh* = 69° 21′
*ah* = 50° 32½′
*ad* = 41° 48½′
*a′g* = 75° 44′

For a comparison of angles with pyroxene, see p. 379.



Arendal, after Dx.

Crystals small, somewhat resembling black augite or hornblende. Faces in zone *c h m* striated ‖ their intersection-edges; also *c d* similarly.

Cleavage: *M* perfect; also *m* less so. Fracture subconchoidal. Brittle. H. = 5·5–6. G. = 3·35–3·37. Luster vitreous, splendent. Color dark greenish black. Pleochroic. Faintly translucent; large crystals opaque, or faintly subtranslucent. Extinction-angles with $\dot{c}$ on $a$ (100) 44°, on $\bar{b}$ (010) 31°, Vogt.

**Comp.**—$(Ca,Fe,Mn)SiO_3$ with $Fe_2(SiO_3)_3$ in the ratio of 9 : 1 (anal. 1), or 6 : 1 (anal. 2), Rg.

**Anal.**—1, Rg., Pogg., **103**, 287, 304, 1858. 2, Jehn, Pogg., **144**, 594, 1871, and Inaug. Diss., Jena. 1871. 3, Forbes, Phil. Mag., **37**, 328, 1869. 4, H. Klemm, Inaug. Diss., Jena, 1873.

| | G. | $SiO_2$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 1. Arendal | 3·366 | 51·22 | 11·00 | 10·26 | 7·91 | 19·32 | 0·77 | 0·44 = 100·92 |
| 2. Hornseelbach | 3·355 | 50·44 | 17·01 | 7·49 | 3·22 | 19·90 | 1·45 | 0·43 alk. *tr.* = 99·94 |
| 3. Devonshire | 3·434 | 49·12 | 9·78 | 12·87 | 1·25 | 20·87 | 3·67 | 0·73 $Al_2O_3$ 1·60 = 99·89 |
| 4. *Artificial* | 3·24 | 48·89 | 16·25[a] | 29·48 | 2·39 | 1·81 | 1·43 | — = 100·25 |

[a] Incl. 10·91 $Mn_2O_3$.

**Pyr., etc.**—B.B. fuses at 2·7 to a black magnetic globule, and with the fluxes gives reactions for iron and manganese. Unacted upon by acids.

**Obs.**—Occurs in distinct crystals at Arendal, in Norway, associated with epidote and massive garnet; in the syenite of Sutherland, Scotland, but falsely reported from the Shetlands (Heddle); at Herbornseelbach, Nassau, implanted upon a massive ferruginous quartz; at Baveno, Italy, in cavities in granite; Devonshire, England.

In the United States it is said to coat crystals of feldspar, at Gouverneur, St. Lawrence Co., N. Y. Small black polished crystals coating mica slate, or micaceous gneiss, at Athol, Mass., referred by Shepard to babingtonite, may possibly belong here. but see 5th Ed., p. 228.

It was named after Dr. Wm. Babington (1757–1833).

**Artif.**—Observed in crystals in slag at the Bessemer steel manufacture at Hoerde; the composition (anal. 4) varies somewhat widely from that of the natural mineral; also in cavities in a roasted iron ore from Finspong, Vogt, Ak. H. Stockh., Bihang, 9, No. 1, 37, 1884.

**Ref.**—[1] Arendal, Pogg., **94**, 402, 1855; cf. rhodonite. See also Lévy, l. c.; Dx., Min., 1, 73, 1862; Rath, Baveno, Pogg., **135**, 583, 1868; Id., Nassau, Pogg., Erg., **5**, 420, 1871; Schrauf, Atlas, xxx, 1871.

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## 3. Amphibole Group.

Orthorhombic, Monoclinic, Triclinic.

Composition $RSiO_3$ with R = Ca,Mg,Fe chiefly, also $Mn,Na_2(K_2),H_2$. Further often containing aluminium and ferric iron, in part as $NaAl(SiO_3)_2$ or $NaFe(SiO_3)_2$; perhaps also as $\overset{\text{II}}{R}\overset{\text{III}}{R}_2SiO_6$.

### α. *Orthorhombic Section.*

| | | $\breve{a}:\bar{b}$ |
|---|---|---|
| **337. Anthophyllite** | $(Mg,Fe)SiO_3$ | 0·5138 : 1 |
| 337A. GEDRITE | $(Mg,Fe)SiO_3$ with $(Mg,Fe)Al_2SiO_6$ | |

### β. *Monoclinic Section.*

| | | $\grave{a}:\bar{b}:\dot{c}$ | β |
|---|---|---|---|
| **338. Amphibole** | | 0·5511 : 1 : 0·2938 | 73° 58′ |
| *Non-aluminous* | | | |
| TREMOLITE | $CaMg_3(SiO_3)_4$ | | |
| ACTINOLITE | $Ca(Mg,Fe)_3(SiO_3)_4$ | | |
| Nephrite, Asbestus, Smaragdite, etc. | | | |

| | |
|---|---|
| CUMMINGTONITE | $(Fe,Mg)SiO_3$ |
| Amphibole-anthophyllite | |
| DANNEMORITE | $(Fe,Mn,Mg)SiO_3$ |
| Silfbergite, Hillängsite | |
| GRÜNERITE | $FeSiO_3$ |
| RICHTERITE | $((K,Na)_2Mg,Ca,Mn)SiO_3$ |
| *Aluminous* | |
| EDENITE<br>PARGASITE<br>HORNBLENDE | Chiefly $Ca(Mg,Fe)_3Si_4O_{12}$ with $Na_2Al_2Si_4O_{12}$ and $(Mg,Fe)_2(Al,Fe)_4Si_2O_{12}$ |
| **339. Glaucophane** | $NaAl(SiO_3)_2.(Fe,Mg)SiO_3$ |
| **340. Riebeckite** | $2NaFe(SiO_3)_2.FeSiO_3$ |
| **341. Crocidolite** | $NaFe(SiO_3)_2.FeSiO_3$ |
| **342. Arfvedsonite** | $Na_8(Ca,Mg)_3(Fe,Mn)_{14}(Al,Fe)_2Si_{21}O_{45}$ |
| 342 A. Barkevikite. | |

### γ. *Triclinic Section.*

| | | $\breve{a} : \bar{b} : \acute{c}$ |
|---|---|---|
| **343. Ænigmatite** | $Na_4Fe_9Al\overset{III}{Fe}(Si,Ti)_{12}O_{38}$ | 0·6778 : 1 : 0·3506 |
| Cossyrite | | $\alpha = 90^\circ$ $\beta = 72^\circ 49'$ $\gamma = 90^\circ$ approx. |

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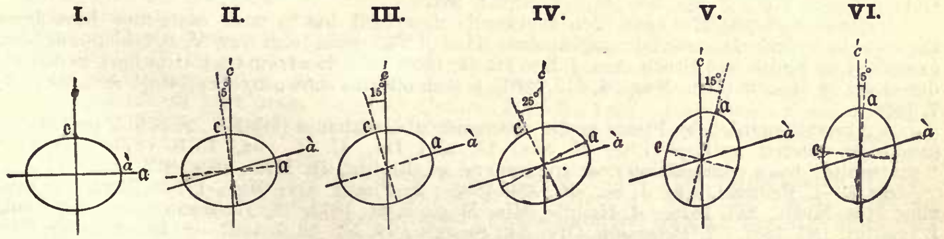
The AMPHIBOLE GROUP embraces a number of species which, while falling in different systems, are yet closely related in form—as shown in the common prismatic cleavage of 54° to 56°—also in optical characters and chemical composition. As already noted (see p. 345), the species of this group form chemically a series parallel to that of the closely allied Pyroxene Group, and between them there is a close relationship in crystalline form and other characters. The amphibole group, however, is less fully developed, including fewer species, and those known show less variety in form.

The chief distinctions between pyroxene and amphibole proper are the following: prismatic angle with pyroxene 87° and 93°; with amphibole 56° and 124°; the prismatic cleavage being much more distinct in the latter. With pyroxene, crystals usually short prismatic and often complex, structure of massive kinds mostly lamellar or granular; with amphibole, crystals chiefly long prismatic and simple, columnar and fibrous massive kinds the rule. The specific gravity of most of the pyroxene varieties is higher than of the like varieties of amphibole. In composition of corresponding kinds, magnesium is present in larger amount in amphibole (Ca : Mg = 1 : 1 in diopside, = 1 : 3 in tremolite); alkalies more frequently play a prominent part in amphibole. Cf also pp. 388, 390.

The optical relations of the prominent members of the group, as regards the position of the axes of light-elasticity, is exhibited by the following figures (after Cross); compare p. 346 for a similar representation for the corresponding members of the pyroxene group.



I. Anthophyllite. II. Glaucophane. III. Tremolite, etc. IV. Hornblende. V. Arfvedsonite (?). VI. Riebeckite (?).

### *a. Orthorhombic Section.*

**337. ANTHOPHYLLITE.** Anthophyllit *Schumacher*, Verzeichn., 96, 1801. Antophyllit *Karst.*, Tab., 32, 1808. Anthogrammit *Breith.*, Char., 29, 1820. Antholith *Breith.*, Uib., 38, 1830. Kupfferit *R. Hermann*, Bull. Soc. Nat. Moscou, **35**, 243, 1862.

**337A.** GEDRITE *Dufrenoy*, Ann. Mines, **10**, 582, 1836.

Orthorhombic. Axial ratio $\breve{a} : \bar{b} = 0{\cdot}51375 : 1$, Penfield[1]. Prismatic angle, $mm''' = 54^\circ 23'$. Crystals rare, habit prismatic but prisms not terminated. Commonly lamellar, or fibrous massive; fibers often very slender. Also in aggregations of prisms, like actinolite.

Cleavage: prismatic, perfect; *b* less so; *a* sometimes distinct. H. = 5·5–6. G. = 3·1–3·2. Luster vitreous, somewhat pearly on the cleavage-face. Color brownish gray, yellowish brown, clove-brown, brownish green, emerald-green, sometimes metalloidal. Streak uncolored or grayish. Transparent to subtranslucent.

Anthophyllite is usually optically + (Dx., anal. 2); also optically + for red, — for yellow, green (Pfd., anal. 1). Ax. pl. always $\parallel b$. $Bx_a$ usually $\perp c$; also $\perp c$ for red, $\perp a$ for yellow, green. Axial angles and indices:

Kongsberg[2] (anal. 2) $2H_{o.r} = 117^\circ 26'$ $2H_{o.y} = 116^\circ 26'$ $\therefore$ $2V_{o.r} = 99^\circ 58'$ $\beta_r = 1{\cdot}636$ Dx.
" (other sections) $2H_{o.r} = 110^\circ 49', 117^\circ 18'$, $2H_{o.y} = 112^\circ 4'$, $2H_{o.bl} = 109^\circ 5', 111^\circ 5\frac{1}{2}'$

Franklin, N. C.[1] (anal. 1) section $\parallel a$ $2H_r = 87^\circ 31'$ $2H_y = 85^\circ 45'$ $2H_{gr} = 83^\circ 44$
" $\parallel c$ $2H_r = 87^\circ 24'$ $2H_y = 88^\circ 5'$ $2H_{gr} = 88^\circ 28'$

$\therefore$ $2V_r = 90^\circ 4'$ $2V_y = 88^\circ 46'$ $2V_{gr} = 87^\circ 28'$ and $\beta_r = 1{\cdot}6276$ $\beta_y = 1{\cdot}6353$ $\beta_{gr} = 1{\cdot}6495$
Also, measured $\beta_y = 1{\cdot}6301$ $\gamma_y = 1{\cdot}6404$ $\therefore$ $\alpha_y = 1{\cdot}6288$.

Gedrite from Fiskernäs is optically —. Axial angles and indices, Ussing[3]:

$2H_{a.r} = 89^\circ 24'$ $2H_{a.y} = 89^\circ 6'$ $2H_{a.gr} = 88^\circ 45'$
$\beta_r = 1{\cdot}6358$ $\gamma_r = 1{\cdot}6439$ $\therefore$ $\alpha_r = 1{\cdot}623$ $2V_r = 78\frac{1}{2}^\circ$.

**Comp., Var.**—$(Mg,Fe)SiO_3$, corresponding to enstatite-bronzite-hypersthene in the pyroxene group. Aluminium is sometimes present in considerable amount. There is the same relation in optical character between anthophyllite (+) and gedrite (—) as between enstatite and hypersthene.

**Var.**—1. ANTHOPHYLLITE, Mg : Fe = 4 : 1, 3 : 1, etc. For 3 : 1, the percentage composition is: Silica 55·6, iron protoxide 16·6, magnesia 27·8 = 100. In anal. 2, Mg : (Fe + Mn + Ca + $H_2$) = 3 : 1 nearly, the water is here chemically combined. Anthophyllite sometimes occurs in forms resembling asbestus.

In *Kupfferite*, the magnesia predominates largely; it thus seems to correspond more nearly to an enstatite; a little chromium gives it a deep green color.

2. *Aluminous*, GEDRITE. Iron is present in larger amount, and also aluminium; it hence corresponds nearly to a hypersthene, some varieties of which are highly aluminous (cf. anals., p. 350); the aluminium may be present as $MgAl_2SiO_6$. The gedrite from Bamle has $mm''' = 54^\circ 40'$ (Dx.), that of Fiskernäs, $mm''' = 55^\circ 12'{\cdot}4$ (Ussing).

*Thalackerite* Breith. is an anthophyllite from Greenland, having a metalloidal luster $\parallel b$. Optically +. $2H_{o.r} = 117^\circ 35'$ Dx., N. R., 32, 1867.

*Hydrous anthophyllites* have been repeatedly described, but in most cases they have been shown to be hydrated monoclinic amphiboles. That of Thomson, from New York Island, has been examined by Smith and Brush, Am. J. Sc., **16**, 49, 1853. Another from Glen Urquhart, Scotland, described by Heddle (Min. Mag., **4**, 213, 1881), is actinolite, as shown by Lcx., Bull. Soc. Min., **9**, 7, 1886.

A mineral regarded by Pisani as the *snarumite* of Breithaupt (5th Ed., p. 316) is probably a somewhat altered anthophyllite, cf. anal 13, and Dx., C. R., **84**, 1510, 1877. Another "snarumite" has a composition near spodumene, cf. Breith., Jb. Min., 820, 1872.

**Anal.**—1, Penfield, Am. J. Sc., **40**, 394, 1890. 2, Pisani, Dx. Min., **1**, 536, 1862. 3, Brezina, Min. Mitth., 247, 1874. 4, Heddle, Min. Mag., **3**, 21, 1879. 5, Hermann, l. c. 6, Pisani, L'Institut, 190, 1861. 7, Petersson, Öfv. Ak. Stockh., **39**, No. 10, 7, 1882. 8, Rosenius, Zs. Kr., **2**, 498, 1878. 9, Stadius, ibid. 10, Lechartier, Dx., N. R., 32, 1867. 11, Ussing, Öfv. Ak. Stockh., **46**, 29, 1889, Zs. Kr., **15**, 609, 1889. 12, 13, Pisani, C. R., **84**, 1510, 1877.

*Anthophyllite.*

| | G. | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | Alk. | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Franklin, N. C. | 3·093 | 57·98 | 0·63 | 10·39 | 0·31 | 28·69 | 0·20 | — | 1·67 ign (100°) 0·12 | = 99·99 |
| 2. Kongsberg | | 56·16 | 2·65 | 14·13 | 0·91 | 23·19 | 1·51 | — | 2·38 | = 100·93 |
| 3. Hermannschlag | | 57·39 | 2·04 | 6·53 | — | 29·08 | 0·69 | — | 2·56 $Fe_2O_3$ 0·42 | = 98·71 |
| 4. Scotland | 3·068 | 56·86 | 4·49 | 8·13 | 0·87 | 25·87 | 1·09 | — | 3·36 | = 100·67 |
| 5. Ilmen Mts., *Kupfferite* | 3·08 | 57·46 | 1·21[a] | 6·05 | 0·65[b] | 30·88 | 2·93 | *tr.* | 0·82 | = 100 |

*Gedrite.*

| | G. | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | Alk. | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6. Héas, Gèdres | $\frac{2}{2}$ | 43·17 | 16·80 | 18·56 | — | 15·73 | 1·32 | — | 4·21 | = 99·79 |
| 7. Hilsen | | 43·92 | 11·34 | 16·81 | 1·47 | 19·14 | 3·02 | — | 1·68 | = 97·38 |
| 8. Stansvik | 3·022 | 51·74 | 8·55 | 20·35 | 0·41 | 16·45 | 1·79 | — | — | = 99·29 |
| 9. " | 3·045 | 52·05 | 9·46 | 20·72 | 0·26 | 17·24 | 1·35 | — | — | = 101·08 |
| 10. "United States" | 3·225 | 46·74 | 13·70 | 28·09 | — | 8·76 | 0·77 | — | 1·90 | = 99·96 |
| 11. Fiskernäs | | 46·18 | 22·22[c] | 2·77 | — | 25·05 | — | 2·30[d] | 1·37 | = 99·89 |
| 12. Bamle | 2·98 | 51·80 | 12·40 | 3·67 | — | 27·60 | — | 1·44 | 3·00 | = 99·91 |
| 13. Snarum, *Snarumite* | | 57·90 | 13·55 | 1·90 | — | 19·40 | 0·87 | 4·50 | 2·86 | = 100·98 |

[a] $Cr_2O_3$. [b] NiO. [c] Incl. 0·44 $Fe_2O_3$. [d] $Na_2O$.

A "kupfferite" analyzed by Lorenzen from Greenland is shown by Ussing to be bronzite (anal. 5, p. 347).

**Pyr., etc.**—B.B. fuses with difficulty to a black magnetic enamel; with the fluxes gives reactions for iron; unacted upon by acids.

**Obs.**—Anthophyllite occurs in mica schist with hornblende and mica in thin and long plates and fibers near Kongsberg in Norway, and with gray cobalt near Modum; in the spherical mica aggregates at Hermannschlag, Moravia; probably in the gabbro of the Lizard, Cornwall (Teall). In the U. S., at the Jenks corundum mine, Franklin, Macon Co., N. C.

Named from *anthophyllum*, *clove*, in allusion to the clove-brown color, as Schumacher states.

*Kupfferite* is from a graphite mine in the Tunkinsk Mts., near L. Baikal. The analysis here given is from a mineral of similar kind from near Miask, in the Ilmen Mts. The former has not been analyzed. Koksharov has also found it near the Sanarka river, Ural. Named after the Russian crystallographer and physicist Adolf Kupffer (1799–1865).

The original *gedrite* is from the valley of Héas, near Gèdres, France, and contains microscopic black spinels (*picotite*). Similar aluminous anthophyllites have been observed in crystalline schists from other localities, as at Hilsen near Snarum, also Kragerö, Bamle, in Norway; Stansvik near Helsingfors, Finland (Sjögren); also Fiskernäs, Greenland.

**Ref.**—[1] Franklin, Macon Co., N. C., Am. J. Sc., **40**, 394, 1890. [2] N. R., 31, 1867. [3] Zs. Kr., **15**, 609, 1889.

Piddingtonite *Haidinger*, Ber. Ak. Wien, **41**, 251, 1860. The ash-gray mass of the meteorite of Shalka, in Bancoorah, consisting in part of grains having two easy cleavages inclined to one another 70°, with H. = 6·5; G. = 3·412 Haid., 3·66 Piddington; and fracture resinous, and containing small embedded grains of chromite. Hauer obtained: $SiO_2$ 57·66, $Al_2O_3$ *tr.*, FeO 20·65, MgO 19·00, CaO 1·53 = 98·84, which is nearly the composition of anthophyllite. The meteorite was first described by H. Piddington in the J. Asiat. Soc. Bengal, **20**, 299, 1852.

**338. AMPHIBOLE.** Skörl (= Schörl) pt. *Wall.*, 1747 (excluding Amiantus, Bergkork, etc., and Asbestus). Sköрl pt., Strälskörl (= Strahlstein) *Cronst.*, Min., 1758 (excl. Asbestus = Amianthus) and Bergkork, id. Hornblende *Wern.*, Bergm. J., 1789 (excl. Strahlstein and Asbest). Hornblende *Karst.*, Tab., 1791 (excl. Strahlstein, Tremolit, and Asbest). Id. (excl. also Smaragdit pt.) *Karst.*, Tab., 1800, 1808; id. *Ullmann*, 1814, and *Jameson*, 1817. Amphibole (incl. Actinote) *H.*, Tr., 1801 (excl. Grammatite = Tremolite and Asbeste). Amphibole (incl. Actinote and Grammatite) *H.*, Tabl., 1809 (excl. Asbeste). Heterotyp (incl. Asbestus, Bronzite, Hypersth., Anthoph. with other varieties) *Hausm.*, Handb., 1813. Hornblende *Jameson*, Syst., 1820 (excl. Actinolite, Tremolite, Asbestus, Carinthine). Amfibole, Orniblenda, *Ital.* Anfibola, Hornblenda, *Span.*

**Tremolite.** Tremolit *Pini*, *de Saussure*, Voy. Alpes, **4**, § 1923, 1796. Grammatite *H.*, Tr., **3**, 1801. Kalamit *Wern.*, Tasch. Min., **10**, 169, 1816. Calamite. Raphilite *Thom.*, Min., **1**, 153, 1836. Sebesit in Breith. Handb., 539, 1847. Nordenskiöldit, Kenng., Ber. Ak. Wien, **12**, 297, 1854. Hexagonite *Goldsmith*, Proc. Ac. Philad., 160, 1876.

**Actinolite.** Strälskörl pt. *Cronst.*, l. c. Strahlstein *Germ.* Actynolite *Kirw.*, Min., **1**, 167, 1794. Schorl vert du Zillerthal, Zillerthite, *Delameth.*, T. T., **2**, 357, 1797. Actinote *H.*, Tr., **3**, 1801.

NEPHRITE. Pietra di hijada [fr. Mexico or Peru] *Span.* Lapis nephriticus *A. Clutius*, Dissert., 1627; *C. Bartholinus*, Opusc., 1628; *de Boot*, Gemm., 1609. Lapis Indicus *Aldrovandus*, Met., p. 706. Talcum nephriticum *Linn.*, 1768. Jade, Pierre néphrétique, *d'Argenville*, Oryct. 186, 1755; *Sage, de Lisle, etc.* Nephrit *Wern.*, Ueb. Cronst., 185, 1780. Kidney Stone. Nierenstein, Beilstein, *Germ.* Cacholong pt.

ASBESTUS. 'Αμίαντος λίθος *Dioscor.*, **5**, 155. [Not ἀσβέστος [= Quicklime] *Dioscor.*, **5**, 133.] Asbestos, Linum vivum, Amiantus, *Plin.*, **19**, 4, **36**, 31. Lapis Carystius (fr. Carystum) *Pausanias.* Lana montana. Amiantus, Asbestus, *Agric.*, Foss., 253, 1546; *Wall.*, Min., 140, 143, 1747 (Caro montana or Bärgkött = Mountain leather, and Suber montanum or Bärgkoark = Mountain cork, being included). Asbestus, Amianthus, Carystine (= Mtn. leather and cork), *Hill*, Foss., 166, 1771. Kymatin *Breith.*, Uib. 1830, Char., 113, 1832. Byssolite (fr. Bourg d'Oisans) *Saussure*, Voy. Alpes, § 1696; Asbestöide (ib.) *Vauq. & Macquart*, Bull. Soc. Philom., No. 54, 1797; Amianthoide (ib.) *Delameth.*, T. T., **2**, 364, 1797.

SMARAGDITE *Saussure*, Voy. Alpes, **4**, §§ 1313, 1362, 1796. Diallage verte pt. *H.*, 1801; Green Diallage *pt.* Diallagon *Ullmann*, Tab., 90, 1814.

CUMMINGTONITE *Dewey*, Am. J. Sc., **8**, 59, 1824. Amphibole-Anthophyllite *Dx.*, N. R., 114, 1867. Antholite *Dana*, Min., 234, 1868.

DANNEMORITE (Jern-och-manganoxidulrik Hornblende *A. Erdmann*, Dannemora Jernm., 52, 1851. Dannemorit *Kenng.*, Ueb. 61, 1855, 1856). Asbeferrite *Igelström*, B. H. Ztg., **26**, 23, 1867. Silfbergit *Weibull*, Öfv. Ak. Stockh., **41**, No. 9, 24, 1884. Hillangsite *Igelström*, Bull. Soc. Min., **7**, 232, 1884; Hillängsite.

GRÜNERITE (Pyroxene ferrugineux (fr. Collobrières) *Grüner*, C. R., **24**, 794; Grünerit *Kenng.*, Min., 69, 1853).

**Richterite** *Breith.*, B. H. Ztg., **24**, 364, 1865. Breislakite *Brocchi*, Cat. di una raccolta di Rocce, 28, 60, 70, 192, 1817. Cyclopeïte *Dx.*, Min., **1**, 65, 1862.

**Hornblende**—

EDENITE. Edenit *Breith.*, Handb., 558, 1847. Kokscharowit *N. Nordenskiöld*, Bull. Soc. Nat. Moscow, **30**, 223, 1857.

PARGASITE. HORNBLENDE. Corneus fissilis pt., Corneus solidus pt., C. crystallisatus pt., Hornbärg, Skiörl pt., *Wall.*, Min., 138, 139, 1747. Sköri pt., Basaltes pt., Bolus particulis squamosis pt., *Cronst.*, 70, 82, 1758. Schorl opaque rhomboidal pt., Schorl argileux pt., *de Lisle*, Crist., **2**, 389 (pl. iv., f. 97, 99), 424, 1783. Basaltische Hornblende *Wern.*, Bergm. J., 1789 (incl. also augite). Basaltische H. (augite excl.) *Wern.*, 1792, and later; *Karst.*, Tab., 1800. Pargasit *Steinheil*, 1814, Tasch., Min., 301, 1815. Amphibolit *Breith.*, Char., 1823, Uib., 34, 1830. Diastatit (fr. Wermland) *Breith.*, Char., 134, 1832. Syntagmatit (fr. Vesuvius), Wallerian, *Breith.*, B. H. Ztg., **24**, 428, 1865.

Noralite *Dana*, Min., 236, 1868. Gamsigradite *Breith.*, B. H. Ztg., **20**, 51, 1861. Bergamaskite *Lucchetti*, Mem. Acc. Bologna, **2**, 397, 1881. Kaersutit *Lorenzen*, Medd. Grönland, **7**, 1884.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 0{\cdot}55108 : 1 : 0{\cdot}29376$; $\beta = 73° 58\frac{1}{4}' = 001 \wedge 100$ N. Nordenskiöld–Koksharov[1].

$100 \wedge 110 = 27° 54\frac{1}{2}'$, $001 \wedge 101 = 24° 4'$, $001 \wedge 011 = 15° 46'$.

**Forms**[2]:

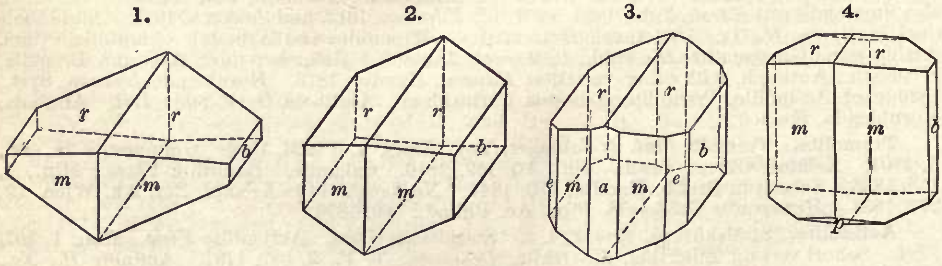
*a* $(100, i\text{-}\bar{\imath})$
*b* $(010, i\text{-}\grave{\imath})$
*c* $(001, O)$
*n* $(310, i\text{-}\bar{3})$
*q* $(210, i\text{-}\bar{2})$[3]
*δ* $(430, i\text{-}\frac{\bar{4}}{3})$[6]

*m* $(110, I)$
*e* $(130, i\text{-}\grave{3})$
*x* $(150, i\text{-}\grave{5})$[5]
*Y* $(170, i\text{-}\grave{7})$[5]
*t* $(101, -1\text{-}\bar{\imath})$
*p* $(\bar{1}01, 1\text{-}\bar{\imath})$

*h* $(\bar{5}03, \frac{5}{3}\text{-}\bar{\imath})$[3]
*l* $(\bar{2}01, 2\text{-}\bar{\imath})$
*f* $(\bar{3}01, 3\text{-}\bar{\imath})$[3]
*r* $(011, 1\text{-}\grave{\imath})$
*i* $(031, 3\text{-}\grave{\imath})$
*ρ* $(051, 5\text{-}\grave{\imath})$

*α* $(112, -\frac{1}{2})$
*d* $(\bar{1}11, 1)$
*β* $(\bar{3}32, \frac{3}{2})$
*P* $(\bar{2}21, 2)$[4]
*π* $(\bar{3}12, \frac{3}{2}\text{-}\bar{3})$[3]
*k* $(\bar{2}11, 2\text{-}2)$
*o* $(121, -2\text{-}\grave{2})$

*v* $(\bar{2}31, 3\text{-}\frac{\grave{3}}{2})$
*z* $(\bar{1}21, 2\text{-}\grave{2})$
*g* $(\bar{2}51, 5\text{-}\frac{\grave{5}}{2})$[3]
*u* $(\bar{1}31, 3\text{-}\grave{3})$[4]
*s* $(\bar{1}41, 4\text{-}\grave{4})$
*y* $(\bar{2}{\cdot}10{\cdot}1, 10\text{-}\grave{5})$[4]



Figs. 1–3, Russell, N. Y. 4, Pierrepont, N. Y. Penfield.

$nn''' = 20^\circ\ 1\frac{1}{2}'$
$qq''' = 29^\circ\ 40'$
$mm''' = {}^*55^\circ\ 49'$
$ee' = 64^\circ\ 22'$
$xx' = 41^\circ\ 22'$
$YY' = 30^\circ\ 11'$

$at = 49^\circ\ 54'$
$cp = 31^\circ\ 0'$
$cl = 55^\circ\ 27'$
$cf = 70^\circ\ 2'$
$ph = 17^\circ\ 32'$
$pf = 39^\circ\ 2'$
$pt = 55^\circ\ 4'$

$rr' = {}^*31^\circ\ 32'$
$ii' = 80^\circ\ 32'$
$\rho\rho' = 109^\circ\ 22\frac{1}{2}'$

$cm = 75^\circ\ 52\frac{1}{2}'$
$cd = 34^\circ\ 27'$
$cP = 58^\circ\ 54'$
$ck = 56^\circ\ 25'$
$co = 33^\circ\ 37'$
$cv = 62^\circ\ 3'$

$ar = 74^\circ\ 35'$
$a\rho = 80^\circ\ 49'$
$a'd = 75^\circ\ 37'$

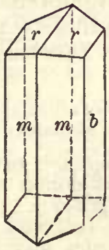
$a'\pi = 61^\circ\ 41'$
$a'k = 51^\circ\ 44'$
$ao = 54^\circ\ 1\frac{1}{2}'$
$a'z = 77^\circ\ 1'$
$a'g = 65^\circ\ 10\frac{1}{2}'$

$dd' = 31^\circ\ 41'$
$kk' = 25^\circ\ 34'$
$PP' = 48^\circ\ 49\frac{1}{2}'$
$oo' = 48^\circ\ 24'$
$vv' = 68^\circ\ 30'$
$zz' = 59^\circ\ 9\frac{1}{2}'$
$gg' = 97^\circ\ 13'$
$ss' = 97^\circ\ 15'$

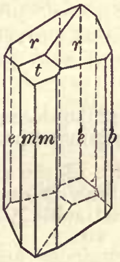
$m'k = 49^\circ\ 24'$
$mr = 68^\circ\ 46\frac{1}{2}'$
$mo = 44^\circ\ 41'$

$pr = {}^*34^\circ\ 25'$
$p\pi = 15^\circ\ 26'$
$pk = 27^\circ\ 25'$
$pm' = 76^\circ\ 48\frac{1}{2}'$
$pr = {}^*34^\circ\ 25'$
$po = 58^\circ\ 30\frac{1}{2}'$
$pv = 41^\circ\ 12'$
$pi = 49^\circ\ 9'$
$p\rho = 60^\circ\ 18'$

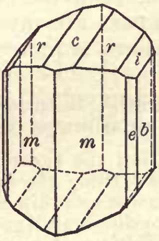
**5.**



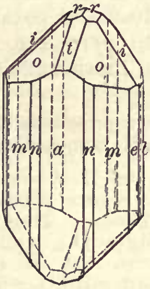
**6.**



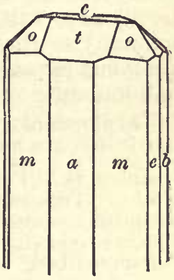
**7.**



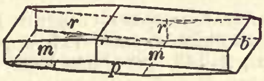
**8.**



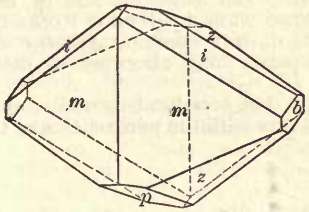
**9.**



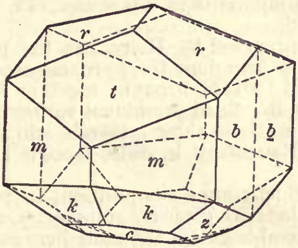
**10.**



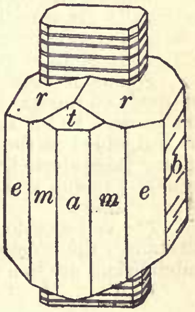
**11.**



**12.**



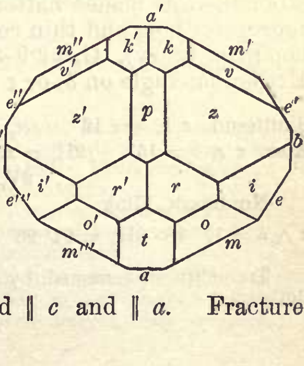
**13.**



Figs. 5–7, 11, Russell, N. Y. 8, 9, Pierrepont, N. Y. 10, Rossie, N. Y. 12, DeKalb, N. Y. Figs. 5–12, Penfield. 13, A dark green amphibole enclosing, in parallel position, a pale green pyroxene, Russell, N. Y., G. H. Williams.

Twins[7]: (1) tw. pl. *a*, common as contact-twins; rarely polysynthetic[4]. (2) *c*, as tw. lamellæ, occasionally producing a parting analogous to that more common with pyroxene (f. 13). Crystals commonly prismatic, with *m* short (f. 1, 2), or elongated (f. 5, etc.); usually terminated by the low clinodome, *r*, sometimes by *r* and *p* equally developed and then suggesting rhombohedral forms (as of the low terminal rhombohedron of tourmaline), since the angles *rr'* and *pr* approximate to each other; the form *a* not very common. Also columnar or fibrous, coarse or fine, fibers often like flax; rarely lamellar; also granular massive, coarse or fine, and usually strongly coherent, but sometimes friable.

**14.**



Cleavage: *m* highly perfect; *a*, *b* sometimes distinct. Parting, due to twinning, sometimes observed ∥ *c* and ∥ *a*. Fracture subconchoidal, uneven. Brittle. H. = 5–6. G. = 2·9–3·4, varying with the composition. Luster vitreous to pearly on cleavage-faces; fibrous varieties often silky. Color between black and white, through various shades of green, inclining to blackish green; also dark brown, rarely yellow, pink, rose-red. Streak uncolored, or paler than color. Sometimes nearly transparent; usually subtranslucent to opaque.

Pleochroism strongly marked in all the deeply colored varieties, as described beyond. Absorption usually $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$. Optically $-$, rarely $+$. Ax. pl. ∥ *b*. Extinction-angle on *b*, or $\mathfrak{c} \wedge \dot{c} = +15°$ to $18°$ in most cases, but varying from about 0° up to 37°; hence also $Bx_a \wedge \dot{c} = -75°$ to $-72°$, etc. Dispersion $\rho < v$. Axial angles, variable; see under the varieties below.

**Comp., Var.**—In part a normal metasilicate of calcium and magnesium, usually with iron, also manganese, and thus in general analogous to the pyroxenes. The alkali metals, sodium and potassium (and hydrogen), also present, and more commonly so than with pyroxene. In part also aluminous, corresponding to the aluminous pyroxenes. Titanium sometimes is present and also rarely fluorine in small amount.

The aluminium is in part present as $NaAl(SiO_3)_2$, but many amphiboles containing aluminium or ferric iron are more basic than a normal metasilicate; they may sometimes be explained as containing $\overset{II}{R}(Al,\overset{III}{Fe})_2SiO_6$ (cf. Tschermak)[8]; but the exact nature of the compound is often doubtful. Tschermak has shown reason for writing the amphibole formulas as double the corresponding ones for pyroxene. Thus, for most tremolite and actinolite, Ca : Mg(Fe) = 1 : 3, and hence tremolite is $CaMg_3Si_4O_{12}$, while diopside is $CaMgSi_2O_6$, etc.

Rammelsberg has shown that the composition of most aluminous amphiboles may be expressed in the general form $m RSiO_3 . n Al_2O_3$. While Scharizer, modifying this view, proposes to regard the amphiboles as molecular compounds of $Ca(Mg,Fe)_3Si_4O_{12}$ (actinolite), and the orthosilicate $(\overset{I}{R}_2,\overset{II}{R})_3\overset{III}{R}_2Si_3O_{12}$, for which he uses Breithaupt's name *syntagmatite* (syntagmit Rg.), originally given to the Vesuvian hornblende. The Jan Mayen amphibole, anal. 117, approximates in composition to syntagmatite in this sense. Cf. Jb. Min., **2**, 143, 1884, also Rg., Min. Ch., Erg., p. 37 *et seq.*, 1886.

The name *amphibole*, proposed by Haüy, has the precedence, because Haüy first rightly appreciated the species, as he had done for pyroxene, and gave it, and not any of its varieties, the name. In his Traité, in 1801, he brought together *hornblende* and *actinolite;* and by 1809 he had added to the group the third prominent variety, *tremolite;* while in all other works not taking their views from him, these three minerals still stood as distinct species. *Asbestus* was annexed to the series by Hausmann in 1813, though kept separate long afterward by many other authors.

The varieties depend chiefly upon composition; in part also, but less fundamentally, upon structure; the prominent kinds are properly sub-species, as was true with the pyroxenes, and the subdivisions are to a considerable extent the same here as there.

## I. *Containing little or no Aluminium.*

TREMOLITE. Grammatite, nephrite pt. *Calcium-magnesium amphibole.* Formula $CaMg_3Si_4O_{12}$ = Silica 57·7, magnesia 28·9, lime 13·4 = 100. Ferrous iron, replacing the magnesium, is present only sparingly, up to 3 p. c. Colors white to dark gray. In distinct crystals, either long-bladed or short and stout; often in thin blades flattened ∥ $\dot{b}$ by the oscillatory repetition of the prism. In aggregates long and thin columnar, or fibrous; also compact granular massive (see nephrite, below). G.=2·9–3·1. Sometimes transparent and colorless. Optically $-$. Extinction-angle on *b*, or $\mathfrak{c} \wedge \dot{c} = +16°$ to $18°$, hence $Bx_a \wedge \dot{c} = -74°$ to $-72°$.

**Skutterud** $\mathfrak{c} \wedge \dot{c} = 16°$ $\alpha_y = 1·6065$ $\beta_y = 1·6233$ $\gamma_y = 1·6340$ $2V_y = 81° 22'$ **Pfd**
**Also** $\mathfrak{c} \wedge \dot{c} = 15°$ $2H_r = 99°–100°$ $2H_y = 100°–101°$ $\beta_r = 1·620$ $\beta_y = 1·622$
$\therefore$ $2V_r = 87° 22'$ $2V_y = 88° 16'$ **Dx.**

**Nordmark, Flink:**

$\mathfrak{c} \wedge \dot{c} = 17° 18'$ $2H_y = 94° 26'$ $\beta_r = 1·616$ **Li** $\beta_y = 1·618$ **Na** $\beta_{gr} = 1·620$ **Tl** $\therefore$ $2V_y = 84° 9'$

Tremolite was named by Pini from the Tremola valley on the south side of the St. Gothard.

*Grammatite* (from γραμμή, *a line*) alludes to a line in the direction of the longer diagonal seen by Haüy on transverse sections of some crystals. It was substituted for tremolite by Haüy, without reason, and does not deserve recognition.

*Nordenskiöldite*, from Ruscola, near Lake Onega, is tremolite.

*Raphilite*, from Lanark in Canada, is probably also tremolite.

*Hexagonite* from Edwards, St. Lawrence Co., N. Y., is a pink tremolite containing a small amount of manganese (anals. 12, 13); it was described as hexagonal, but its true character was shown by Koenig.

Some *nephrite* and *asbestus* (see below) belong here.

ACTINOLITE. Strahlstein *Germ*. *Calcium-magnesium-iron amphibole*. Formula $Ca(Mg,Fe)_3Si_4O_{12}$. Color bright green and grayish green. In crystals, either short- or long-bladed, as in tremolite; columnar or fibrous; granular massive. G. = 3–3·2. Sometimes transparent. The variety in long bright-green crystals is called *glassy actinolite;* the crystals break easily across the prism. The fibrous and radiated kinds are often called *asbestiform actinolite* and *radiated actinolite*. Actinolite owes its green color to the ferrous iron present.

Pleochroism distinct, increasing as the amount of iron increases, and hence the color becomes darker: $\mathfrak{c}$ emerald-green, $\mathfrak{b}$ yellow-green, $\mathfrak{a}$ greenish yellow. Absorption $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$ Zillerthal, Tschermak. Optically —. Extinction-angle on $b$ or $\mathfrak{c} \wedge \dot{c} = +15°$ and $Bx_a \wedge \dot{c} = -75°$. Axial angles, Dx.:

St. Gothard $2H_{a.r} = 90°$ to $91°$ $\beta_r = 1·626$ $2V_r = 79° 38'$
" " $2H_{a.y} = 91°$ $\beta_y = 1·629$ $2V_y = 80° 4'$
Zillerthal $\alpha_y = 1·611$ $\beta_y = 1·627$ $\gamma_{gr} = 1·636$ $\gamma - \alpha = 0·025$ Lévy-Lcx.

Named actinolite from ἀκτίν, *a ray*, and λίθος, *stone*, a translation of the German *Strahlstein* or *radiated stone*. Name changed to *actinote* by Haüy, without reason.

NEPHRITE. Jade pt. Cacholong pt. A tough, compact, fine-grained tremolite (or actinolite), breaking with a splintery fracture and glistening luster. H. = 6–6·5. G. = 2·96–3·1. Named from a supposed efficacy in diseases of the kidney, from νεφρός, *kidney*. It varies in color from white (tremolite) to dark green (actinolite), in the latter iron protoxide being present up to 6 or 7 p. c. The latter kind sometimes encloses distinct prismatic crystals of actinolite (anal. 40). A derivation from an original pyroxenic mineral has been suggested in some cases (Arzruni, Traube).

Nephrite or jade was brought in the form of carved ornaments from Mexico or Peru soon after the discovery of America. Del Rio, in his Mexican Mineralogy (1795), mentions no Mexican locality. A similar stone comes from Eastern Asia, New Zealand, and Alaska as noted beyond. See also pp. 371, 397.

ASBESTUS. Asbestos. Asbest *Germ*. Tremolite, actinolite, and other varieties of amphibole, excepting those containing much alumina, pass into fibrous varieties, the fibers of which are sometimes very long, fine, flexible, and easily separable by the fingers, and look like flax. These kinds are called *asbestus* (fr. the Greek for *incombustible*). Pliny supposed it a vegetable product, although good for making *incombustible* cloth, as he states. The amianthus of the Greeks and Latins was the same thing; the word meaning *undefiled*, and alluding to the ease of cleaning the cloth by throwing it into the fire. The colors vary from white to green and wood-brown. The name *amianthus* is now applied usually to the finer and more silky kinds. Much that is called asbestus is *chrysotile*, or fibrous serpentine (Serpentinasbest *Germ.*), it containing 12 to 14 p. c. of water, see p. 670.

Friederici has described varieties of asbestus in which alkalies are prominent (anals. 84, 85); one was blue in color and resembled crocidolite.

An asbestiform mineral from Franklin Furnace, N. J., has been analyzed by Koenig; he gives: 4·8 p. c. MnO, 4·6 ZnO (also 1·70 MnO, 7·10 ZnO in another sample), Proc. Ac. Philad., 47, 1887. Some other asbestiform amphiboles are noted below. It is possible that some asbestus may properly belong to the pyroxene group; cf. ægirite, p. 366, and crocidolite, p. 400.

The following are related to asbestus:

*Mountain leather* is in thin flexible sheets, made of interlaced fibers; and *mountain cork* (Bergkork) the same in thicker pieces; both are so light as to float on water, and they are often hydrous, color white to gray or yellowish. *Mountain wood* (Bergholz, Holzasbest, *Germ.*) is compact fibrous, and gray to brown in color, looking a little like dry wood.

*Byssolite* (Amianthoid, asbestoid) fr. Bourg d'Oisans in Dauphiny, is of an olive-green color, coarse and stiff fibrous; it is stated to contain a considerable amount of manganese. The name is often given to similar varieties of amphibole, not necessarily manganesian.

SMARAGDITE. A thin-foliated variety of amphibole, near actinolite in composition but carrying some alumina. It has a light grass-green color, resembling much common green diallage. As early urged by Rose it has at least in many cases been derived from pyroxene (diallage) by uralitization, see uralite, below. It retains much of the structure of the diallage and also often encloses remnants of the original mineral. It forms, along with whitish or greenish saussurite, a rock called saussurite-gabbro, the euphotide of the Alps. The original mineral is from Corsica, and the rock is the *corsilyte* of Pinkerton, and the *verde di Corsica duro* of the arts.

Uralite *Rose*, Pogg., **22**, 321, 329, 1831; **27**, 97, 1833; **31**, 609, 1831. Traversellite pt. Pyroxene altered to amphibole. The crystals, when distinct, retain the form of the original mineral, but have the cleavage of amphibole. The change usually commences on the surface, transforming the outer layer into an aggregation of slender amphibole prisms, parallel in position to each other and to the parent pyroxene. When the change is complete the entire crystal is made up of a bundle of amphibole needles or fibers. The color varies from white (tremolite), as in the Canaan, Conn., crystals, to pale or deep green, the latter the more common. In composition uralite appears to conform nearly to actinolite, as also in optical characters (Dx.). The most prominent change in composition in passing from the original pyroxene (cf. anals. below) is that corresponding to the difference existing between the two species in general, that is, an increase in the magnesium and decrease in calcium The change, therefore, is not strictly a case of paramorphism, although usually so designated.

Uralite was originally described by Rose from a green porphyritic rock at Mostovaya, near Ekaterinburg, and at Kaminskaya, near Miask, in the Ural. It has since been observed from many localities. The microscopic study of rocks has shown the process of "uralitization" to be very common, and some authors regard many hornblendic rocks and schists to represent altered pyroxenic rocks on a large scale. The following (1, 2, 5, 7, 9) are analyses of uralite: 1, Rath, Pogg., **95**, 558, 1855. 2, Rg., Min. Ch., 421, 1875; also Kudernatsch, Pogg., **37**, 586, 1836. Analyses 3–5, by Harrington (Geol. Canada, p. 21, 1879), give the composition of the glassy green central portion of a pyroxene crystal (3); of the dull gray zone surrounding this (4); and finally of the amphibole forming the exterior (5). 6, 7 are analyses by Richter and Scheerer (Pogg., **84**, 383, 1851) of the diopside (6) from Reichtenstein and of a fibrous actinolite (7) derived from it. 8, 9, by Dahms (Jb. Min., Beil., **7**, 99, 1890), show the change of composition from the original diallage (8) to the resulting amphibole (9). 10, 11, by Rammelsberg (Ber. Ak. Berlin, 243, 1862), give the composition of diopside (10) and tremolite (11) associated together in granular limestone at Gulsjö, Wermland, Sweden, the latter apparently derived from the former.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | ign. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Neurode | 3·273 | $\frac{2}{2}$ 48·70 | 0·82 | — | 25·21 | — | 12·01 | 11·25 | *tr.* | | 1·01= 99·00 |
| 2. L. Baltym | 3·143 | 50·75 | 5·65 | — | 16·48 | 0·79 | 12·28 | 11·59 | — | — | 1·80= 99·34 |
| 3–5, Templeton, Quebec. | | | | | | | | | | | |
| 3. *Pyroxene* | 3·181 | 50·87 | 4·57 | 0·97 | 1·96 | 0·15 | 15·37 | 24·44 | 0·22 | 0·50 | 1·44=100·49 |
| 4. " | 3·205 | 50·90 | 4·82 | 1·74 | 1·36 | 0·15 | 15·27 | 24·39 | 0·08 | 0·15 | 1·20=100·06 |
| 5. *Uralite* | 3·003 | 52·82 | 3·21 | 2·07 | 2·71 | 0·28 | 19·04 | 15·39 | 0·90 | 0·69 | 2·40= 99·51 |
| 6. 7, Reichenstein. | | | | | | | | | | | |
| 6. *Diopside* | | 54·50 | 1·10 | — | 3·00 | — | 18·96 | 21·41 | — | — | 1·19=100·16 |
| 7. *Uralite* | | 55·85 | 0·56 | — | 5·22 | 0·40[a] | 23·99 | 11·66 | — | — | 2·15= 99·83 |
| 8, 9, Zwartkoppies, Transvaal, S. Africa. | | | | | | | | | | | |
| 8. *Diallage* | | $\frac{5}{5}$ 53·53 | 3·12 | 5·09 | 13·54 | — | 18·77 | 6·19 | 0·57 | 0·20 | — =101·01 |
| 9. *Uralite* | 3·038 | $\frac{4}{4}$ 52·73 | 4·70 | 5·26 | 10·21 | — | 12·59 | 12·58 | 0·23 | 0·06 | 1·54= 99·90 |
| Gulsjö, Wermland. | | | | | | | | | | | |
| 10. *Diopside* | 3·249 | 55·11 | — | — | 0·54 | — | 18·39 | 25·63 | — | — | — = 99·67 |
| 11. *Tremolite* | 3·003 | 57·62 | — | — | 0·84 | — | 26·12 | 14·90 | — | — | — = 99·48 |

[a] CuO

It is interesting to compare in this connection the analyses of green pyroxene (anal. 68, p. 360) and amphibole (anal. 112, p. 396) associated in parallel position at Vesuvius by Rath; also of a similar occurrence by Hawes, from Edenville, anal. 32, p. 359, and anal. 108, p. 396.

Cummingtonite. Amphibole-Anthophyllite. *Iron-Magnesium-Amphibole.* Des Cloizeaux has used the name amphibole-anthophyllite for certain varieties of amphibole resembling anthophyllite and essentially identical with it in composition, but optically proved to be monoclinic. For that from Kongsberg (anal. 89) he finds $mm''' = 54° 48'$, and $\mathfrak{c} \wedge \dot{c} = 15°$ to $16°$. Also:

$$2H_{o.r} = 120° 43\tfrac{1}{2}' \quad 2H_{o.y} = 120° 2\tfrac{1}{2}' \quad 2H_{o.bl} = 118° 31\tfrac{1}{2}' \quad \beta_r = 1·638 \quad \therefore \quad 2V_a = 77° 52'$$

For that from Greenland (anal. 90) $\mathfrak{c} \wedge \dot{c} = 16°$ to $17°$:

$$2H_{o.r} = 119° 43' \quad 2H_{o.bl} = 118° 22'. \quad \text{Also } 2H_{o.r} = 119° 27' \quad 2H_{o.bl} = 117° 24'.$$

The original *cummingtonite* is nearly the same, but contains more iron and less magnesium (anal. 92, 93). It is gray to brown in color; usually fibrous or fibro-lamellar, often radiated. G. = 3·1–3·32. Named from the locality, Cummington, Mass. The name has also been used for a partially altered rhodonite, which Hermann erroneously called a "Mangan-amphibol."

*Antholite.* This name (Kenng., Ueb., 6, 1859, 1860; Dana, Min., 5th Ed., p. 234) has been used for certain asbestiform amphiboles containing 26 to 31 p. c. MgO and 12·6 to 9 p. c. FeO without lime and alumina. Cf. anals. 31–33, 5th Ed., p. 237.

**DANNEMORITE.** *Iron-Manganese Amphibole.* Color yellowish brown to greenish gray. Columnar or fibrous, like tremolite and asbestus. Contains iron and manganese. In thin pieces B.B. fuses to a dark slag.

*Asbeferrite* of Igelström is similar; it is grayish white to ash-gray, and like a gray asbestus; in acids not soluble (anal. 95).

*Silfbergite.* Like amphibole in form, cleavage, and twinning (∥ *a*). H. = 5·5. G. = 3·446. Color dark yellow to brownish gray. Pleochroism distinct. Extinction-angle on *b*, 13° 45′. Shown by Bertrand to belong here with also the following mineral. From Vester Silfberg, Wermland, Sweden. See anal. 96.

*Hillängsite.* Near dannemorite, cf. anal. 97. Resembles anthophyllite. Optically −. Occurs with garnet, magnetite, and igelströmite at the iron mine of Hilläng, parish of Ludvika, Dalarne, Sweden.

**GRÜNERITE.** *Iron-Amphibole.* Asbestiform or lamellar-fibrous. Luster silky; color brown; G. = 3·713. Formula $FeSiO_3$. Optical properties those of amphibole, according to Des Cloizeaux (Min., 1, 59, 1862). Lévy-Lcx. give the extinction-angle as 11° to 15°. Pleochroism feeble. Occurs in metamorphic schists in the Dept. du Var, France. Grüner's analysis gave: $SiO_2$ 43·9, $Al_2O_3$ 1·9, FeO 52·2, MgO 1·1, $H_2O$ 0·5 = 99·6. This amphibole needs further study.

**RICHTERITE.** *Sodium-Magnesium-Manganese Amphibole.* In elongated crystals, seldom terminated. Observed forms, Långban:

*a, b, c, n, m, e, p, r, o, z, k*? (cf. p. 386). Measured angles: *mm‴* = 56° 7′, *rr′* = 31° 18′, *mr* = 68° 29′, *mp* = 77° 28′. See Flink, Ak. H. Stockh., Bihang, 13 (2), No. 7, 82, 1888.

G. = 3·09. Color brown, yellow, rose-red. Transparent to translucent. $\mathfrak{c} \wedge \dot{c} = +17°$ Flink, 20° and $\beta_y = 1·63$ Lévy-Lcx.

From Pajsberg and Långban, Sweden. Characterized by the presence of manganese and alkalies in relatively large amount. See anals. 98, 99. Michaelson gave for a Långban amphibole, with G. = 3·09, Öfv. Ak. Stockh., 20, 197, 1863:

$SiO_2$ 54·15 $Al_2O_3$ 0·52 $Fe_2O_3$ 1·77 FeO 2·80 MnO 5·09 MgO 20·18 CaO 6·06 $Na_2O$ 2·77
[$K_2O$ 6·37 ign. 0·12 = 99·83

The above is the richterite of Igelström and Flink. The character of the original mineral named by Breithaupt is doubtful. Breithaupt describes it as occurring in acicular crystals, affording the prismatic angle 46° 22′; with G. = 2·826; color isabella-yellow, rarely pale yellowish brown; B.B. very fusible. See ASTOCHITE, p. 1027.

**MARMAIROLITE** *N. O. Holst*, G. För. Förh., 2, 530, 1875. In very fine crystalline needles. H. = 5. G. = 3·07. Color pale yellow. Powder white. Transparent. Analysis (mean of several):

$SiO_2$ 56·27 FeO 2·03 MnO 4·86 MgO 21·36 CaO 6·33 $K_2O$ 1·89 $Na_2O$ 5·94 ign. 0·90=99·58

Formula approximately $RSiO_3$. B.B. fuses with some difficulty to an opaque bead. Not attacked by acids. Occurs with schefferite in a brownish manganesian limestone (containing 6·56 MnO and 1·35 PbO) at Långban, Wermland, Sweden. Named from *μαρμαίρειν, to glisten.* Groth suggests that this may be a massive form of richterite.

*Breislakite.* Occurs in wool-like forms at Vesuvius and Capo di Bove. It was made a variety of pyroxene by Chapman (Phil. Mag., 37, 444, 1850), but Lasaulx (Jb. Min., 380, 1878) shows that it has the form and optical characters of amphibole. The color is dark brown to black, and the pleochroism strongly marked. Blowpipe tests prove the presence of iron and, in less amount, of manganese, hence it is inferred that it may belong near richterite. Named after S. Breislak, an Italian geologist (1748–1826).

### II. *Aluminous.*

**ALUMINOUS AMPHIBOLES.** Contain alumina or ferric iron, and usually both, with ferrous iron (sometimes manganese), magnesium, calcium, and alkalies. The kinds here included range from the light colored *edenite,* containing but little iron, through the light to dark green *pargasite,* to the dark colored or black *hornblende,* the color growing darker with increase in amount of iron. Extinction-angle variable, from 0° to 37°, see below. Pleochroism strong. Absorption usually $\mathfrak{c} < \mathfrak{b} < \mathfrak{a}$.

**EDENITE.** *Aluminous Magnesium-Calcium Amphibole.* Color white to gray and pale green, and also colorless; G. = 3·0–3·059. Resembles anthophyllite and tremolite. Named from the locality at Edenville, N. Y. To this variety belong various pale-colored amphiboles, having less than 5 p. c. of iron oxides.

*Koksharovite* is a variety from the neighborhood of L. Baikal named after the Russian mineralogist, N. von Koksharov. See anal. 105.

PARGASITE and COMMON HORNBLENDE. Colors bright or dark green, and bluish green to grayish black and black. G. = 3·05–3·47. *Pargasite* is usually made to include green and bluish-green kinds, occurring in stout lustrous crystals, or granular; and *common hornblende* the greenish black and black kinds, whether in stout crystals or long-bladed, columnar, fibrous, or massive granular. But no line can be drawn between them. The extinction-angle on *b*, or $\mathfrak{c} \wedge \dot{c} = +18°$ to 20° chiefly. Pargasite occurs at Pargas, Finland, in bluish green and grayish black crystals. The dark brown to black hornblendes from basaltic and other igneous rocks vary somewhat widely in optical characters, the angle $\mathfrak{c} \wedge \dot{c} = 0°$ to $+10°$ chiefly. They carry both aluminium and ferric iron and also alkalies.

The following table (Tschermak *et al.*) shows the variation in optical characters for the amphiboles embraced here; cf. observations on tremolite and actinolite already given, pp. 388, 389.

| | Optical character and extinction-angle on *b* | | Axial angles | | | Pleochroism | | |
|---|---|---|---|---|---|---|---|---|
| | | $\mathfrak{c} \wedge \dot{c}$ | | | | $\mathfrak{c}$ | $\mathfrak{b}$ | $\mathfrak{a}$ |
| *Pargasite* | + | +18° | $2E_r=107° 30'$ | $\beta=1·64$ | $2V=59°$ | grn.-blue | emd.-grn. | grn.-yw. |
| *Common Hornblende.* | | | | | | | | |
| Volpersdorf | + | 19° 53' | | $\beta_r=1·642$ | $2V_r=85° 4'$ | brown | yellow | yw.-grn. |
| Saualpe | | | | | | | | |
| *Karinthin* | | 17° | | | | grn.-brn. | yw.-brn. | yw.-grn. |
| Franklin, N. J. | | 17° 15' | | | | blue grn. | yw.-grn. | hny.-yw |
| Arendal, *blk.* | | 17° 30' | | | | blk.-brn. | brn.-yw. | blk.-brn. |
| Nordmark | | 12° 34' | | | | | | |
| *Basaltic Hornblende.* | | | | | | | | |
| Jan Mayen | | 0° | | | | orange | orange | black |
| Czernosin | − | 1° 40' | $2H_r= 93° 24'$ | $\beta=1·71$ | $2V_r=79° 24'$ | blk.-brn. | brn.-red | hny.-yw. |
| Aranyer Berg | | 37° 12' | $2E_y= 67° 37'$ | $2H_y=51°·3$ | | grn.-brn. | yw.-brn. | olive-grn. |
| *Gamsigradite* | | 30° | | | | grn.-yw. | yellowish | btl.-grn. |

Wiik obtained for a light green variety (15 to 16 p. c. $Al_2O_3$) $\mathfrak{c} \wedge \dot{c} = 26° 30'$, and for a similar one from Korpo (20 p. c. $Al_2O_3$) $\mathfrak{c} \wedge \dot{c} = 27° 30'$; a black variety from Pargas (12 p. c. $Al_2O_3$) gave 24° 30'. Black hornblende from Sillböle, Finland (4·98 $Al_2O_3$), gave him $\mathfrak{c} \wedge \dot{c} = 18° 30'$.

*Noralite* (5th Ed., p. 236) is a black aluminous iron-calcium amphibole in which magnesium is nearly absent. Anal. 120. From Nora, Westmanland, Brevik, Norway, etc.

*Gamsigradite* contains manganese in considerable amount, anal. 121. Color velvet-black. G. = 3·12. For optical characters see above, and Lcx., Bull. Soc. Min., **10**, 147, 1887. Named from the locality, Gamsigrad in Servia, where it forms with white feldspar a rock called *timazyte*. An amphibole from Franklin Furnace examined by Kloos (anal. 122) belongs near here in composition; it contains both manganese and zinc. G. = 3·352. Color dark leek-green. Optical characters, see above.

*Mangan-amphibol* of Hermann (Cummingtonite *Rammelsberg*, and Hermannite *Kenngott*) is nothing but rhodonite of Cummington, Mass., erroneously analyzed. The error is perpetuated by Rg., Min. Ch., 1875, and Groth, Tab. Ueb., 1889.

*Diastatite* is a black hornblende from Nordmark in Wermland, stated by Breithaupt to have $mm''' = 59° 40'$, and G. = 3·08–3·11.

*Syntagmatite* is the black hornblende of Vesuvius, analyzed by Rammelsberg (anal. 110), in which he found $mm''' = 55° 52'$, G. = 3·272. For Scharizer's use of this name, see p. 388.

Breithaupt has also introduced other names (as *Amphibolus ferrosus*, *A. basalticus*, *A. saxosus*, etc.). His *A. Wallerianus*, or Wallerian, is a black hornblende from Nordmark, supposed to be triclinic. The amphibole from the Saualpe, Carinthia, is *A. Carinthinus* or Carinthine (Karinthin), etc.

*Bergamaskite* is an iron-amphibole containing almost no magnesia. It occurs in a quartzose hornblende-porphyry, from Monte Altino, Province of Bergamo, Italy. Forms acicular crystals, vertically striated, and arranged in parallel or radiated groups; cleavage prismatic, 56°. G. = 3·075. See anal. 123.

*Kaersutite* is a titaniferous amphibole from Kaersut, Umanaks fiord, North Greenland, occurring in a chrysolitic rock. Crystals prismatic, $mm''' = 55° 29'$. G. = 3·04. Color black, brownish by reflected light, streak chocolate-brown. Peculiar in containing a large amount of titanium, anal. 124.

The following analyses, largely recent, exhibit the composition of the various kinds of amphibole from the important localities. Additional (older) analyses are given in 5th Ed., pp. 236 to 239; also Rg., Min. Ch., 1860 and 1875. Cf. also Heddle, Trans. R. Soc., Edinburgh, **28**, 502 *et seq.*, 1878.

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I. *Containing little or no Alumina.*

| | | G. | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | TREMOLITE. | | | | | | | | | |
| 1. | St. Gothard | 3·027 | 58·40 | 0·56 | 0·26 | — | 24·82 | 13·63 | 1·85 | = 99·52 |
| 2. | Gulsjö | 3·003 | 57·62 | — | 0·84 | — | 26·12 | 14·90 | — | = 99·48 |
| 3. | Sweden | 2·930 | 58·87 | 1·77 | *tr.* | — | 28·19 | 11·00 | 0·18 | = 100·01 |
| 4. | Gouverneur | 3·000 | 57·40 | 0·38 | 1·36 | — | 25·69 | 13·89 | 0·40 | = 99·12 |
| 5. | Greenland | 3·004 | 54·71 | — | 2·41 | — | 23·92 | 15·06 | 3·33 | = 99·43 |
| 6. | St. Gothard | 2·930 | 58·80 | 0·31 | 3·00 | — | 24·12 | 12·22 | 1·20 | = 99·65 |
| 7. | Pierrepont, *brown* | | 56·44 | 2·61[a] | 0·73 | 0·11 | 22·98 | 11·83 | 2·46 | $Na_2O$ 2·13, $K_2O$ 0·75, [$TiO_2$ 0·11 = 100·15 |
| 8. | Russell, *green* | | 56·54 | 1·79[b] | 2·36 | — | 24·42 | 13·69 | — | $Na_2O$ 1·15 = 99·95 |
| 9. | Chejnon | | 57·74 | 1·85 | 0·34 | — | 25·47 | 12·71 | — | = 100·11 [= 100·02 |
| 10. | Sutherland | 2·964 | 56·15 | 1·48[c] | 0·72 | 0·07 | 24·14 | 13·31 | 2·50 | $Na_2O$ 0·21, $K_2O$ 0·44 |
| 11. | Gumeck, Styria | 2·950 | 57·45 | 0·82 | 1·35 | — | 24·03 | 13·75 | 2·32 | = 99·72 |
| 12. | Edwards, *Hexag.* | 2·996 | 58·20 | 1·40 | — | 1·37 | 24·14 | 12·20 | — | $Na_2O$ 1·90 = 99·21 |
| 13. | " " | 2·998 | 58·54 | 0·30 | 0·44 | 2·39 | 25·16 | 10·43 | 0·63 | $Na_2O$ 0·98, F 0·41 |
| 14. | Nordmark | | 55·77 | — | 2·95 | — | 24·73 | 15·92 | — | = 99·37 [= 99·28 |
| 15. | Morawitza | 2·987 | 56·93 | 0·64 | 3·87 | 0·37 | 21·73 | 15·12 | 1·25 | = 99·91 |

[a] Incl. 0·84 $Fe_2O_3$. [b] 0 69 $Fe_2O_3$. [c] 1·62 $Fe_2O_3$.

| | | G. | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ACTINOLITE. | | | | | | | | | |
| 16. | Brewster, N. Y. | | $\frac{2}{2}$ 57·44 | 1·13 | 4·33 | 0·15 | 22·59 | 13·29 | 1·52 | = 100·45 |
| 17. | Felling, Austria | 2·99 | $\frac{2}{2}$ 56·88 | 1·84[a] | 3·26 | *tr.* | 26·43 | 12·35 | — | = 100·76 |
| 18. | Lojo, Finland | | 55·45 | 1·89 | 4·87 | — | 22·98 | 13·96 | — | = 99·15 |
| 19. | Orijärvi | | 56·92 | 5·10 | 1·01 | — | 20·99 | 16·68 | — | = 100·70 |
| 20. | Amelia Co., Va. | 3·041 | 56·96 | 6·77[b] | 2·24 | — | 22·33 | 11·44 | 0·31 | = 100·05 |
| 21. | Arendal | 3·026 | 56·77 | 0·97 | 5·88 | — | 21·48 | 13·56 | 2·20 | = 100·86 |
| 22. | Greiner | 3·067 | 55·50 | — | 6·25 | — | 22·56 | 13·46 | 1·29 | = 99·06 |
| 23. | Sulzbach, *fibrous* | 2·848 | 54·60 | — | 12·80 | 1·16 | 16·98 | 12·81 | 0·61 | = 98·96 |
| 24. | *Raphilite* | 2·845 | 55·30 | 0·40 | 6·30 | *tr.* | 22·50 | 13·36 | 0·30 | alk. 1·05 = 99·21 |

[a] 0·48 $Fe_2O_3$. [b] 2·45 $Fe_2O_3$.

| NEPHRITE. | G. | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | ign. |
|---|---|---|---|---|---|---|---|---|
| 25. Schwemmsal | 3·025 | 57·66 | 1·80 | 2·07 | 1·02 | 23·00 | 13·44 | 1·05 = 100·04 |
| 26. Agraffe | 3·008 | 57·30 | 1·43[a] | 4·29 | 0·49[b] | 21·96 | 13·10 | 1·35 = 100·21 |
| 27. | 2·968 | 59·32 | 0·65 | 0·76 | 0·51 | 24·50 | 13·58 | 1·05 = 100·37 |
| 28. New Zealand | 3·023 | 57·75 | 0·90 | 4·79 | 0·68 | 19·86 | 14·89 | 0·68 = 99·93 |
| 29. Turkestan | 2·972 | 59·30 | 0·53 | 0·70 | 0·55 | 25·64 | 10·47 | 0·62 $K_2O$ 1·02, $SiF_4$ 1·28 = 100·11 |
| 30. " | 2·957 | 59·50 | 0·75 | 1·35 | 0·79 | 24 24 | 11·60 | 0·85 $K_2O$ 1·57 = 100·65 |
| 31. " | 2·980 | 58·42 | 0·70 | 0·67 | 0·46 | 24·39 | 13·85 | 1·20 $K_2O$ 0·10, $SiF_4$ 0·60 = 100·29 |
| 32. " | 2·974 | 59·21 | 0·84[c] | 0·97 | 0·53 | 23·55 | 14·61 | 0·78 $K_2O$ 0·19 = 100·68 |
| 33. Meilen | | 57·10 | — | 6·30 | 0·65 | 20·60 | 12·76 | 3·25 = 100·66 |
| 34. " | 3·02 | 56·50 | — | 6·75 | 0·42 | 20·09 | 13·37 | 3·50 = 100·63 |
| 35. " | 2·98 | 56·90 | — | 7·06 | 0·67 | 20 37 | 12·94 | 2 80 = 100·74 |
| 36. Concise | 2·974 | 56·14 | 0·48 | 4·66 | 1·13 | 22·68 | 11·12 | 3·72 = 99·93 |
| 37. China | 2·970 | 57 60 | 0·25 | 0·66 | 0·16 | 25 61 | 12·68 | 2·74 = 99·70 |
| 38. New Zealand | 3·015 | 51·70 | 0·95[d] | 7·62 | *tr.* | 23·50 | 13·09 | 2·42 = 99·28 |
| 39. "*Oceanic jade*" | 3·18 | 52·25 | 0·84[e] | 6·80 | — | 18·07 | 19 27 | 150 $Na_2O$ 0·68 = 99·41 |
| 40. New Zealand, *cryst.* | 3·090 | 56·55 | 0·21 | 6·21 | — | 19·78 | 13·60 | 2·81 = 99·16 |
| 41. " | | 57·35 | 0·22 | 5·94 | — | 20·70 | 13·47 | 3·13 = 100·81 |
| 42. " | 3·031 | 57·38 | 0·22 | 3·50 | — | 22·32 | 13·68 | 2·78 $K_2O$ 0·69 = 100·57 |
| 43. S. America | 2·949 | 57·32 | 1·36 | 3·56 | — | 21·85 | 13·39 | 3·23 = 100·71 |
| 44. Karakash | 2·98 | 57·35 | 1·03 | 1·22 | — | 22·73 | 13·40 | 2·69 alk. 0·48 = 98·90 |
| 45. New Zealand | 3·026 | 56·34 | 1·60 | 4·86 | — | 20·23 | 13·51 | 3·57 alk. 0·58 = 100·69 |
| 46. Tienshan, *dark-grn.* | 2·980 | 56·72 | 0·47 | 3·88 | 0·29 | 21·95 | 12·13 | 4·31 alk. 0·49 = 100·24 |
| 47. Khotan, *violet-gray* | 2·947 | 57·06 | 0·74 | 0·31 | 0·20 | 24·16 | 12·88 | 4·33 alk. 0·50 = 100·18 |
| 48. Irkutsk, *yw.-grn.* | 2 954 | 56·92 | 4·35 | 1·88 | 0·24 | 21·92 | 12·56 | 1·84 alk. 0·44 = 100·15 |
| 49. Kansu, *grn-gray* | 2·943 | 57·72 | 3·85 | 0·18 | — | 28·67 | 9·42 | 0·79 = 100·63 |
| 50. Khorkue Chamil, *white* | 2·973 | 54·83 | 4·77 | 1·04 | — | 25·50 | 8·13 | 0·23 $Na_2O$ 5·71 = 100·21 |
| 51. R. Belaya | 3·004 | 56·20 | 2·18[f] | 3·58 | 0·24 | 22·25 | 13·23 | 3·11 = 100·79 |
| 52. R. Kitoï | 3·035 | 54·73 | 2·12 | 3·12 | — | 23·25 | 12·87 | 2·99 alk. 1·07 = 100·15 |
| 53. " | | 55·00 | 1·95[g] | 3·51 | 0·21 | 22·51 | 13·05 | 3·41 alk. 0·75 = 100·39 |
| 54. " | 3·020 | 55·61 | 1·89 | 4·01 | — | 22·10 | 12·35 | 3·51 alk. 0·89 = 100·36 |
| 55. R. Bystraya | 3·035 | 55·97 | 1·98 | 3·82 | — | 22·12 | 12·99 | 3·21 = 100·09 |
| 56. Caucasus | 2·969 | 56·48 | 1·35 | 2·90 | — | 22·56 | 12·73 | 3·61 = 99·63 |
| 57. Yarkand | 2·949 | 56·56 | 1·04 | 0·46 | — | 25 24 | 13·27 | 3·23 = 99·80 |
| 58. " | 2·962 | 57·07 | 0·91 | 0·31 | — | 25·43 | 13·22 | 3·14 = 100·08 |
| 59. Timur's Tomb | 2·926 | 56·88 | 1·54 | 3·46 | — | 23·39 | 11·49 | 3·14 = 99·90 |
| 60. Termes | 2·948 | 56·71 | 1·23 | 0·92 | — | 24·62 | 12·98 | 3·74 = 100·20 |
| 61. Peking | | 56·86 | 1·41 | 0·38 | — | 25·31 | 13·01 | 3·59 = 100·56 |
| 62. Mt. Botogol, *light* | 3·15 | 56·60 | 1·37 | 2·38 | — | 23·04 | 13·45 | 3·03 = 99·87 |
| 63. " " *green* | 3·08 | 55·13 | — | 8·50 | — | 19·67 | 14·13 | 3·10 = 100·53 |
| 64. Yunnan | | 56·58 | 0·92 | 4·12 | *tr.* | 21·65 | 12·92 | 3·25 = 99·44 |
| 65. Saunthal | 2·93 | 55·14 | — | 4·81 | — | 22·92 | 13·12 | 2·88 = 98·87 |
| 66. Murthal | 3·00 | 55·94 | 0·56 | 6·01 | *tr.* | 22·12 | 12·63 | 2·59 = 99·87 |
| 67. Jordansmühl | 2·982 | 56·93 | 1·01 | 4·99 | 0·71 | 19·21 | 14·54 | 1·93 = 99·32 |
| 68. " *white* | 3·043 | 59·21 | 1·16 | 2·40 | 0·80 | 20·81 | 14·08 | 1·81 = 100·27 |
| 69. Reichenstein | 3·04 | 56·59 | 1·41 | 5·85 | *tr.* | 21·86 | 12·06 | 1·33 = 99·10 |
| 70. Alaska, *yw.-grn.* | 2·989 | 56·01 | 1·98 | 6·34 | *tr.* | 21·54 | 12 54 | 1·91 = 100·32 |
| 71. " *sisk.-grn.* | 3·006 | 56·12 | 0·63 | 7·45 | *tr.* | 20·92 | 12·72 | 1·42 = 99·26 |
| 72. " *blk. grn.* | 3·010 | 56·08 | 1·01 | 7·67 | *tr.* | 19·96 | 13·35 | 2 03 = 100·10 |
| 73. " *black* | 2·922 | 57·11 | 2·57 | 5·15 | *tr.* | 21·38 | 11·54 | 2·06 = 99·81 |
| 74. " *dark green* | 3·012 | 57·01 | 0·42 | 6·95 | — | 21·36 | 12·75 | 1·41 = 99·90 |
| 75. New Zealand, *drk. grn.* | | 56·73 | 3·22 | 5·96 | *tr.* | 19·42 | 13·24 | 0·83 = 99·40 |
| 76. Swiss, *green* | 3·015 | 56·87 | 1·50 | 6·33 | *tr.* | 21·06 | 13·45 | 0·63 = 99·84 |

[a] Incl. 0·55 $Cr_2O_3$. [b] 0·15 NiO. [c] 0·34 $Fe_2O_3$. [d] 0·30 $Cr_2O_3$. [e] 0·26 $Cr_2O_3$.
[f] 0·31 $Cr_2O_3$. [g] 0·34 $Fe_2O_3$.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | ign. | |
|---|---|---|---|---|---|---|---|---|---|
| 77. Jade Mts., Alaska, *grn. gray* | 58·11 | 0·24 | 5·44 | 0·38 | *tr.* | 21·97 | 12·01 | 1·78 | = 99·93 |
| 78. " " | 55·87 | 2·07 | 5·79 | 0·38 | *tr.* | 21·62 | 12·43 | 1·38 | = 99·54 |
| 79. " *white* | 56·85 | 0·88 | 4·33 | 1·45 | *tr.* | 21·56 | 13·09 | 1·76 | = 99·92 |
| 80. " *brownish* | 57·38 | 0·19 | 4·43 | 1·25 | *tr.* | 22·71 | 12·14 | 1·73 | = 99·83 |

ASBESTUS, ETC.

| | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|
| 81. Zillerthal, *Asbestus* | 55·87 | — | 4·31 | 1·12 | 20·33 | 17·76 | — | — | — | = 99·39 |
| 82. Kuhnsdorf, *Kymatin* | 57·98 | 0·58 | 6·32 | — | 22·38 | 12·95 | — | — | — | = 100·21 |
| 83. Zillerthal. *Rock Cork* | 57·20 | — | 4·37 | — | 22·85 | 13·39 | — | — | 2·43 | = 100·24 |
| 84. Frankenstein | 57·69 | — | 2·46 | 0·13 | 23·68 | 13·39 | 3·14 | — | 0·17 | = 100·66 |
| 85. Mexico, *blue* | 55·48 | 2·01 | — | — | 17·23 | 10·35 | 1·54 | — | 1·47 | = 100·40 |

SMARAGDITE.

| | $SiO_2$ | $Al_2O_3$ | FeO | MgO | CaO | $Na_2O$ | $K_2O$ | ign. | |
|---|---|---|---|---|---|---|---|---|---|
| 86. Alps | 54·30 | 5·15[a] | 3·87 | 19·01 | 13·72 | 2·80 | — | 0·30 | = 99·15 |
| 87. L. Geneva | 52·34 | 4·32[b] | 7·39 | 16·43 | 14·88 | 2·2 | — | 1·16 | = 98·73 |
| 88. Du Toits' Pan, S. Africa | 52·97 | 1·94 | 4·52 | 17·49 | 20·47 | 1·77 | *tr.* | 0·58 | = 99·74 |

[a] Incl. 0·61 $Cr_2O_3$. [b] Incl. some $Cr_2O_3$.

CUMMINGTONITE, AMPHIBOLE-ANTHOPHYLLITE.

| | G. | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 89. Kongsberg | 3·14 | 55·24 | 0·18 | 17·63 | 2·00 | 21·17 | 1·85 | — | — | 2·41 | = 100·48 |
| 90. Greenland | 3·15 | 55·82 | 0·47 | 20·22 | | 20·61 | 1·14 | — | — | 2·10 | = 100·36 |
| 91. Baltimore | 3·068 | 57·26 | 1·28[a] | 15·64 | — | 21·70 | *tr.* | 2·80 | *tr.* | — | = 99·88 |
| 92. Cummington | | 51·09 | 0·95 | 32·07 | 1·50 | 10·29 | *tr.* | 0·75 | *tr.* | 3·04 | = 99·69 |
| 93. " | | 50·74 | 0·89 | 33·14 | 1·77 | 10·31 | *tr.* | 0·54 | *tr.* | 3·04 | = 100·43 |

[a] 1·28 $Fe_2O_3$.

DANNEMORITE.

| | | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 94. Dannemora | | 48·89 | 1·46 | 38·21 | 8·46 | 2·92 | 0·73 | — | — | — | = 100·67 |
| 95. Brunsjö, *Asbeferrite* | | 46·25 | — | 40·40 | | 10·88 | | — | — | 2·47 | = 100 |
| 96. *Silfbergite* G. = 3·446 | $\frac{3}{3}$ | 48·83 | — | 30·49 | 8·34 | 8·39 | 1·74 | — | — | 0·44 | = 98·23 |
| 97. Hillängsite | | 48·25 | — | 28·17 | 12·08 | 5·86 | 3·22 | — | — | — | = 97·58 |

RICHTERITE.

| | G | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 98. Pajsberg | | 52·23 | — | 1·35 | 11·37 | 21·03 | 5·20 | 8·82 | | — | = 100 |
| 99. Långban | 3·09 | 53·28 | 2·31 | 1·62 | 7·54 | 19·20 | 8·43 | 6·33 | 0·66[a] | 0·71 | = 100·08 |

[a] $Li_2O$.

II. *Aluminous Amphiboles.*

EDENITE.

| | G. | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100. Edenville | 3·059 | $\frac{2}{2}$ | 51·67 | 5·75 | 2·86 | — | — | 23·37 | 12·42 | 0·75 | 0·84 | 0·46 | [= 98·12 |
| 101. Monroe | 3·123 | $\frac{2}{2}$ | 45·93 | 12·37 | — | 4·55 | 0·34 | 21·12 | 12·22 | 2·24 | 0·08 | 0·59 | [= 100·34 |
| 102. Saualpe, *Carinthin* | 3·102 | | 49·33 | 12·72 | 1·72 | 4·63 | — | 17·44 | 9·91 | 2·25 | 0·63 | 0·29 | [F 0·21 = 99·13 |
| 103. Pargas | 3·109 | | 42·97 | 16·42 | — | 1·32 | — | 20·14 | 14·99 | 1·53 | 2·85 | 0·87 | [F 1·66 = 102·75 |
| 104. Cullakenee, N. C. | 3·120 | | 45·14 | 17·59 | 0·79[a] | 8·45 | 0·21[b] | 16·69 | 12·51 | 2·25 | 0·36 | 1·34 | [= 100·33 |
| 105. L. Baikal, *Koksharovite* | 2·97 | | 45·99 | 18·20 | — | 2·40 | — | 16·45 | 12·78 | 1·53 | 1·06 | 0·60 | [= 99·01 |
| 106 Fiskernäs | 3·07 | | 46·79 | 15·36 | 0·69[a] | 2·38 | — | 20·17 | 13·11 | — | — | 2·13 | [= 100·63 |

[a] $Cr_2O_3$. [b] NiO.

PARGASITE, HORNBLENDE.

| | | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2C$ | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 107. | Bathurst | | 40·02 | 15·55 | 3·44 | 8·60 | — | 14·37 | 12·21 | 2·40 | 2·13 | 1·81 | = 100 53 |
| 108. | Edenville | | 42·97 | 11·90 | 3·08 | 13·84 | 0·481 | 1·49 | 11·63 | 2·73 | 0·88 | 0·38 | = 99·38 |
| 109. | Pargas | | 41·26 | 11·92 | 4·83 | 9·92 | *tr.* | 13·49 | 11·95 | 1·44 | 2·70 | 0·52 | F 1·70<br>[= 99·73 |
| 110. | Vesuvius | 3·282$\frac{2}{2}$ | 39·92 | 14·10 | 6·00 | 11·03 | 0·30 | 10·72 | 12·62 | 0·55 | 3·37 | 0·37 | = 98·98 |
| 111. | " *blk.* | 3·298 | 39·80 | 14·28 | 2·56 | 19·02 | — | 9·10 | 10·73 | 1·79 | 2·85 | 1·42 | = 101·55 |
| 112. | " *brn.* | 3·112 | 41·7 | 8·3 | 14·7 | — | — | 16·5 | 14·5 | [4·3] | — | — | = 100 |
| 113. | " *blk.* | 3·235 | 41·7 | 9·5 | 17·7 | — | — | 13·4 | 13·4 | [4·3] | — | — | = 100 |
| 114. | Czernosin | 3·225 | 40 65 | 14·31 | 5·81 | 7·18 | — | 14·06 | 12·55 | 1·64 | 1·54 | 0·26 | $TiO_2$<br>[0·80 = 98·80 |
| 115. | Stenzelberg | 3·266 $\frac{2}{2}$ | 39·62 | 14·92 | 10·28 | 7·67 | 0·24 | 11·32 | 12 65 | 1·12 | 2·18 | 0·48 | $TiO_2$<br>[0·19 = 99 67 |
| 116. | Bohemia | | 39·66 | 14·83 | 12·37 | 1·97 | — | 14·25 | 12·74 | 2·47 | 1·25 | — | $TiO_2$<br>[0·89 = 100·43 |
| 117. | Jan Mayen | 3·33 | 39·17 | 14·37 | 12·42 | 5·86 | 1·51 | 10·52 | 11·18 | 2·48 | 2·01 | 0·39 | = 99·91 |
| 118. | Mayo | | 39·96 | 16·91 | 3·42 | 8·86 | — | 6·03 | 15·94 | 9·01 | — | — | = 100·13 |
| 119. | Pajsberg | | 51·66 | 0·57 | 15·19 | 2·73 | 6·17 | 7·87 | 13 77 | [1·53] | — | 0·51 | = 100 |

[a] $Cr_2O_3$.

| | | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 120. | Nora, *Noralite* | 3·243 | 42·00 | 12·00 | — | 30·00 | 0·25 | 2·25 | 11 00 | — | *tr.* | $H_2O$ 0·75<br>[= 98·25 |
| 121. | Gamsigrad,<br>*Gamsigradite* | | 46·58 | 13·63 | — | 12·29 | 6·00 | 8·44 | 8·83 | 3·17 | 1·00 | = 99·94 |
| 122. | Franklin Furnace,<br>N. J. | | 39·59 | 11·20 | 5·97 | 11·31 | 3·07 | 8·42 | 12·85 | 3·31 | 1·95 | [$Cr_2O_3$ 0·13, ZnO 0·53, $TiO_2$ 1·76 = 101·01<br>1·02 = |
| 123. | M. Altino,<br>*Bergamaskite* | 3·07 | 536·77 | 15·13 | 14·46 | 22·89 | — | 0·93 | 5·14 | 4·00 | 0·42 | [99·74 |
| 124. | Kaersut, *Kaersutite* | 3·04 | 41·38 | 14·41 | — | 11·28 | — | 13·51 | 12·97 | $TiO_2$ | 6·75 | $SnO_2$<br>[0·26 = 100·56 |

**Pyr.**—Essentially the same as for the corresponding varieties of pyroxene, see p. 361.

**Obs.**—Amphibole occurs in many crystalline limestones, and granitic and schistose rocks, and sparingly in serpentine, and volcanic or igneous rocks. Tremolite, the magnesia-lime variety, is especially common in limestones, particularly magnesian or dolomitic; actinolite (also nephrite), the magnesia-lime-iron variety, in steatitic rocks and with serpentine; and dark green and black hornblende, in chlorite schist, mica schist, gneiss, and in various other rocks of which it forms a constituent part; brown to black hornblende occurs in trachyte and other eruptive rocks. Asbestus is often found in connection with serpentine.

*Hornblende-rock*, or *amphibolyte*, consists of massive hornblende of a dark greenish black or black color, and has a granular texture. Occasionally the *green* hornblende, or actinolite, occurs in rock-masses, as at St. Francis, in Canada. *Hornblende-schist* has the same composition as amphibolyte, but is schistose or slaty in structure. It often contains a little feldspar. In some varieties of it the hornblende is in part in minute needles. *Hornblendic granite* contains hornblende in addition to the ordinary constituents of granite, or replacing the mica. *Gneiss* and *mica schist* are often *hornblendic* in the same way. The hornblende in mica schist is usually in prisms, either stout or acicular, which sometimes are aggregated in sheaf-like tufts. The *fasciculite* of Hitchcock is merely this tufted hornblende. *Syenite* is a granitoid rock, containing hornblende along with orthoclase feldspar. *Dioryte* is a similar rock, grayish white to nearly black in color, consisting of hornblende and a triclinic feldspar.

Prominent foreign localities of amphibole are the following; many others have been mentioned in connection with the descriptions of varieties and analyses. *Tremolite* (grammatite) in dolomite at Campolongo in Canton Tessin, Switzerland; also at Orawitza; Rezbánya, Hungary; Gulsjö, Wermland, Sweden; Tromsö, Norway, etc. *Actinolite* in the crystalline schists of the Central and Eastern Alps, especially at Greiner in the Zillerthal; Pfitsch; Zermatt; in fine fibrous form at the Knappenwand, Sulzbachthal, Tyrol, with epidote; Zöblitz in Saxony; Arendal, Norway. *Asbestus* at Sterzing, Zillerthal, and elsewhere in Tyrol; in Savoy; also in the island of Corsica, where it is so abundant that Dolomieu is said to have employed it in packing his minerals; at Dretlitz, Pyrenees. *Rock cork* is obtained in the Zillerthal, Saxony, Portsoy, and Leadhills, where also mountain leather occurs. Bourg d'Oisans, in France, affords a variety of amianthus, composed of fibers having some degree of elasticity; it is the *amianthoide* of Haüy. *Pargasite* at Pargas, Finland; Saualpe in Carinthia. *Hornblende* at Arendal and Kongsberg, Norway; in Sweden and Finland; at Vesuvius; Aussig and Teplitz, Bohemia; in basalt at Wolfsberg near Czernosin; Klotzberg, Bohemia; the Rhöngebirge; Vogelsgebirge; Kaiserstuhl.

*Nephrite*, which in the form of "jade" ornaments and utensils is widely distributed among the relics of early man (see jade, p. 371), is obtained at various points in central Asia. The most important source is that in the Karakash valley in the Kuen Lun Mts. on the southern borders of Turkestan; the exact locality of the quarries, which have been extensively worked by the Chinese, is 7 miles from the Kirghiz encampment of Balakchi, which is 12 miles S.E. of Shahidulla (Stoliczka, Q. J. G. Soc., 30, 568, 1874). Quarries also exist in the Kuen-Lun Mts., to the south of Khotan, which have been known by the Chinese for 2000 years; probably also at other points in the same range (cf. Schlagenweit, Ber. Ak. München, 227, 1873*). Another locality has been described in the same region on the eastern slope of the Pamir on the Raskem-daria, where it has been extensively mined by the Chinese; from this source the material for the tombstone† of Timur (anal. 59) in Samarkand is believed to have been obtained; white "jadeite" (like that of Burma) is mentioned as occurring with it (Nature, 1890). It has also been found at various localities in the government of Irkutsk, eastern Siberia, near L. Baikal, but only as rolled masses in river beds, etc. (cf. Beck and Mushketov, l. c.). Also reported from the province of Yunnan, southern China. In New Zealand it has been much used by the Maoris (called by them Pumamu, Tangiwai, Kawakawa, etc.), and obtained from several points on the west coast of the South Island (Hochstetter, Ber. Ak. Wien, **49** (1), 466, 1864).

Nephrite has been found in Europe as a rolled mass at Schwemmsal near Leipzig; in Swiss Lake habitations and similarly elsewhere. Also an extremely fine-fibrous amphibole closely resembling oriental nephrite (anals. 67–69) occurs in place at Reichenstein and Jordansmühl, Silesia (Traube, l. c.), where it occurs with serpentine and has resulted from the uralitization of a massive pyroxenic rock; further, rolled masses (anals. 65, 66) have been found in the Sannthal and Murthal, Styria, which were probably derived from the neighboring mountains (cf. Berwerth, Ann. Mus. Wien, **3**, 79, 1888).

In America, besides the jade ornaments common in Mexico, South America and Alaska, nephrite has been found in pebbles in gravel bars (Rep. G. Canada, 1887–88) on the Lewis river in the Yukon district, North-west Territory. A mass of a pale green color, translucent to subtransparent and weighing 1¾ lbs., was found in Miles Cañon; another at the Kwikpak mouth of the Yukon. Further, nephrite (anals. 77–80) has been found in place at the Jade Mts., north of the Kowak river, about 150 miles above its mouth (Storey, Clarke). Also found in rolled pebbles and as Indian implements near Lytton in the valley of the Fraser river, Br. Columbia.

In the United States, in *Maine*, black crystals occur at Thomaston, at Moultenboro in syenite; pargasite at Phippsburg and Parsonsfield; radiated or asbestiform actinolite at Unity; tremolite at Thomaston and Raymond. In *N. Hamp.*, black crystals at Franconia. In *Vermont*, glassy and radiated actinolite in the steatite quarries of Windham, Readsboro', and New Fane. In *Mass.*, white crystals of tremolite at Lee; glassy and radiated actinolite at Middlefield and Blandford; radiated actinolite at Carlisle, Pelham, Windsor, Lee, and Great Barrington: black crystals at Chester; asbestus at Brighton, Sheffield, Pelham, Newbury, Dedham; cummingtonite at Cummington and Plainfield. In *Conn.*, in large flattened white crystals and in bladed and fibrous forms (tremolite) in dolomite, at Canaan, between the Falls and the post-office, and also at other places in Litchfield Co.; asbestus at West Farms, Winchester, and Wilton, and with mountain leather at the Milford serpentine quarries.

In *N. York*, in good black crystals at Willsboro', presenting interesting forms; also near the bridge at Potsdam, near Greenwood Furnace, and in Warwick, Orange Co.; dark green crystals near Two Ponds, and also 1 m. N., 2½ m. N., and 1 m. S., of Edenville, together with gray or hair-brown crystals and tremolite, titanite, and chondrodite, in granular limestone; of various forms and colors, and often in large and perfect crystals, near Amity; in dark green crystals, with ilmenite, at the Stirling mines, Orange Co.; in short green crystals at Gouverneur, St. Lawrence Co., sometimes 2 or 3 in. in diameter, along with apatite, also in fine long prisms of tremolite with brown tourmaline; with pyroxene at Russell in fine crystals; a black variety at Pierrepont; at Macomb, Pitcairn; tremolite at Fine; in Rossie, 2 m. N. of Oxbow, the variety pargasite in neat bright green crystals; glassy and radiated actinolite near a hamlet called Peeksville, in Fishkill; radiated at Brown's serpentine quarry, 3 m. N.W. of Carmel, Putnam Co; in large white crystals at Diana, Lewis Co.; radiated and bladed tremolite at Dover, Kingsbridge, the Eastchester quarries, Hastings, and near Yonkers, in Westchester Co.; at Knapp's quarry, Patterson, in Putnam Co., and on the banks of Yellow lake and elsewhere in St. Lawrence Co.; asbestus, near Greenwood Furnace; Rogers's farm in Patterson; Colton rock and Hustis's farm in Phillipstown, Putnam Co.; near the Quarantine in Richmond Co., in long fibers.

In *N. Jersey*, tremolite or gray amphibole in good crystals at Bryam, and other varieties of the species at Franklin and Newton, radiated actinolite, also a zinc-manganese variety (anal. 122) at Franklin Furnace, Sussex Co.; asbestus and mountain leather at Brunswick. In *Penn.*, actinolite in Providence, at Mineral Hill, in Delaware Co.; at Unionville; at Kennett, Chester Co., often in fine crystals; tremolite with asbestus at Chestnut Hill near the Wissahickon, near Philadelphia; at London Grove, Chester Co. In *Maryland*, actinolite and asbestus at the Bare Hills in serpentine; asbestus is mined at Pylesville, Harford Co.; amphibole-anthophyllite at Mt. Washington, 6 miles north of Baltimore. In *Virginia*, actinolite at Willis's Mt., in Buckingham Co.; asbestus at Barnet's Mills, Fauquier Co. Nephrite in Alaska as already noted.

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* Also later Beck & Mushketov (Vh. Min. Ges., **18**, 1, 1883), who give a map of the known localities in the Kuen-Lun Mts., and a summary of the occurrence of nephrite in different parts of the world; besides describing with many analyses (quoted on p. 394) the Siberian occurrences.

† The size of this stone (in centimeters) is as follows: length 192 (= 6·3 ft.), breadth 36½ above and 34 below, height, 30 (B. & M.).

In Canada, tremolite is abundant in the Laurentian limestones, at Calumet Falls, Litchfield, Pontiac Co., Quebec; also at Blythfield, Renfrew Co., and Dalhousie, Lanark Co.; good crystals in limestone at Algona, Renfrew Co. Black hornblende at various localities in Quebec and Ontario with pyroxene, apatite, titanite, etc., as in Renfrew Co.; fine crystals of pargasite, also tremolite, on the Madawaska, Blythfield, Renfrew Co., Ontario. Black hornblende with the magnetite of Bathurst and South Sherbrooke, Lanark Co., Ontario. Asbestus and mountain cork at Buckingham, Ottawa Co., Quebec; a bed of actinolite at St. Francis, Beauce Co., Quebec; nephrite has been found in British Columbia and North-west Territory, as already noted.

**Alt.**—The alterations of amphibole are similar to those of pyroxene (see pp. 362, 363). The fibrous and diallage-like varieties are especially liable to take up water, owing to the finely or thinly divided state of the mineral. Talc, steatite, serpentine, chlorite, epidote, biotite, pinite, chabasite, limonite, magnetite, iron ocher, are among the reported results of alteration.

At Ilmenau, a magnesia-mica, a chlorite, and also (as an after-product from the chlorite) iron-ocher, occur as pseudomorphs after hornblende. *Groppite*, and perhaps *rosite* (4th Ed., p. 287), may be altered pargasite. Genth describes the asbestiform or fibrous serpentine of Texas and Providence, Pa., and the *baltimorite* as altered asbestus, and a chrysotile of Delaware Co., Pa., as altered actinolite (Am. J. Sc., 33, 203, 1862). The *hydrous anthophyllite* of New York Island occurs in place near the corner of 59th street and 10th avenue, and also in many places in boulders. The variations in the analyses, as well as in the aspect of the material, show that it is a result of the alteration of an asbestiform tremolite. Cf. p. 384.

Several alteration-products of amphibole are given below.

**Artif.**—Obtained artificially by Khrushchov, see p. 1026.

**Ref.**—[1] Finl. Min., 56, 1855, Min. Russl., 8, 159, 1878; cf. Rath, Pogg., Erg., **6**, 229, 1874, Arzruni, Ber. Ak. Berlin, March 30, 1882, Franzenau, Zs. Kr., 8, 568, 1884.

The position here taken is that adopted by Tschermak (Min., 442, 1884) and shown conclusively by G. H. Williams (Am. J. Sc., **39**, 352, 1890) to be the true one as exhibiting the relation to pyroxene; cf. 13, p. 387, where the crystals of the two species are in parallel position and the basal planes nearly coincide. It was early shown by Rath (l. c.) of Vesuvian amphibole that crystals occur parallel with augite, with $p$ of the one corresponding to $s/s'$ of the other.

To transform the formerly accepted symbols, $hkl$ (where $p = 001$, $r = \bar{1}11$, etc.), to those here taken ($pqr$), note that $p = -(h + l)$, $q = k$, $r = l$.

The following (Tschermak, Franzenau) show the variation in angle in some of the kinds of amphibole:

| | | Actinolite | Vesuvius | Brevik | Pargas | Aranyer Berg |
|---|---|---|---|---|---|---|
| $mm'''$ | = | 55° 32′ | 55° 31′ | 55° 41′ | 56° 0′ | 55° 43′ |
| $rr'$ | = | | 31° 29′ | | 31° 42′ | 31° 38′ |
| $mr'$ | = | | | 68° 46′ | | 68° 58′·3 |

[2] Cf. Mlr., 297, 1852; Dx., **1**, 77, 1862; Schrauf, Atlas, Tf. VII, VIII, 1864; Kk., l. c.; Gdt. Index, **1**, 190, 1886. [3] Franzenau, Aranyer Berg, l. c. [4] Cathrein, Fleimsthal, Zs. Kr., **9**, 357, 1884, **13**, 9, 1887. [5] Williams, Russell, N. Y., Jb. Min., **2**, 175, 1885. [6] Flink, Nordmark, anal. 14, l. c.

[7] On *twins* ‖ *c*, Cross, Min. Mitth., 3, 386, 1881; G. H. Williams, Am. J. Sc., **39**, 352, 1889; tw. striations and parting, Mügge, Jb. Min., **1**, 242, 1889.

[8] *Composition* discussed, Scheerer, Pogg., **84**, 321 *et seq.*, 1851; Rg., Pogg., **103**, 273 *et seq.*, 1858; Tschermak, Min. Mitth., 38, 1871; Berwerth, Ber. Ak. Wien, **85** (1), 153, 1882; Scharizer, Jb. Min., **2**, 143, 1884. Relation between composition and optical characters, Wiik, Zs. Kr., **7**, 79, 1882.

The following are more or less altered amphiboles:

KIRWANITE *Thomson*, Min., **1**, 378, 1836. A fibrous, green, chlorite-like mineral from the basalt of the N. E. coast of Ireland. R. D. Thomson found in it: $SiO_2$ 40·50, $Al_2O_3$ 11·41, FeO 23·91, CaO 19·78, $H_2O$ 4·35 = 99·95. According to Lacroix it is an impure altered amphibole, Bull. Soc. Min., **8**, 429, 1885.

LOGANITE *T. S. Hunt*, Phil. Mag., **2**, 65, 1851, Rep. G. Canada, 491, 1863. Amphibole from Calumet Falls, Quebec, retaining its form and cleavage, but near penninite in composition. See 5th Ed., p. 242, p. 496.

PALIGORSKITE *T. v. Savchenkov*, Vh. Min. Ges., 102, 1862. Fibrous. Soft, but tough. G. = 2·217. Color white. Analysis: $SiO_2$ 52·18, $Al_2O_3$ 18·32, MgO 8·19, CaO 0·59, $H_2O$ 12·04, hygrosc. water 8·46 = 99·84. B.B. infusible. Not acted on by the acids.

From the Permian mining district of the Ural. Probably an altered asbestus.

PHĀACTINITE *Bertels*, Verh. Würzb. Ges., 8, in JB. Ch., 1267, 1874. An alteration product of amphibole, forming radiated masses, doubly refracting. H. = 2. G. = 2·997–3·057. Color dirty grayish brown. Analysis after deducting a little magnetite: $SiO_2$ 35·5, $Al_2O_3$ 16·9, $Fe_2O_3$ 25·4, MnO 1·4, MgO 5·3, CaO 7·2, $H_2O$ 8·1 = 99·8. From the rock called by the same author isenite, occurring in Nassau, Germany.

WALDHEIMITE. Amphibol-ähnliches Min. von Waldheim *A. Knop*, Lieb. Ann., **110**, 363, 1859; Waldheimit *Rg.*, Min. Ch., 780, 1860. An amphibole-like mineral from the serpentine of Waldheim, Saxony, which contains much *soda*, and is peculiar also in its excess of silica, both suggesting that it may be amphibole altered by the alkaline process. It occurs in veins an inch thick, and resembles actinolite. H. = 5; G. = 2·957; color leek-green; translucent. Analysis, Knop:

$SiO_2$ 58·71 $Al_2O_3$ 1·52 FeO 5·65 MnO 0·25 MgO 10·01 CaO 11·53 $Na_2O$ 12·38 = 100·05

**339. GLAUCOPHANE.** Glaukophan *Hausmann*, J. pr. Ch., 34, 238, 1845. Gastaldite *Strüver*, Mem. Acc. Linc., 2, 333, 1875.

Monoclinic; near amphibole in form. In thin prismatic crystals with *a*, *b*, *m*, and rarely *p* ($\bar{1}01$) and *r* (011). Measured angles, Bodewig:

$mm''' = 58° 16'$, $cr = 34° 12'$, $m'r = 67° 17'$, cf. Amphibole, p. 387.

Crystals prismatic in habit, usually indistinct; commonly massive, fibrous, or columnar to granular.

Cleavage: *m* perfect. Fracture conchoidal to uneven. Brittle. H. = 6–6·5. G. = 3·103–3·113 Hausm.; 3·044 Svr. Luster vitreous to pearly. Color azure-blue, lavender-blue, bluish black, grayish. Streak grayish blue. Translucent.

Pleochroism strongly marked: $\mathfrak{c}$ sky-blue to ultramarine-blue, $\mathfrak{b}$ reddish or bluish violet, $\mathfrak{a}$ yellowish green to colorless. Absorption $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$. Optically +. Ax. pl. ‖ *b*. $\mathfrak{c} \wedge \dot{c} = 4°$ to 6°, rarely higher values: 11° to 12° Kotō. Bodewig gives for the extinction-angles with $\dot{c}$ on *b*: 4° 24′ Li, 4° 16′ Na, 4° 13′ Tl. Axial angles:

$2E_{a.r} = 84° 42'$ $2E_{a.y} = 85° 35'$ $2E_{a.gr} = 86° 39'$ $2H_{a.r} = 51° 3'$ $2H_{a.y} = 51° 11'$ $2H_{a.gr} = 51° 24'$

Also $\beta = 1·6442$ gastaldite, Sanger (Rosenbusch).

**Comp.**—Essentially $NaAl(SiO_3)_2.(Fe,Mg)SiO_3$. If Mg : Fe = 2 : 1, the formula requires: Silica 57·6, alumina 16·3, iron protoxide 7·7, magnesia 8·5, soda 9·9 = 100.

**Anal.**—1, Schnedermann, J. pr. Ch., **34**, 240, 1845. 2, Luedecke, Zs. G. Ges., **28**, 249, 1876. 3, Bodewig, Pogg., **158**, 224, 1876. 4, Berwerth, Ber. Ak. Wien, **85** (1), 185, 1882. 5, Lasaulx and Bettendorff, Ber. nied. Ges., 263, 1883. 6, Schluttig, Inaug. Diss., Groitzsch, 6, 1884, recalc. by Grünhut, Zs. Kr., **13**, 73, 1886. 7, Liversidge, Proc. Soc. N. S. W., Sept. 1, 1880. 8, Yoshida, quoted by Kotō, J. Coll. Sci., Japan, **1**, 85, 1886. 9, Cossa, Mem. Acc. Linc., **2**, 33, 1875. 10, Barrois & Offret, C. R., **103**, 221, 1886.

| | G. | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Syra | 3·108 | $\frac{2}{2}$ | 56·49 | 12·23 | — | 10·91 | 0·50 | 7·80 | 2·40 | 9·34 | *tr.* | = 99·63 |
| 2. " | 3·101 | | 55·64 | 15·11 | 3·08 | 6·85 | 0·56 | 7·80 | 2·40 | 9·34 | — | = 100·78 |
| 3. Zermatt | 3·091 | $\frac{2}{2}$ | 57·81 | 12·03 | 2·17 | 5·78 | — | 13·07 | 2·20 | 7·33 | — | = 100·39 |
| 4. " | 3·047 | $\frac{2}{2}$ | 58·76 | 12·99 | — | 5·84 | — | 14·01 | 2·10 | 6·45 | — | $H_2O$ 2·54<br>[= 102·69 |
| 5. Is. Groix | 3·112 | | 57·13 | 12·68 | 8·01 | | — | 11·12 | 3·34 | 7·39 | *tr.* | = 99·67 |
| 6. " | 3·110 | $\frac{3}{3}$ | 56·65 | 12·31 | 3·01 | 4·58 | — | 12·29 | 2·20 | 7·93 | 1·05 | = 100·02 |
| 7. N. Caledonia | 3·12 | $\frac{2}{2}$ | 52·79 | 14·44 | — | 9·82 | — | 11·02 | 4·29 | 5·26 | 0·88 | $H_2O$ 1·38<br>[= 99·88 |
| 8. Shikoku, Japan | 2·991 | | 56·71 | 15·14 | 9·78 | 4·31 | — | 4·33 | 4·80 | 4·83 | 0·25 | = 100·15 |
| 9. Aosta, *Gastaldite* | 3·044 | $\frac{3}{3}$ | 58·55 | 21·40 | — | 9·04 | — | 3·92 | 2·07 | 4·77 | *tr.* | = 99·71 |
| 10. Andalusia | | | 47·42 | 8·42 | — | 9·68 | — | 15·28 | 12·95 | 2·97 | — | ign. 4·16<br>[= 100·88 |

**Obs.**—Occurs as the hornblendic constituent of certain crystalline schists, called *glaucophane-schists*, or glaucophanyte; also more or less prominent in mica schists, amphibolytes, gneiss, eclogytes, etc. It is often associated with mica, garnet, diallage and omphacite, epidote and zoisite, etc.

First described from the island of Syra, one of the Cyclades; since shown to be widely distributed (cf. Oebbeke, Zs. G. Ges., **38**, 634, 1886, and Zs. Kr., **12**, 282, 1886). Occurs at Zermatt in Switzerland, on the north side of the Matterhorn, as also on the south side in the Val Tournanche; in the valley of Aosta, near Camp de Praz and St. Marcel, also at Brosso, near Ivrea, and in the Val Locana, Val d'Ala, Valle-Grande di Lanzo (*gastaldite*); at other points in the southern slope of the Alps, as well as in Switzerland; on the island of Corsica; Is. Groix, northwest coast of France; in the Fruška gora in Croatia. In New Caledonia with garnet and mica at the Balade mine. On the island of Shikoku, Japan.

In the U. S., glaucophane schists, closely resembling those of Syra, have been described from the Coast Ranges of California, as at Sulphur Bank, Lake Co., and at other points; the glaucophane is associated with zoisite and mica (Becker).

Glaucophane has been noted as a secondary product due to the alteration of diallage by a process of "glaucophanization:" the original diallage contained 2·23 p. c. $Na_2O$, Kotō, l. c.

Glaucophane is named from γλαυκος, *bluish green*, and φάινεσθαι, *to appear*. Gastaldite is named after Prof. Bartolomeo Gastaldi.

**340. RIEBECKITE** *A. Sauer*, Zs. G. Ges., **40**, 138, 1888. *Bonney*, Phil. Trans., **174**, 283, 1883.

Monoclinic. In embedded prismatic crystals, longitudinally striated.

Cleavage: prismatic (56°) perfect. Luster vitreous. Color black. Pleochroism very strongly marked: $\mathfrak{c}$ green, $\mathfrak{b}$ ($= \overset{|}{\bar{b}}$) deep blue, $\mathfrak{a}$ (nearly $\parallel c$) dark blue. Optically −. Extinction-angle small, $\mathfrak{a} \wedge \dot{c} = 4°–5°$ (±?). Axial angle large.

**Comp.**—Essentially $2Na\overset{III}{Fe}(SiO_3)_2.FeSiO_3$ = Silica 50·5, iron sesquioxide 26·9, iron protoxide 12·1, soda 10·5 = 100. It corresponds closely to acmite (ægirite) among the pyroxenes.

**Anal.**—1, Sauer, after deducting 7·12 p. c. zircon. 2, Id. 3, Koenig, Zs. Kr., **1**, 430, 1877 (also with slightly different numbers, Proc. Ac. Philad., 10, 1877).

| | $SiO_2$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $Na_2O$ | $K_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Socotra | 50 01 | 28·30 | 9·87 | 0·63 | 1·32 | 0·34 | 8·79 | 0·72 | = 99·98 |
| 2. " | 49·30 | 30·72 | 7·97 | — | 2·75 | — | — | — | |
| 3. *Colorado* G. = 3·433 | 49·83 | 14·87 | 18·86 | 1·75 | — | 0·41 | 8·33[a] | 1·44 | $TiO_2$ 1·43, $ZrO_2$ 0·75, ign. 0·20 = 97·87 |

[a] Incl. $Li_2O$.

Analysis 3 is referred here by Lcx. (see below) on the basis of an optical examination, but it differs in the state of oxidation of the iron, and approaches more nearly to crocidolite.

**Obs.**—Originally described from the granite and syenite of the island of Socotra in the Indian Ocean, 120 miles N. E. of Cape Guardafui, the eastern extremity of Africa. It occurs in groups of prismatic crystals, often radiating and closely resembling tourmaline.

A similar amphibole occurs at Mynydd Mawr, Carnarvonshire, Wales (Bonney, Min. Mag., 8, 103, 1888, ib. p. 169, 1889). Also another in granulyte in Corsica. Pleochroism: $\mathfrak{c}$ yellowish green, $\mathfrak{b}$ blue, $\mathfrak{a}$ indigo, nearly black. Axis $\mathfrak{a}$ inclined a few degrees to $\dot{c}$. Cf. Le Verrier, Lcx., C. R., **109**, 38, 39, 1889.

An "arfvedsonite" from St. Peter's Dome, Pike's Peak region, El Paso Co., Colorado, occurring with astrophyllite and zircon is shown by Lacroix (ibid.) to be near riebeckite. Extinction-angle on $b$, $\mathfrak{a} \wedge \dot{c} = 3°$ to $4°$.

**341. CROCIDOLITE.** Blau-Eisenstein (fr. S. Africa) *Klapr.*, Mag. Berl. Ges. N. Fr., **5**, 72, 1811, Beitr., **6**, 237, 1815. Krokydolith *Hausm.*, Gel. Anz. Gött., 1585, 1831. Blue Asbestus. Abriachanite *Heddle*, Min. Mag., **3**, 61, 193, 1879.

Fibrous, asbestus-like; fibers long but delicate, and easily separable. Also massive or earthy.

Cleavage: prismatic, 56°. H. = 4. G. = 3·20–3·30. Luster silky; dull. Color and streak lavender-blue or leek-green. Opaque. Fibers somewhat elastic. Pleochroism: $\mathfrak{c}$ green, $\mathfrak{b}$ violet, $\mathfrak{a}$ blne.

Optically +. Extinction-angle on $b$, inclined 18° to 20° with $\dot{c}$. 2E = 95° approx. Indices $\gamma - \alpha = 0·025$ Lcx.[1]

**Comp.**—Near riebeckite and perhaps only a fibrous variety. Formula $Na\overset{III}{Fe}(SiO_3)_2.FeSiO_3$ nearly = Silica 49·6, iron sesquioxide 22·0, iron protoxide 19·8, soda 8·6 = 100.

Magnesium and calcium replace part of the ferrous iron, and hydrogen part of the sodium. Chester's analysis gives: $2H_2O.Na_2O.3FeO.Fe_2O_3.9SiO_2$.

**Anal.**—1, Doelter, Zs. Kr., **4**, 40. 1879. 2, Renard and Klement, Bull. Ac. Belg., 8, 530, 1884. Also earlier Stromeyer, 5th Ed., p. 243. 3, Delesse, Ann. Mines, **10**, 317, 1836. 4, 5, Chester and Cairns, Am. J. Sc., **34**, 108, 1887. 6, 7, Heddle, l. c., 6, original fragments, 7, material obtained by washing and decantation; also Jolly and Cameron, Q. J. G. Soc., **36**, 109, 1880.

| | G. | $SiO_2$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. S. Africa | | 52·11 | 20·62 | 16·75 | — | 1·77 | — | [6·16] | — | 1·58 | $Al_2O_3$ 1·01 = 100 |
| 2. " | | 51·89 | 19·22 | 17·53 | — | 2·43 | 0·40 | 7·71 | 0·15 | 2·36 | = 101·69 |
| 3. Vosges | | 53·02 | — | 25·62 | 0·50 | 10·14 | 1·10 | 5·69 | 0·39 | 2·52 | $P_2O_5$ 0·17, Cl 0·51 = 99·66 |
| 4. Rhode Island | 3·2 | 52·13 | 15·93 | 21·25 | — | 0·22 | — | 6·26 | — | 3·95 | = 99·74 |
| 5. " " | | 51·03 | 17·88 | 21·19 | — | 0·09 | — | 6·41 | — | 3·64 | = 100·24 |
| 6. Dochfour, *Abriach.* | 3·326 | 51·15 | 14·92 | 9·80 | 0·30 | 10·80 | 1·12 | 6·52 | 0·63 | 4·77[a] | = 100·01 |
| 7 " " | | 52·40 | 9·34 | 15·17 | 0·40 | 10·50 | 1·17 | 7·11 | 0·61 | 2·97 | S 1·00 = 100·67 |

[a] Loss 0·95 p. c. at 100°.

**Pyr.**, etc.—In the closed tube yields on strong ignition a little water. B B. fuses easily with intumescence to a black magnetic glass, coloring the flame yellow (soda). With the fluxes gives reactions for iron. Unacted upon by acids.

**Obs.**—Occurs in South Africa, in Griqualand-West, north of the Orange river, in a range of quartzose schists called the Asbestos Mountains, which extends in a northeasterly direction from Griquastad toward Transvaal, 700 m. north of the Cape of Good Hope. In a micaceous porphyry at Wakembach, near Framont, in the Vosges. At Golling in Salzburg, in gypsum with blue quartz; at Ruka, near Domaschow in Moravia, with a ferruginous dolomite; in Greenland, both fibrous and earthy.

In the U. S., at Beacon Pole Hill, near Cumberland, R. I., in a granite ledge disseminated in fine particles in feldspar, also in as large as a butternut masses with radiated fibrous structure. Emerald Mine, Buckingham and Perkin's Mill, Templeton, Ottawa Co., Ontario, Canada (Lcx., Bull. Soc. Min., **13**, 10, 1880).

*Abriachanite* is an earthy amorphous form occurring in seams and cavities of the gneiss and granite of the Abriachan district, near Loch Ness, in Inverness-shire, Scotland.

A similar mineral from the zircon-syenite of Stavern, Norway, is referred here by Hausmann; this is the Faseriger Siderit *Leonh.*, Gebl. J., 3, 101, and Fasriges Eisenblau *Hausm.*, Handb., 1076, 1813. According to Brögger the Stavern mineral is a fibrous variety of the pyroxene, ægirite; he suggests further a like relation for the South African mineral; but cf. Lcx., l. c., and C. R., **109**, 39, 1889.

Crocidolite is named from *κροκίς*, *woof*, in allusion to its fibrous structure.

**Alt.**—The South African mineral is largely altered by both oxidation of the iron and infiltration of silica, resulting in a compact siliceous stone of delicate fibrous structure, chatoyant luster, and bright yellow to brown color, popularly called *tiger-eye* (also cat's-eye and Faserquarz, Tigerauge, Falkenauge (bluish var.) *Germ.*). Many varieties occur forming transitions from the original blue mineral to the final product; also varieties depending upon the extent to which the original mineral has penetrated the quartz. Cf. Renard and Klement, l. c. The softer (H. = 4) alteration product, consisting of silica with iron oxide, is made a ferric silicate by Hepburn, Ch. News, **55**, 240, 1887, and called *griqualandite* (cf. Brough., ib., **56**, 244, 1887).

Anal.—1, 2, Renard and Klement, l. c. 3, Rg., Min. Ch., Erg., 194, 1886. 4, 5, Wibel and Neelsen, Jb. Min., 367, 1873. 6, Hepburn, l. c.

| | G. | $SiO_2$ | $Fe_2O_3$ | FeO | $Al_2O_3$ | CaO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. *Tiger-eye* | | 93·05 | 4·94 | — | 0·66 | 0·44 | 0·26 | 0·76 | = 100·11 |
| 2. *Bluish* | | 93·43 | 2·41 | 1·43 | 0·23 | 0·13 | 0·22 | 0·82 | = 98·67 |
| 3. | 2·684 | 94·45 | 4·50 | — | — | — | — | 0·80 | = 99·75 |
| 4. *Blue* | 2·69 | 97·27 | — | 1·67 | — | 0·15 | — | 0·76 | = 99·85 |
| 5. *Brown* | 3·05 | 57·46 | 37·56 | — | — | — | — | 5·15 | = 100·17 |
| 6. *Griqualandite* | 3·136 | 56·75 | 37·64 | 1·09 | — | — | 0·10 | 5·23 | = 100·81 |

**Ref.**—[1] Bull. Soc. Min., **13**, 10, 1890.

**342. ARFVEDSONITE.** *Brooke*, Ann. Phil., **5**, 381, 1823. Arfwedsonit. Soda-hornblende.

Monoclinic. Axes: $\breve{a} : \bar{b} : \dot{c} = 0·55687 : 1 : 0·29781$; $\beta = 73° 2\frac{1}{4}' = 001 \wedge 100$ Brögger[1].

$100 \wedge 110 = 28° 2\frac{1}{2}'$, $001 \wedge 101 = 23° 52\frac{1}{6}'$, $001 \wedge 011 = 15° 54'$.

**Forms:** *a* (100, *i*-ī), *b* (010, *i*-ĭ), *m* (110, *I*), *t* (101, 1-ī), *p* (1̄01, 1-ī), *r* (011, 1-ĭ), *i* (031, 3-ĭ), *k* (2̄11, 2-2), *z* (1̄21, 2-2̆).

Angles (cf. f. 14, p. 387): *mm'''* = *56° 5′, *at* = 49° 10′, *a′p* = *75° 44½′, *rr′* = 31° 48′, *br* = *74° 6′, *ii* = 81° 2′, *zz′* = 60° 0′, *pr* = 34° 40′, *pm* = 77° 27′.

Crystals long prisms, often tabular ∥ *b*, but seldom distinctly terminated: also in prismatic aggregates. Twins: tw. pl. *a*.

Cleavage: prismatic, perfect; *b*, less perfect. Fracture uneven. Brittle. H. = 6. G. = 3·44–3·45. Luster vitreous. Color pure black; in thin scales deep green. Streak deep bluish gray. Opaque except in thin splinters.

Pleochroism strongly marked: $\mathfrak{c}$ deep greenish blue, $\mathfrak{b}$ lavender, $\mathfrak{a}$ pale greenish yellow. Absorption $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$; sections ∥ *a* are deep greenish blue, ∥ *b* olive-green. Optical character somewhat uncertain, probably (Bgr.) +, and $\mathfrak{c} = Bx_a$ (but cf. below and p. 383). Extinction-angle on *b*, with $\dot{c}$, = −14°.

**Comp.**—A slightly basic metasilicate of sodium, calcium, and ferrous iron chiefly; Lorenzen's analysis gives $4Na_2O.3CaO.14FeO.(Al,Fe)_2O_3.21SiO_2$.

**Anal.**—1, Lorenzen, Min. Mag., **5**, 50, 1882. 2, Berwerth, Ber. Ak. Wien, **85** (1), 168, 1882.

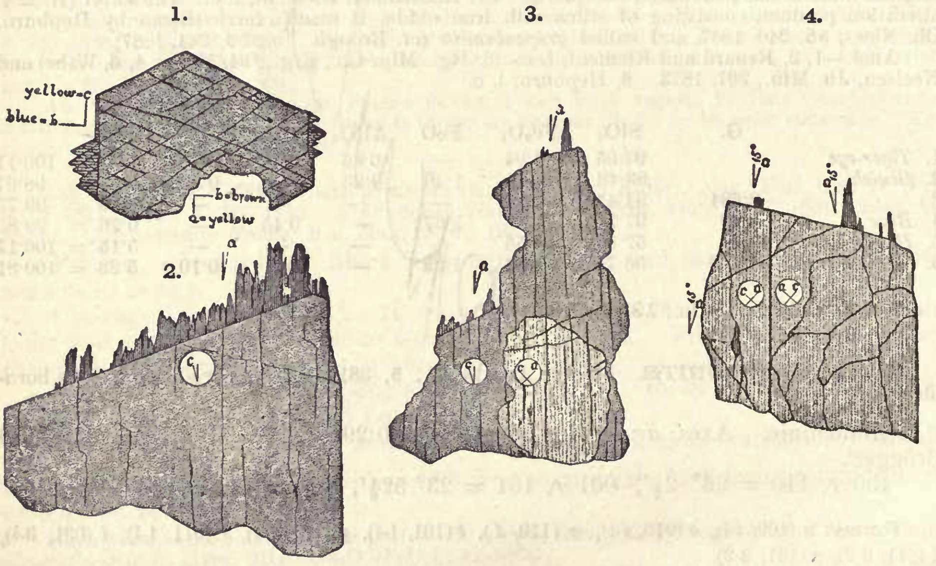
|  | G. |  | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Kangerdluarsuk | 3·44 |  | 43·85 | 4·45 | 3·80 | 33·43 | 0·45 | 0·81 | 4·65 | 8·15 | 1·06 | 0·15=100·80 |
| 2. " | 3·454 | ⅔ | 47·08 | 1·44 | 1·70 | 35·65 | — | — | 2·32 | 7·14 | 2·88 | 2·08=100·29 |

The supposed arfvedsonite from Greenland analyzed by von Kobell, Rbg., etc., has been shown to be ægirite (see p. 365); that from Pike's Peak, Colorado, analyzed by Koenig is referred to riebeckite by Lacroix, C. R., **109**, 39, 1889.

**Pyr., etc.**—B.B. fuses at 2 with intumescence to a black magnetic globule; colors the flame yellow (soda); with the fluxes gives reactions for iron and manganese. Not acted upon by acids.

**Obs.**—Occurs in black hornblende-like crystals at Kangerdluarsuk in Greenland, with sodalite, eudialyte, and feldspar; also from Kumernit, near Tunugdliarfik, Siorarsuit; the Greenland crystals are sometimes 9 inches long; also very sparingly in the augite and elæolite-syenite of the Langesund fiord, southern Norway. More abundant in quartz-syenite and soda-granite between Mjösen and the Langesund fiord, near Christiania especially at the lake Sognsvand, at Gunilrud in the parish of Eker, and Kongsberg; at Rökeberg, Eker, occurs interlaminated with ægirite in parallel position.

A blue amphibole occurring as a pseudomorphic replacement and also as a secondary growth fringing crystals and grains of ordinary brown hornblende and others of pyroxene, seems to belong here, cf. Cross, Am. J. Sc., **39**, 359, 1890. Optical character probably negative. Ax. pl. ‖ $b$. Extinction-angle on $b$, or $\mathfrak{a} \wedge \dot{c} = -13°$ to $-15°$. Axial angle large. Pleochroism: $\mathfrak{c}$ pale yellow, $\mathfrak{b}$ purple to violet, $\mathfrak{a}$ deep blue. Absorption $\mathfrak{a} > \mathfrak{b} > \mathfrak{c}$. Occurs in a dike-rock cutting the Archæan gneisses at the northern base of the Rosita hills, 5 miles east of the mining town Silver Cliff, Custer Co., Colorado. Riebeckite and a secondary pyroxene near ægirite occur in the same rock.



Figs. 1, 2, A secondary blue amphibole (arfvedsonite ?) fringing, in parallel position, brown hornblende; 3, also enclosing pyroxene. 4, Pyroxene (twin, ‖ $a$) with similar secondary amphibole, also in twinning position. Cross.

**Alt.**—The following are analyses of altered arfvedsonite by Rördam, Zs. Kr., **16**, 406, 1890.

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MnO | MgO | $Na_2O$ | $K_2O$ | $H_2O$ |  |
|---|---|---|---|---|---|---|---|---|
| 48·73 | 2·18 | 37·32 | — | 0·58 | 10·24 | 0·82 | 0·72 | = 100·59 |
| 52·12 | 2·33 | 32·33 | — | 0·62 | 10·95 | 0·88 | 0·77 | = 100 |
| 49·90 | 2·62 | 32·99 | 0·05 | 0·57 | 12·88 | 0·10 | 1·07 | = 100·18 |
| 49·50 | 2·75 | 32·86 | 0·06 | 0·60 | 13·01 | — | 1·53 | = 100·31 |

As shown by Steenstrup and Brögger, the change is one leading in the direction of the formation of an acmite (ægirite) free from calcium—in other words, a process the reverse of uralitization. Ferric hydrate and, again, magnetite occur with the acmite. Lepidomelane also occurs with the acmite as a result of the change, analogous to "pterolite" noted under barkevikite beyond.

**Ref.**—[1] Lille-Arö, Norway, Zs. Kr., **16**, 398, 1890.

342A. BARKEVIKITE *W. C. Brögger*, G. För. Förh., **9**, 269, 1887; Zs. Kr., **16**, 412, 1890. Barkevicite.

An amphibole near arfvedsonite. In short or long prismatic crystals, sometimes very large and rough; showing the forms: *b* (010), *r* (011), *p* ($\bar{1}01$), *k* ($\bar{2}11$), *z* ($\bar{1}21$). Cleavage: prismatic, perfect, yielding an angle of 55° 44½′; *b* also rather perfect. Fracture uneven. Brittle. G. = 3·428 Rg. Luster vitreous. Color deep velvet-black. Pleochroism marked: deep brown and light brown-yellow for the axes ∥ *b*, the former for the axis inclined + 12½° to $\acute{c}$; brownish red for the axis $\mathfrak{b}$, normal to *b*. Extinction-angle with $\acute{c}$ on *b* = + 12½°.

Composition near arfvedsonite, but more basic; the ratio of $SiO_2 : (Al,Fe)_2O_3 : (Fe,Mn,Ca,Mg)O : (Na,K)_2O = 0·707 : 0·148 : 0·498 : 0·113$ for Flink's analysis (calc., Bgr.). Analyses 1, 2 are referred here by Brögger, while other amphiboles from Fredriksvärn analyzed by Rg. (l. c.) are shown to be intermediate between barkevikite and ordinary hornblende.

1, Plantamour, Bibl. Univ., **6**, 337, 1841. 2, Rg., Pogg., **103**, 447, 1858. 3, Flink, Zs. Kr., **16**, 412, 1890.

| | G. | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $Na_2O$ | $K_2O$ | Ign. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Brevik | | 46·57 | 2·02 | 3·41 | — | 24·38 | 2·07 | 5·91 | 5·88 | 7·79 | 2·96 | — | =100·99 |
| 2. " | 3·428 | 42·27 | 1·01 | 6·31 | 6·62 | 21·72 | 1·13 | 9·68 | 3·62 | 3·14 | 2·65 | 0·48 | = 98·63 |
| 3. Barkevik | | 42·46[a] | — | 11·45 | 6·18 | 19·93 | 0·75 | 10·24 | 1·11 | 6·08 | 1·44 | — | = 99·64 |

[a] Incl. $TiO_2$.

B B. fuses easily, but somewhat less so than arfvedsonite.

Occurs at the wöhlerite locality, Skudesundsskjär near Barkevik (or Barkevig) on the Langesund fiord; also as an essential constituent of the augite-syenite of southern Norway, in the region between the Christiania and Langesund fiords. Sometimes occurs in parallel intergrowth with arfvedsonite, and again with a green hornblende.

PTEROLITE *Breithaupt*, B. H. Ztg., **24**, 336, 1865. Described as a member of the mica group, from the Brevik region, Norway, occurring in scales of an olive-green to liver-brown color grouped in fan-shaped forms (hence named from *πτερόν, feather*). Analyzed by Müller (l. c.). Shown by Lacroix to be a heterogeneous substance (Bull. Soc. Min., **10**, 145, 1887), and later by Brögger (Zs. Kr., **16**, 418, 1890) to be an alteration-product of the amphibole, barkevikite, the soluble portion being lepidomelane and the insoluble ægirite. Anal., Müller:

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| *Soluble* | 36·08 | 4·99 | 25·98 | 14·28 | 5·43 | 3·68 | 7·96 | 1·31 |
| *Insoluble* | 50·14 | 12·03 | — | 23·43 | 6·88 | — | 7·52 | — |

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## γ. *Triclinic Section.*

**343. ÆNIGMATITE.** Ainigmatit *Breith.*, B. H. Ztg., **24**, 398, 1865. Kölbingit *Id.*, ibid. *Lorenzen*, Min. Mag., **5**, 55, 1882. Cossyrit *Förstner*, Zs. Kr., **5**, 348, 1881.

Triclinic. In crystals approximating closely in angle, habit, and occurring forms to ordinary amphibole, but having a prismatic angle of 66°. Axes[1] (approx.) $\breve{a} : \bar{b} : \acute{c} = 0·6778 : 1 : 0·3506$; $\alpha = 90°$, $\beta = 72° 49'$, $\gamma = 90°$.

**Forms,** *Ænigmatite:*
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)
*m* (110, *I*′)
*e* (130, *i*-3̆′)
*M* ($1\bar{1}0$, ′*I*)
*ϵ* ($1\bar{3}0$, ′*i*-3̆)
*p* ($\bar{1}01$, ,1-ī,)?
*r* (011, 1-ĭ′)
*j* (031, 3-ĭ′)
*ρ* (051, 5-ĭ′)
*R* ($0\bar{1}1$, ′1-ĭ)
*i* ($0\bar{3}1$, ′3-ĭ)
*ξ* ($0\bar{5}1$, ′5-ĭ)
*z* ($\bar{1}21$, ,2-2̆)
*φ* ($\bar{4}\bar{3}3$, $\frac{4}{3}$-$\frac{4}{3}$,)
*ζ* ($\bar{1}\bar{2}1$, 2-2̆,)

Measured angles: $mM = 66° 31'$ Breith.; also, Bgr., $mM = 66° 4'$ to $66° 11'$, $bm = 56° 44'$ to 45′, $b\rho = 29° 38\frac{1}{2}'$, $Mz = 62° 23\frac{1}{2}'$, $m\rho = 53° 12'$, $M\rho = 68° 34'$.

*Cossyrite:*
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)
*m* (110, *I*′)
*e* (130, *i*-3̆′)
*M* ($1\bar{1}0$, ′*I*)
*ϵ* ($1\bar{3}0$, ′*i*-3̆)
*p* ($\bar{1}01$, ,1-ī,)
*r* (011, 1-ĭ′)
*ρ* (051, 5-ĭ′)
*i* ($0\bar{3}1$, ′3-ĭ)
*d* ($0\bar{7}1$, ′7-ĭ)
*x* (213, $\frac{2}{3}$-2′)
*u* (233, 1-$\frac{3}{2}$′)
*f* ($\bar{4}33$, ,$\frac{4}{3}$-$\frac{4}{3}$)
*v* ($\bar{2}31$, ,3-$\frac{3}{2}$)
*z* ($\bar{1}21$, ,2-2̆)
*k* ($\bar{2}\bar{1}1$, 2-2̄,)
*ζ* ($\bar{1}\bar{2}1$, 2-2̆,)
*σ* ($\bar{2}\bar{5}1$, 5-$\frac{5}{2}$,)
*q* ($2\bar{1}1$, ′2-2̄)

The following are angles for cossyrite (Förstner) compared with the corresponding angles for amphibole:

| | Cossyrite | Amphibole | | Cossyrite | Amphibole |
|---|---|---|---|---|---|
| $mM =$ | 65° 51′ | 55° 49′ | $b\rho =$ | 29° 27′ | 35° 19′ |
| $bm =$ | 56° 38′ | 62° 5½′ | $bi =$ | 44° 50′ | 49° 44′ |
| $ab =$ | 90° 6′ | 90° 9′ | $bk =$ | 74° 6′ | 77° 13′ |
| $a'p =$ | 77° 47′ | 75° 2′ | $mk =$ | 50° 36′ | 49° 24′ |
| $br =$ | 71° 29′ | 74° 14′ | $pk =$ | 29° 23′ | 27° 25′ |

Crystals prismatic in habit. Twins common with tw. pl. $b$, contact-twins; also with enclosed tw. lamellæ, giving striations on the terminal planes and on $a$.

Cleavage: prismatic, distinct. Fracture uneven. Brittle. G. = 3·85 Breith., 3·80 Lorenzen, for ænigmatite; 3·74–3·75 Förstner, for cossyrite. Luster vitreous. Color black. Streak reddish brown. Translucent to opaque.

Pleochroism strongly marked, especially for sections ∥ $b$; for those ∥ $a$ less so. $\mathfrak{c}$ brown-black, $\mathfrak{b}$ deep chestnut-brown, $\mathfrak{a}$ clear red-brown. Absorption strong, $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$. Optically +. Ax. pl. nearly ∥ $b$. Extinction-angle with $\acute{c}$ on $a = 3°\ 46'$, on $b = 44°\ 57'$. Bx $\wedge\ \acute{c} = +\ 45°$ approx. Ax. angle rather small, 2E = 60° approx. Bgr.

**Var.**—1. *Ænigmatite* occurs in prismatic crystals, sometimes several inches in length. H. = 5·55. G. = 3·833–3·863 Breith., 3·80 Lorenzen. Color black. Streak reddish brown. Optical characters as given above. Breithaupt regarded the ænigmatite as pseudomorphous after kölbingite, which latter was distinguished by a pistachio-green streak and low specific gravity, viz. 3·60–3·61. The form of the two he made the same. Lorenzen, however, shows that the ænigmatite crystals cannot be pseudomorphs, while Brögger suggests that "kölbingite" may be only a parallel intergrowth of arfvedsonite and ænigmatite, such as he has observed.

2. *Cossyrite* occurs in minute embedded crystals. G. = 3·74–3·75. Color black. Extinction-angle with $\acute{c}$ on $a = 3°$, on $b = 39°$ approx.

**Comp.**—Essentially a titano-silicate of ferrous iron and sodium, but containing also aluminium and ferric iron, and slightly more basic than a normal metasilicate.

Forsberg's analysis for ænigmatite gives nearly $2Na_2O.9FeO.AlFeO_3.12(Si,Ti)O_2$.

Förstner's analysis for cossyrite approximates to $2Na_2O.10FeO.Al_2O_3.Fe_2O_3.15SiO_2$. As has been suggested, it is not improbable that cossyrite, like ænigmatite, contains titanium, replacing part of the silicon.

**Anal.**—1, Forsberg, quoted by Bgr. 2, Förstner, l. c.

| | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. *Ænigmatite* | 37·92 | 7·57 | 3·23 | 5·81 | 35·88 | 1·00 | 0·33 | 1·36 | 6·58 | 0·51 | = 100·19 |
| 2. *Cossyrite* | 43·55[a] | — | 4·96 | 7·97 | 32·87 | 2·37[b] | 0·86 | 2·01 | 5·29 | 0·33 | = 100·21 |

[a] Incl. $TiO_2$?. [b] Incl. 0·39 CuO.

**Pyr., etc.**—B.B. fuses easily to a brownish black glass. Partially decomposed by acids.

**Obs.**—*Ænigmatite* (and kölbingite) occurs in sodalite-syenite at Naujakasik near Tunugdliarfik, also at Kangerdluarsuk, Greenland; the first crystals were collected by Giesecke about 1810. Probably also in the Langesund fiord region of southern Norway, but not positively identified; Breithaupt is quoted (Bgr.) as mentioning the occurrence of a mineral resembling kölbingite with a prismatic angle of 66° to 67° from "Brevik." Probably in the elæolite-syenite of the peninsula Kola, Russian Lapland (Ramsay). Ænigmatite is named from αἴνιγμα, an *enigma*.

*Cossyrite* occurs in minute crystals embedded in the liparyte lavas of the island Pantellaria (whose ancient name was Cossyra). The crystals examined were weathered out of the groundmass.

**Ref.**—[1] Calculated from Förstner's angles: $110 \wedge 1\bar{1}0 = 65°\ 51'$; $br = 71°\ 29'$, $ar = 73°\ 44'$. Förstner calculates the following axial ratio and angles (referred to the usual amphibole position, where $r = \bar{1}\bar{1}1$, etc., see p. 398):

$$\breve{a} : \bar{b} : \acute{c} = 0·6627 : 1 : 0·3505; \quad \alpha = 90°\ 6', \quad \beta = 89°\ 54', \quad \gamma = 102°\ 13'.$$

Inasmuch, however, as the fundamental angles are the means of measurements varying widely, in one case more than 2°, the results can only be regarded as approximations. The table of calculated angles contains bewildering errors, *e. g.*: $010 \wedge 110 = 56°\ 38'$, $110 \wedge 1\bar{1}0 = 65°\ 51'$, $1\bar{1}0 \wedge 010 = 57°\ 6'$, which together equal 179° 35′ instead of 180°; again, $100 \wedge 110 = 33°\ 3'$, $110 \wedge 130 = 30°\ 21'$, $130 \wedge 010 = 26°\ 17'$, that is 89° 41′; while $100 \wedge 010 = 90°\ 6'$; etc.

The triclinic form of kölbingite (and ænigmatite), partly made out by Breithaupt, was established by Brögger, who also shows that there can be no doubt as to the identity of ænigmatite and the triclinic cossyrite.

## 4. Beryl Group. Hexagonal.

**344. Beryl** $Be_3Al_2(SiO_3)_6$ Hexagonal $\dot{c}$ 0·4989

**344. BERYL.** Σμάραγδος pt. [rest Chrysocolla, Malachite, etc., and other green stones] *Theophr.* Βήρυλλος *Gr.* Smaragdus pt. [rest as above] + Beryllus (Chrysoberyllus, Chrysoprasius, incl.) *Plin.*, **37**, 16–20. Emerald; Beryl; Aquamarine. Smaragdus + Beryll *Wall.*, Min., 117, 122, 1747. Smaragdus + Bloagrön Topas (= Beryll, Aquamarin) *Cronst.*, Min., 44, 1758. Émeraude (incl. Emerald and Beryl or "Aigue-marine," and Chrysolite du Brésil) *de Lisle*, Crist., 135, 1772, **2**, 245, 1783; *H.*, J. d. M., **4**, 72, 1798, Tr., **2**, 1801. Schmaragd + Beril *Wern.*, the two as distinct sp. until 1811. A silicate of alumina with lime *Achard*, Edelst., 47, 1779; *Bergm.*, Opusc., **2**, 96, 1782; and others. A silicate of alumina and glucina *Vauq.*, J. d. M., **4**, 1798, **7**, 97, 1800; *Klapr.*, Beitr., **3**, 221, 1802. Davidsonite *Thomson*, Min., **1**, 247, 1836. Goshenite *Shep.*, Min., **1**, 143, 1844. Rosterite *Grattarola*, Riv. Scientif.-industr., No. 19, 1880.

Smaragd, Beryll, *Germ.* Beryl, Émeraude, Aigue-marine, *Fr.* Berillo, Smeraldo, *Ital.* Berilo, Esmeralda, *Span.*

Hexagonal. Axis $\dot{c}$ = 0·498855; 0001 ∧ $10\bar{1}1$ = 29° 56′ 35″ Koksharov[1].

**Forms**[2]:

$c$ $(0001, O)$

$m$ $(10\bar{1}0, I)$
$a$ $(11\bar{2}0, i\text{-}2)$
$\epsilon$ $(51\bar{6}0, i\text{-}\frac{6}{5})^8$
$i$ $(21\bar{3}0, i\text{-}\frac{3}{2})$

$\rho$ $(1\cdot0\cdot\bar{1}\cdot14, \frac{1}{14})$
$\psi$ $(1\cdot0\cdot\bar{1}\cdot12, \frac{1}{12})^7$
$\tau$ $(20\bar{2}5, \frac{2}{5})$
$\pi$ $(10\bar{1}2, \frac{1}{2})$
$p$ $(10\bar{1}1, 1)$
$r$ $(30\bar{3}2, \frac{3}{2})$
$u$ $(20\bar{2}1, 2)$
$\vartheta$ $(30\bar{3}1, 3)^5$
$\lambda$ $(70\bar{7}2, \frac{7}{2})^{10}$
$t$ $(40\bar{4}1, 4)^5$
$\Omega$ $(50\bar{5}1, 5)$
$x$ $(15\cdot0\cdot\bar{15}\cdot2, \frac{15}{2})$
$T$ $(12\cdot0\cdot\bar{12}\cdot1, 12)^5$
$e$ $(39\cdot0\cdot\bar{39}\cdot2, \frac{39}{2})$

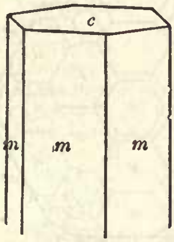
$\omega$ $(1\cdot1\cdot\bar{2}\cdot12, \frac{1}{6}\text{-}2)^6$
$q$ $(3\cdot3\cdot\bar{6}\cdot10, \frac{3}{5}\text{-}2)^3$
$\sigma$ $(11\bar{2}3, \frac{2}{3}\text{-}2)^5$
$o$ $(11\bar{2}2, 1\text{-}2)$
$\delta$ $(5\cdot5\cdot\bar{10}\cdot7, \frac{10}{7}\text{-}2)$?
$d$ $(33\bar{6}4, \frac{3}{2}\text{-}2)$
$s$ $(11\bar{2}1, 2\text{-}2)$
$f$ $(33\bar{6}1, 6\text{-}2)^5$
$\Phi$ $(6\cdot6\cdot\bar{12}\cdot1, 12\text{-}2)$

Zone *ms*

$h$ $(19\cdot1\cdot\bar{20}\cdot1, 20\text{-}\frac{20}{19})$
$y$ $(13\cdot1\cdot\bar{14}\cdot1, 14\text{-}\frac{14}{13})$
$\beta$ $(11\cdot1\cdot\bar{12}\cdot1, 12\text{-}\frac{12}{11})$
$w$ $(71\bar{8}1, 8\text{-}\frac{8}{7})$
$l$ $(11\cdot2\cdot\bar{13}\cdot2, \frac{13}{2}\text{-}\frac{13}{11})^4$?
$\nu$ $(51\bar{6}1, 6\text{-}\frac{6}{5})^8$
$n$ $(31\bar{4}1, 4\text{-}\frac{4}{3})$
$v$ $(21\bar{3}1, 3\text{-}\frac{3}{2})$

$\gamma$ $(71\bar{8}4, 2\text{-}\frac{8}{7})$
$g$ $(51\bar{6}5, \frac{6}{5}\text{-}\frac{6}{5})^5$
$\Delta$ $(21\bar{3}3, 1\text{-}\frac{3}{2})$
$z$ $(42\bar{6}3, 2\text{-}\frac{3}{2})$
$k$ $(42\bar{6}1, 6\text{-}\frac{3}{2})$
$\Sigma$ $(16\cdot8\cdot\bar{24}\cdot1, 24\text{-}\frac{3}{2})$
$X$ $(36\cdot24\cdot\bar{60}\cdot5, 12\text{-}\frac{5}{3})^{15}$

1.



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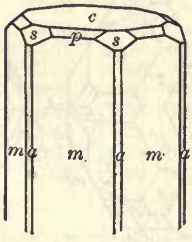

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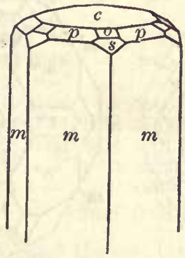

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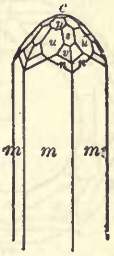


Figs. 1, 2, Middletown, Conn. 3, Haddam, Conn. 4, Alexander Co., N. C.

$mi$ = 19° 6′
$ma$ = 30° 0′

$c\rho$ = 2° 21′
$c\psi$ = 2° 45′
$c\tau$ = 12° 58½′
$c\pi$ = 16° 4′
$cr$ = 40° 50′
$cu$ = 49° 2½′
$c\vartheta$ = 59° 56½′
$ct$ = 66° 32′
$c\Omega$ = 70° 51′
$cx$ = 76° 58′
$cT$ = 81° 46′
$ce$ = 84° 55′

$c\omega$ = 4° 45′
$c\sigma$ = 18° 24′
$co$ = 26° 31′
$cd$ = 36° 48′
$cs$ = 44° 56′
$cf$ = 71° 31½′
$c\Phi$ = 80° 31′

$cn$ = 64° 17′
$cv$ = 56° 44′

$\tau\tau'$ = 12° 53½′
$\pi\pi'$ = 15° 54½′
$pp'$ = *28° 54¼′
$rr'$ = 38° 10′
$uu'$ = 44° 22′

$\omega\omega'$ = 4° 45′
$\sigma\sigma'$ = 18° 9½′
$oo'$ = 25° 48′
$dd'$ = 34° 52′
$ss'$ = 41° 21½′

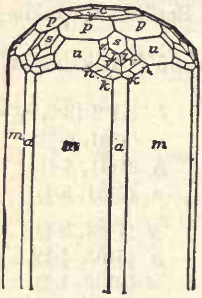
$mh$ = 5° 41′
$my$ = 8° 11′
$m\beta$ = 9° 34½′
$mw$ = 14° 30′
$ml$ = 17° 55′
$mn$ = 29° 0′
$mv$ = 37° 49′
$ms$ = 52° 17′
$mg'$ = 70° 9½′
$mp'$ = 75° 33′

$ap$ = 64° 23′
$nn'$ = 28° 56½′
$nn^{xi}$ = 25° 0′
$zz'$ = 15° 29′
$zz^{xi}$ = 26° 59′
$vv'$ = 18° 11′
$vv^{xi}$ = 31° 46′
$kk'$ = 20° 41′
$kk^{xi}$ = 36° 14½′
$\gamma\gamma'$ = 34° 1′
$\gamma\gamma^{xi}$ = 9° 41′
$\Delta\Delta'$ = 9° 49′
$\Delta\Delta^{xi}$ = 17° 3′
$ww'$ = 45° 34′
$ww^{xi}$ = 12° 50′

Crystals usually long prismatic, often striated vertically, rarely transversely; distinct terminations exceptional. Rarely tabular in habit[9]. Occasionally in large masses, coarse columnar or granular to compact.

Cleavage: ĉ imperfect and indistinct. Fracture conchoidal to uneven. Brittle. H. = 7·5–8. G. = 2·63–2·80; usually 2·69–2·70. Luster vitreous, sometimes resinous. Color emerald-green, pale green, passing into light blue, yellow and white; also pale rose-red. Streak white. Transparent to subtranslucent. Dichroism more or less distinct. Optically –. Double refraction feeble. Often abnormally biaxial[11]. Refractive indices, for green rays, Dx.[13]:

5.



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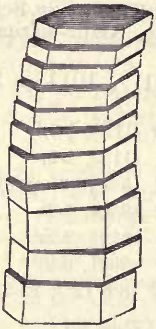

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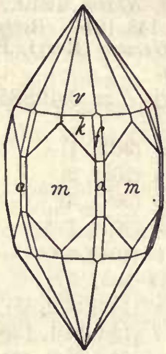

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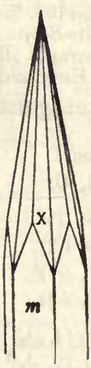
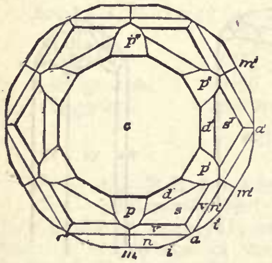


5, Alexander Co., N. C., Washington. 6, Monroe, Conn. 7, Willimantic, Conn., Pfd.[12]
8, Mt. Antero, Col., Id.

9.



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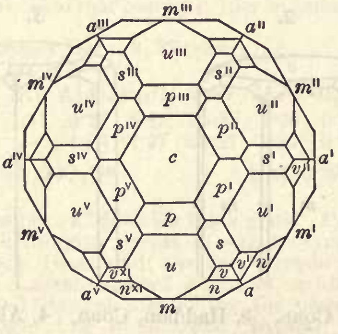

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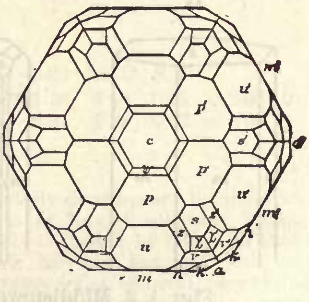

9–11, Alexander Co., N. C., basal projections; 9, 11, Washington.

*Emerald*, Muso $\omega = 1{\cdot}5841$ Elba $\omega = 1{\cdot}5771$ *Aquamarine*, Siberia $\omega = 1{\cdot}5820$
" " $\epsilon = 1{\cdot}5780$ " $\epsilon = 1{\cdot}5720$ " " $\epsilon = 1{\cdot}5765$

Also, Dufet[13]:

$\omega_r = 1{\cdot}58620$ Li $\omega_y = 1{\cdot}58935$ Na $\omega_{gr} = 1{\cdot}59210$ Tl
$\epsilon_r = 1{\cdot}57910$ Li $\epsilon_y = 1{\cdot}58211$ Na $\epsilon_{gr} = 1{\cdot}58485$ Tl

**Var.**—1. *Emerald.* Color bright emerald-green, due to the presence of a little chromium; it is highly prized as a gem when clear and free from flaws. The gem emeralds are locally known in South America as *canutillos;* the coarse, ill-formed or nodular emeralds are called morallons, see anal. 2 (Bouissingault).

The color was attributed to chromium by Vauquelin, but this was questioned by Lewy (see below). Wöhler, however, found in a Muso emerald 0·186 p. c. $Cr_2O_3$; it lost 1·62 p. c. upon ignition, but retained its color, Pogg., **122**. 492, 1864. This has been confirmed by later observers, Hofmeister, Rose, Williams. The last named (Proc. Roy. Soc., **21**. 409, 1873) finds carbon present as such, but the color is not lost by heating though the specific gravity falls by fusion from 2·69 to 2·40 and the fused mass can be scratched by quartz.

2. *Ordinary; Beryl.* Generally in hexagonal prisms. often coarse and large; green the common color. The following are determinations of the specific gravity given by Koksharov for Uralian beryls: colorless, transparent 2·694, 2 695; yellowish 2·681–2·694; green 2·702, 2·710; rose-red 2·725. Also 2·65, 2·66 for an Irish beryl, Williams, but after fusion 2·41. The cæsium beryl from Hebron, Me. (anal. 10), has G. = 2·79–2·81; it is perfectly transparent with a pale greenish tinge.

The principal kinds are: (*a*) colorless; (*b*) bluish green, called *aquamarine*, a name suggested, though not used, by Pliny, where he says of it, "qui viriditatem puri maris imitantur;" (*c*) apple-green; (*d*) greenish yellow to iron-yellow and honey-yellow (apparently *chrysoberyllus* of Pliny and ancient jewelry); sometimes a clear bright yellow as in the *golden beryl;* (*e*) pale yellowish green (probably the *chrysoprasius* Plin., and perhaps his *chrysolithus* in part, as also in more modern times); (*f*) clear sapphire-blue (*hyacinthozontes* of Plin.); (*g*) pale sky-blue (*aeroides* Plin.); (*h*) the pale violet or reddish (*améthiste basaltine* Sage, Min., 231); (*i*) the opaque brownish yellow, of waxy or greasy luster.

The *oriental emerald* of jewelry is emerald-colored sapphire. *Davidsonite* is greenish yellow beryl from near Aberdeen; it was supposed to contain "donium," Rec. Gen. Sc., 3, 426, 1836. *Goshenite* is a colorless or white variety of beryl from Goshen, Mass.

The union of emerald and beryl in one species, which Pliny says was suggested in his time, was first recognized on crystallographic grounds by De Lisle, and more satisfactorily through measurements of angles by Haüy; and chemically by Vauquelin.

**Comp.**—$Be_3Al_2Si_6O_{18}$ or $3BeO.Al_2O_3.6SiO_2$ = Silica 67·0, alumina 19·0, glucina 14·0 = 100.

As shown by Penfield alkalies ($Na_2O$, $Li_2O$, $Cs_2O$) are sometimes present replacing the beryllium, from 0·25 to 5 p. c.; also chemically combined water, including which the formula becomes $H_2Be_6Al_4Si_{12}O_{37}$. The Hebron beryl (anal. 10) is remarkable as containing 3·6 p.c. of cæsium oxide.

**Anal.**—1, Lewy, Ann. Ch. Phys., **53**, 5, 1858. 2, Boussingault, C. R., **69**, 1249, 1869. 3, Brax, Zs. Kr., **7**, 80, 1882. 4, Rg., Min. Ch., 650, 1875. 5, Spezia, Att. Acc. Torino, **17**, June 25, 1882. 6, Klatzo, JB. Ch., 1216, 1869. 7, Dmr., Bull. Soc. Min., **9**, 153, 1886. 8, Baker, Am. Ch. J., **7**, 175, 1885. 9, Penfield and Harper, Am. J. Sc., **32**, 110, 1886; the earlier analyses by Pfd., ib., **28**, 25, 1884, are rejected by him as regards the $Al_2O_3$ and BeO, but the determinations of alkalies and water are given below. 10, H. L. Wells, priv. contr. 11, Genth, Am. Phil. Soc., 402, 1882. Also 5th Ed., p. 247, 1868.

| | | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | BeO | CaO | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Muso, *emerald* | 2·67 | $\frac{2}{2}$ 67·85 | 17·95 | *tr.*[a] | 12·4 | 0·9[b] | 0·7 | — | = 99·8 |
| 2. | " " | 2·640 | 67·2 | 19·4 | *tr.*[a] | 12·7 | 0·4[b] | — | — | = 99·7 (loss on ign. 1·92) |
| 3. | Paavo, Finl., " | 2·614 | 66·37 | 19·26 | — | 14·01 | — | — | — | = 99·64 |
| 4. | Elba | 2·618 | 66·08 | 18·16 | — | 14·69 | — | — | 1·07 | = 100 |
| 5. | Craveggia | | 65·12 | 19·65 | 0·67 | 11·49 | 0·48[b] | — | 1·95 | = 99·36 |
| 6. | Limoges | | $\frac{2}{2}$ 67·78 | 17·58 | 0·27 | 13·72 | — | — | — | = 99·35 |
| 7. | Madagascar, *rose* | 2·72 | 66·56 | 18·66 | 0·30[c] | 12·47 | 0·06 | — | 2·30 | = 100·35 |
| 8. | Amelia Co., N.C. | 2·702 | 65·24 | 17·05 | 2·20 | 12·64 | 0·57 | 0·68 | 2·70 | = 101·08 |
| 9. | Stoneham, Me. | 2·706 | 65·54 | 17·75 | 0·59[d] | 13·73 | 0·06 | 0·71 | 2·01 | $Li_2O$ *tr.* = 100·39 |
| 10. | Hebron, Me. | 2 80 | 62·44 | 17·74 | 0·40 | 11·36 | — | 1·13 | 2·03 | $Li_2O$ 1·60, $Cs_2O$ 3·60 = [100·30 |
| 11. | Alex. Co., N. C. | 2·703 | 66·28 | 18·60 | 0·22[e] | 13·61 | — | — | 0·83 | = 99·54 |

[a] $Cr_2O_3$. [b] MgO. [c] FeO. MnO 0·21. [d] Incl. 0·38 FeO. [e] FeO.

The following are alkali determinations by Penfield and Harper, l. c.:

| | Hebron | Norway, Me. | Branchville | Amelia Co. | Royalston | Stoneham | Adun-Chalon |
|---|---|---|---|---|---|---|---|
| G. | | 2·744 | 2·732 | 2·685 | 2·711 | 2·708 | 2·676 |
| $Na_2O$ | 1·82 | 1·39 | 1·45 | 0·46 | 0·51 | 0·49 | 0·24 |
| $Li_2O$ | 1·17 | 0·84 | 0·72 | 0·13 | 0·05 | *tr.* | *tr.* |
| $Cs_2O$ | 2·92 | 1·66 | — | — | — | — | — |
| Ign. | 2·33 | 2·44 | 2·69 | 2·19 | 2·04 | 2·08 | 1·14 |

Also Habachthal, Tyrol, 2·26 $Na_2O$; Bodenmais 1·20 $Na_2O$; Limoges 0·73 $Na_2O$; further some $Li_2O$ in all. In a beryl from Elba, with G. = 2·70–2·71, Bechi found 0·88 $Cs_2O$, Boll. Com. Geol., 1, 83, 1870.

An anomalous composition to a beryl from Glencullen, Ireland, is given by Hartley, but the analysis calls for confirmation. Proc. R. Dublin Soc., 5, 627, 1887.

Rosterite *Grattarola*, l. c. A slightly altered variety of beryl from Elba, named after Dr. G. Roster. It occurs in short prismatic to tabular doubly-terminated crystals. In polarized light a basal section is divided into six sectors, corresponding to the prismatic edges, for the three alternate of which the extinction is the same. Optically biaxial. Color pale rose-red. Anal. 1–4, Grattarola; 1, 2, from the ends of a crystal, which had a nucleus of normal beryl (anal. 3); 4, "typical rosterite."

| | G. | $SiO_2$ | $Al_2O_3$ | BeO | MgO | CaO | $Na_2O,K_2O$ | $Li_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 2·77 | 61·97 | 21·93 | 8·62 | 1·26 | 0·42 | *undet.* | — | *undet.* | |
| 2. | 2·74 | 60·26 | 21·18 | 9·71 | 1·57 | 2·55 | *undet.* 0·58 | *tr.* | 3·07 | = 98·92 |
| 3. | 2·77 | 62·88 | 17·09(?) | 15·97(?) | 2·62 | 2·99 | *undet.* | — | 2·32 | = 103·87 |
| 4. | 2·75 | 61·34 | 23·20 | 8·81 | 0·50 | 2·19 | 1·00 | — | 2·03 | = 99·07 |

**Pyr., etc.**—B.B. alone, unchanged or, if clear, become milky white and clouded; at a high temperature the edges are rounded, and ultimately a vesicular scoria is formed. Fusibility = 5·5 (Kobell), but somewhat lower for beryls rich in alkalies. Glass with borax, clear and colorless for beryl, a fine green for emerald. A yellowish variety from Broddbo and Finbo yields with soda traces of tin. Unacted upon by acids.

According to Lewy, the emerald of Muso becomes white at a red heat, and loses, as a mean result, 1·66 of water and 0·12 of organic matter, the latter consisting of 0·03 to 0·05 of hydrogen and 0·09 to 0·06 of carbon. Wöhler and Williams, however, as noted above, confirm the loss upon ignition (cf. Pfd.), but find the color retained.

**Obs.**—Beryl is a common accessory mineral in granite veins, in all parts of the world, especially in those of a pegmatitic character. Emeralds occur in clay slate, in isolated crystals or in nests, near Muso, etc., 75 m. N.N.E. of Bogota, United States of Colombia; the rock contains Cretaceous fossils in its limestone concretions. Emeralds of less beauty, but much larger, occur in Siberia, on the river Tokovoya, N. of Ekaterinburg, with phenacite, chrysoberyl, apatite, rutile, etc., embedded in mica schist. Also at Paavo, near Orijärvi, Finland. Mount Zalora, in Upper Egypt, affords a less distinct variety, and was the only locality which was known to the ancients. Occurs in the Heubachthal in Salzburg, in mica schist.

Emeralds of large size, though not of uniform color or free from flaws, have been obtained in Alexander Co., N. C., in pockets in gneiss, associated with hiddenite (spodumene), rutile, muscovite, etc. One crystal had a length of 9 inches; another was 3 in. long by 1¾ across and weighed 9 oz.

Transparent beryls are found in Siberia, India, and Brazil. In Siberia they occur at the emerald mine mentioned, at Mursinka and Shaitanka, near Ekaterinburg; near Miask with topaz; in the mountains of Adun-Chalon with topaz, in E. Siberia; in British India in the Coimbatore district and in the Punjab Himalayas; in Brazil on Rio San Mateo. Some Siberian transparent crystals exceed a foot in length. The most splendid aquamarine of which we have any account is from Brazil; it approaches in size, and also in form, the head of a calf, and exhibits a crystalline structure only on one side; the rest is water-worn; and it weighs 225 oz. troy, or more than 18½ lbs.; the specimen is transparent and without a flaw. Beautiful crystals also occur at Elba; at Lonedo in north-eastern Italy, with corundum, zircon, topaz, spinel; the tin mines of Ehrenfriedersdorf in Saxony, and of Schlackenwald in Bohemia.

Other localities are, the Mourne Mts., Ireland, Co. of Down; also Killiney near Dublin; yellowish green at Rubislaw, near Aberdeen, Scotland (davidsonite), and elsewhere in Aberdeenshire; in small bluish crystals at St. Michael's Mount in Cornwall; Limoges in France; Finbo and Broddbo in Sweden; Tamela and Somero in Finland; Fossum in Norway; Pfitsch-Joch, Tyrol; Bodenmais and Rabenstein in Bavaria; in New South Wales at various localities.

In the United States, beryls of gigantic dimensions have been found in *N. Hamp.*, at Acworth and Grafton, and in *Mass.*, at Royalston; but they are mostly poor in quality. One beryl from Grafton weighs 2,900 lbs.; it is 32 in. through in one direction and 22 in another transverse, and is 4 ft. 3 in. long. Another crystal from this locality, according to Prof. Hubbard, measures 45 in. by 24 in its diameters, and a single foot in length by calculation weighs 1,076 lbs., making it in all nearly 2½ tons. At Royalston, one crystal exceeded a foot in length; the smaller crystals are often limpid, and a yellowish variety forms a gem resembling chrysolite; the colors are mostly aquamarine, grass-green, and yellowish green; one locality is in the south-east part of Royalston, near the school-house, on the land of Mr. Clarke; the best crystals are embedded in quartz; a still better is situated 4 m. beyond the old one in South Royalston; some crystals of a sky-blue color in white quartz are beautiful.

Other localities are in *Maine*, at Albany; Norway; Bethel; at Hebron, a cæsium beryl (anal. 10) associated with pollucite; in Paris, with black tourmaline; at Bowdoinham and Topsham, pale green or yellowish; at Georgetown, Parker's island, mouth of Kennebec. In *N. Hamp.*, at Wilmot; at Compton, as good as at Royalston. In *Mass.*, at Barre, excellent specimens; at Pearl Hill in Fitchburg; at Goshen (goshenite), and at Chesterfield. In *Conn.*, at Haddam, in a feldspar vein in gneiss, on the east side of the river, the crystals having the terminations for a twelfth of an inch transparent; also at the chrysoberyl locality; at the Middletown and Portland feldspar quarries; in Chatham, in granite; at Monroe, in a granite vein, the crystals often consisting of displaced pieces separated by quartz; at Madison, in beautiful crystals; at New Milford, of a clear golden yellow to dark amber color, also fine green; a clear glassy kind in Willimantic, Conn.[12]; in large columnar masses at Branchville. In *Penn.*, at Leiperville and Chester, crystals sometimes 10 to 12 in. long and 1½ in diameter, with black tourmaline; at Mineral Hill. In *Virginia*, at Amelia Court House, sometimes pure white. In *N. Carolina*, in Alexander Co., near Stony Point, fine emeralds (see above), also clear green crystals, sometimes very highly modified; in Mitchell Co.; Morganton, Burke Co., and elsewhere. In *Alabama*, Coosa Co., of a light yellow color. In *Colorado*, near the summit of Mt. Antero, beautiful aquamarines with phenacite, bertrandite, etc., often corroded leaving steep pyramidal forms in the cavities (f. 8), the crystals having been the source of the beryllium in the associated secondary minerals. In *S. Dakota*, in the Black Hills in large crystals.

**Alt.**—Kaolin, mica, limonite, and quartz occur as pseudomorphs after beryl, the last two by substitution, the others by alteration. Analyses of altered beryls; 1, Müller, J. pr. Ch., **58**, 182, 1853. 2, Damour, Bull. G. Fr., **7**, 224, 1850. Anal. 2 corresponds nearly to kaolin.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | BeO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|
| 1. Tirscheureuth | 58·8 | 24·7 | 2·6 | 10·2 | 2·5 | = | 98·8 |
| 2. Vilate, Chanteloube | 45·61 | 38·86 | 0·94 | 1·10 | 14·04 | = | 100·55 |

PSEUDOSMARAGD *Atterberg*, G. För. Förh., 2, 405, 1874. Pseudo-emerald. A mineral resulting from the alteration of beryl. The name was introduced by Berzelius for pseudomorphous crystals, consisting, as he regarded it, of ordinary beryl and mica. Atterberg retains the name for the hard portion of similar pseudomorphs, which, however, he finds to be not true beryl. Its characters are: Hardness 5·5; G. = 2·70; luster waxy; color dark grayish green; fracture splintery. Intimately mixed with mica scales. Analyses: 1, 2; the latter on material not entirely free from mica:

| | $SiO_2$ | $Al_2O_3$ | BeO | FeO | MgO | $K_2O$ | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 57·32 | 17·46 | 13·11 | 0·30 | 0·32 | 7·82 | 3·64 | = | 99·97 |
| 2. | 56·23 | 19·05 | 12·55 | 0·18 | 0·50 | 7·45 | 4·83 | = | 100·79 |

The mineral differs from ordinary beryl in having lost part of its silica and gained potash and water; the alumina and glucina are sensibly unchanged. From Kårarfvet, near Falun, Sweden.

**Ref.**—[1] Min. Russl., **1**, 147, 1853. [2] See Schrauf, Ber. Ak. Wien, **65** (1), 255, 1872, Atlas, Tf. XXXIII; also Kk., l. c. and ibid., **2**, 356; **4**, 125; **6**, 94; Vh. Min. Ges., **7**, 316, 1872 (adding some complex planes not included above); Hbg., Min. Not., **5**, 28, 1863; Dx., Min., **1**, 366, 1862; D'Achiardi, Nuovo Cimento, 1870, he adds two doubtful planes; Wiik, Öfv. Finsk. Soc., **27**, 1885, and Zs. Kr., **12**, 515.

[3] Becker-Websky, Striegau, Zs. G. Ges., **19**, 736, 1867. [4] Websky, Eidsvold, Min. Mitth., 117, 1876. [5] Vrba, emerald, Zs. Kr., **5**, 430, 1881. [6] E. S. D., Alexander Co., N. C., Am. J. Sc., **32**, 484, 1886. [7] Washington and Hidden, Alex. Co., ib., **33**, 505, 1887, also somewhat uncertain $\phi$ ($8\cdot7\cdot\bar{15}\cdot6$), $\psi$ ($9\cdot7\cdot\bar{16}\cdot8$), $\chi$ ($8\cdot7\cdot\bar{15}\cdot7$); cf. Rath, Ber. nied. Ges., Feb. 6, July 7, 1886, who adds $54\bar{9}4$ (?). [8] Busz, S. Piero, Elba, Zs. Kr., **17**, 552, 1890. [9] N. von Koksharov, Jr., Min. Russl., 8, 223. [10] Panebianco, Lonedo, Att. Ist. Veneto, **5**, 387, 1887.

[11] Mld., Ann. Mines, **10**, 148, 1876. [12] *Etching-figures* and corrosion forms, Petersson, Ak. H. Stockh., Bihang, **15** (2), No. 1, 1889; Wiik, l. c.; Pfd., Am. J. Sc., **36**, 317, 1888, **40**, 488, 1890; R. C. Hills, Proc. Colorado Soc., **3**, 191, 1889. [13] *Refractive indices*, Dx., Min., **1**, 366, 1862; Heusser, Pogg., **87**, 468, 1862; Dufet, Bull. Soc. Min., **8**, 261, 1885, also variations with change of temperature. Experiments on *Elasticity*, Vater, Zs. Kr., **11**, 582, 1886; Voigt, Jb. Min., Beil., **5**, 68, 1887. *Specific heat* = 0·2066, 0·2127, Joly, Proc. Roy. Soc., **41**, 250, 1887. *Pyroelectricity*, Hankel, Pogg., **157**, 161, 1876.

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## 5. Eudialyte Group.

**345. Eudialyte** $Na_{13}(Ca,Fe)_6Cl(Si,Zr)_{20}O_{52}$ $\dot{c} = 2{\cdot}1116$
Eucolite

**346. Catapleiite** $H_4(Na_2,Ca)ZrSi_3O_{11}$ $\dot{c} = 1{\cdot}3629$

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**345. EUDIALYTE.** Eudialyt *Stromeyer*, Gel. Anz. Gött. 1998, 1819. Eudyalite *wrong orthography*. Eukolit *Scheerer*, Pogg., **72**, 561, 1847. Eucolite. Grönlandischer Hyazinth *Trommsdorff*, Crell's Ann., **1**, 433, 1801.

Rhombohedral. Axis $\dot{c} = 2{\cdot}1116$; $0001 \wedge 10\bar{1}1 = 31° 22'$ Miller[1].

**Forms**[2]:
*c* (0001, *O*)
*m* ($10\bar{1}0$, *I*)
*a* ($11\bar{2}0$, *i*-2)
*z* ($10\bar{1}4$, $\frac{1}{4}$)
*y* ($50\bar{5}8$, $\frac{5}{8}$)
*r* ($10\bar{1}1$, 1)
*h* ($01\bar{1}5$, $-\frac{1}{5}$)
*e* ($01\bar{1}2$, $-\frac{1}{2}$)
*s* ($02\bar{2}1$, $-2$)
*n* ($11\bar{2}3$, $\frac{2}{3}$-2)
$\phi$ ($31\bar{4}2$, $1^2$)?
*t* ($21\bar{3}1$, $1^3$)

Also, but somewhat uncertain, $10\bar{1}5$, $10\bar{1}4$, $0\cdot3\cdot\bar{3}\cdot11$, $9\cdot6\cdot\bar{15}\cdot4$, Magnet Cove[3].

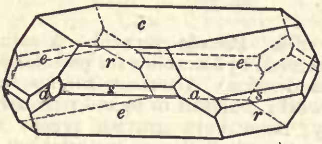
$cz = 31^\circ\ 22'$
$cy = 56^\circ\ 44'$
$cr = {}^*67^\circ\ 42'$
$ch = 26^\circ\ 0'$
$ce = 50^\circ\ 38'$
$cs = 78^\circ\ 24'$

$cn = 54^\circ\ 37'$
$c\phi = 77^\circ\ 11'$
$ci = 81^\circ\ 11'$
$zz' = 53^\circ\ 35'$
$yy' = 92^\circ\ 47'$
$rr' = 106^\circ\ 30'$

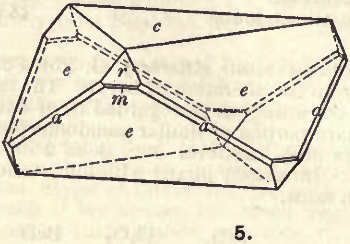
$hh' = 44^\circ\ 37'$
$ee' = 84^\circ\ 4'$
$ss' = 116^\circ\ 4'$
$ar = 36^\circ\ 45'$
$at = 23^\circ\ 59'$

$as = 47^\circ\ 58'$
$\phi\phi' = 89^\circ\ 16\frac{1}{2}'$
$\phi\phi^{v} = 27^\circ\ 5'$
$tt' = 80^\circ\ 37'$
$tt^{v} = 37^\circ\ 45'$

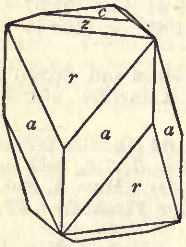
1.



2.



3.



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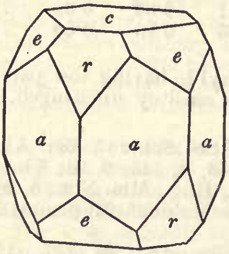
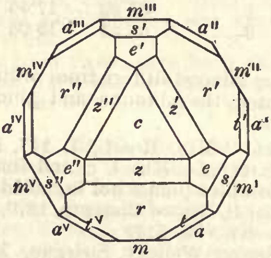


5.



Figs. 1, *Eudialyte*, 2, *Eucolite*, Magnet Cove, Ark., J. F. Williams. 3, 4, Greenland; 4, Lang. 5, Id., Mlr.

Crystals often tabular ‖ *c*, or rhombohedral in habit and highly modified (eudialyte); also prismatic, *a*, with *r* large or small (eucolite). Also massive in embedded grains; sometimes reniform.

Cleavage: in eudialyte, *c* perfect; *a* and *z* ($10\bar{1}4$) difficult, Dx.; in eucolite, *c* most distinct; also *a* and *m* imperfect, Bgr. Fracture subconchoidal, splintery. Brittle. H. = 5–5·5. G. = 2·91–2·93 eudialyte; 3·0–3·1 eucolite. Luster vitreous. Color rose-red, bluish red, brownish red, chestnut-brown. Streak uncolored. Translucent to subtranslucent.

Eudialyte is optically positive; eucolite is negative. Double refraction strong. Indices:

*Eucolite* $\omega = 1{\cdot}6205$ $\epsilon = 1{\cdot}6178$ Brögger.

**Var.**—Eudialyte and eucolite differ in optical character, the former +, the latter −, as stated above. Ramsay notes that both + and − zones, as also others which are isotropic, occur in the same crystal of the Kola eudialyte. The crystals of eudialyte are ordinarily more complex, and its specific gravity is sensibly lower. In composition a distinction can hardly be made.

Williams gives for Magnet Cove eudialyte, G. = 2·804–2·833; for eucolite 2·624–2·663. The eucolite is softer and probably somewhat altered; a derivation from eudialyte is suggested.

**Comp.**—Formula uncertain because the zirconium may be taken with either base or acid; the part played by the chlorine is also doubtful. Most simply regarded (Bgr.) as essentially a metasilicate, $\overset{I}{R}_4\overset{II}{R}_3Zr(SiO_3)_7$, with $\overset{I}{R} = Na$ chiefly, also K, H; $\overset{II}{R} = Ca$ chiefly, also Fe, Mn, and Ce(OH); further with $ZrOCl_2$ in part replacing the $SiO_2$; niobium (tantalum) may be present in small amount.

Rammelsberg, who has contributed most to our knowledge of the composition, regards the chlorine present as NaCl, and the zirconium as replacing silicon. For anals. 5–9 and 15, 16, he writes $2\overset{I}{R}_6\overset{II}{R}_3(Si,Zr)_{10}O_{26} + NaCl$; for 17–21, $R_{12}R_9(Si,Zr)_{25}O_{55}$. If Zr is to be taken as base he suggests $3(\overset{I}{R}_8\overset{II}{R}_6Zr_2Si_{13}O_{39}) + 2NaCl$. Groth regards it as probably a salt of $H_2Si_2O_5$.

**Anal.**—1, Rg., Pogg., **63**, 142, 1844. 2, Dmr., C. R., **43**, 1197, 1856. 3, Nylander [Act. Univ. Lund, 2], Jb. Min., 488, 1870. 4, Lorenzen, Min. Mag., **5**, 61, 1882. 5–9, Rg., Ber. Ak. Berlin, 441, 1886. 10, Genth, Am. J. Sc., **41**, 397, 1891.

11, Scheerer, Pogg., **72**, 565, 1847, recalc. by Rg. 12, Dmr., l. c. 13, Nylander, l. c. 14, Cleve, Zs. Kr., **16**, 504, 1890. 15–21, Rg., l. c., 1886.

*Eudialyte.*

| | G. | $SiO_2$ | $Ta_2O_5$ | $ZrO_2$ | $Ce_2O_3$[a] | FeO | MnO | CaO | $Na_2O$ | $K_2O$ | Cl | ign. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Greenland | | 49·92 | — | 16·88 | — | 6·97 | 1·15 | 11·11 | 12·28 | 0·65 | 1·19 | 0·37 |
| | | | | | | | | | | | | [= 100·52 |
| 2. " | 2·906 | 50·38 | 0·35 | 15·60 | — | 6·37 | 1·61 | 9·23 | 13·10 | — | 1·48 | 1·25 |
| | | | | | | | | | | | | [= 99·37 |
| 3. " | | 51·86 | — | 14·67 | — | 6·54 | 1·46 | 9·82 | 12·32 | — | 1·37 | 1·43 |
| | | | | | | | | | | | | [= 99·47 |
| 4. " | | 48·63 | — | 14·49 | 2·27 | 5·54 | 0·42 | 10·57 | 15·90 | — | 1·04 | 1·91 |
| | | | | | | | | | | | | [MgO 0·15 = 100·92 |
| 5. " | 2·928 | 49·37 | — | 15·09 | | 6·58 | 1·12 | 10·83 | 12·83 | 0·66 | 1·53 | 1·24 |
| | | | | | | | | | | | | [= 99·25 |
| 6. " | | 49·84 | — | 14·01 | 2·35 | 5·96 | 0·64 | 10·77 | 13·32 | 0 75 | — | — |
| 7. " | | 50·09 | — | 14·05 | 2·49 | 6·34 | 0·75 | 10·30 | 13·53 | 0·44 | — | — |
| 8. " | | 49·86 | — | 14·28 | 2·60 | 5·12 | 1·14 | 11·02 | 13·76 | | — | 1·24 |
| 9. " | | 49·62 | — | 14·12 | 2·50 | 7·16 | 1·34 | 9 66 | 13·24 | | 1·36 | — |
| 10. MagnetCove | 2·810 | 51·83 | 0·39? | 11·45 | — | 4·37 | 0·37 | 14·88[b] | 13·29 | 0·43 | 1·42 | 1·88 |
| | | | | | | | | | | | | [= 100·31 |

[a] Incl. $La_2O_3, Di_2O_3$. [b] Incl. 0·11 MgO.

*Eucolite.*

| | G. | $SiO_2$ | $Ta_2O_5$ | $ZrO_2$ | $Ce_2O_3$ | FeO | MnO | CaO | $Na_2O$ | $K_2O$ | Cl | ign. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11. Norway | 3·01 | 47·85 | — | 14·05 | 2·32 | 7·42 | 1·94 | 12·06 | 12·31 | — | — | 0·94 |
| | | | | | | | | | | | | [= 98·89 |
| 12. " | 3·007 | 45·70 | 2·35 | 14·22 | 3·60[a] | 6·83 | 2·35 | 9·66 | 11·59 | — | 1·11 | 1·83 |
| | | | | | | | | | | | | [= 99·24 |
| 13. " | | 50·47 | — | 14·26 | 4·30 | 5·42 | 3·67 | 9·58 | 10·46 | — | 1·68 | 1·57 |
| | | | | | | | | | | | | [= 101·41 |
| 14. Barkevik | 3·104 | 45·15 | 3·52 | 12·51 | 5·12[b] | 3·90 | 3·60 | 12·11 | 11·17 | 0·11 | 0·55 | 2·11 |
| | | | | | | | | | | | | [= 99·85 |
| 15. "Brevik" | 2·908 | 48·88 | — | 15·17 | 4·07 | 7·28 | 0·52 | 10·63 | 8·80 | 1·24 | 1·57 | 2·50 |
| | | | | | | | | | | | | [= 100·66 |
| 16. " | | 48·91 | — | 16·10 | 3·38 | 6·54 | 0·93 | 10·57 | 9·74 | | — | 2·65 |
| 17. Sigtesö | 3·081 | 46·68 | — | 15·43 | — | 7·32 | 2·82 | 11·76 | 11·24 | — | 1·70 | 0·90 |
| 18. " | | 46·98 | — | 14·52 | 4·02 | 6·42 | 2·55 | 10·70 | 0·42 | — | — | 0·75 |
| 19. Arö | 3·00 | 46·84 | — | 16·09 | 5·19 | 5·92 | 1·50 | 10·52 | 10·70 | 0·50 | 1·44 | 1·77 |
| | | | | | | | | | | | | [= 100·47 |
| 20. " | | — | 62·59 | — | — | 6·45 | 2·95 | 10·59 | 10·29 | 0·37 | — | — |
| 21. " | | 46·14 | — | 15·40 | — | 7·59 | 2·63 | 10·73 | — | — | — | — |

[a] Incl. $La_2O_3$ 1·11 p. c. [b] Incl. $Y_2O_3$ 0·32 p. c.

**Pyr., etc.**—In the closed tube affords water. B.B. fuses at 2·5 to a light green opaque glass, coloring the flame yellow (soda). With the fluxes gives reactions for iron and manganese. With hydrochloric acid gelatinizes, and the dilute acid solution imparts a deep orange to turmeric paper even after the iron in solution has been reduced to colorless protochloride by boiling with metallic tin (reaction for zirconia).

**Obs.**—*Eudialyte* is found at Kangerdluarsuk, West Greenland, where it was discovered by Giesecke early in the century. It is associated with arfvedsonite and sodalite, or embedded in compact white feldspar; the crystals are usually small, but sometimes an inch or more in length; also on the island Sedlovaty in the White Sea in massive form, embedded in sodalite; at Lujavr on the Kola peninsula, Russian Lapland, in elæolite-syenite (Ramsay).

*Eucolite* is from islands of the Langesund fiord in Norway; it is common on the Arö islands. Eikaholmen; also in dikes in the ledges off Barkevik; on Låven and Stokö rare. It is associated with ægirite, catapleiite, astrophyllite, sodalite, leucophanite, also wöhlerite, fluorite.

Eudialyte and eucolite also occur at Magnet Cove, in Arkansas, of a rich crimson to peach-blossom-red color, in feldspar, with elæolite and ægirite (first noted by Shepard); probably also in the elæolite syenite of Saline Co., Ark., seven miles N.E. of Benton (Williams).

Eudialyte is named from εὔ, *easily*, and διαλύειν, *to dissolve*, alluding to its easy solubility in acids. Eucolite from εὔκολος has much the same meaning.

**Ref.**—[1] Mlr., Phil. Mag., **16**, 477, 1840; Min., 357, 1852. Other values are, for eudialyte $\dot{c}$ = 2·11159 Kk., Vh. Min. Ges., **14**, 205, 1879, and Min. Russl., **8**, 29; for eucolite $\dot{c}$ = 2·0966 Bgr. (but it should be 2·0895 from *ar* = *36° 52′); eudialyte, $\dot{c}$ = 2·1174 Magnet Cove, Williams, Am. J. Sc., **40**, 457, 1890.

[2] Cf. Mlr., l. c. Also Lang. Phil. Mag., **25**, 436, 1863; Dx., **1**, 160, 1862; Nd., Öfv. Ak. Stockh., **27**, 559, 1870; Kk., l. c.; Gdt., Index, **1**, 519, 1886. [3] Williams, l. c.

A mineral probably identical with eudialyte, but not investigated chemically, is described by Ussing (G. För. Förh., **10**, 190, 1888), from Kangerdluarsuk, Greenland. It occurs in rhombohedral crystals, with *c* prominent, also *e*. Observed forms: *c* (0001), *m* $(10\bar{1}0)$, *a* $(11\bar{2}0)$, *x* $(10\bar{1}6)$, *z* $(10\bar{1}4)$, *r* $(10\bar{1}1)$, *e* $(01\bar{1}2)$, *s* $(02\bar{2}1)$. Measured angles: *cx* = 22° 37′, *cz* = 31° 37′. *cr* = 67° 56′, *ce* = 51° 10′. H. = 5. G. = 2·970. Color yellow-brown. Transparent. Optically +.

Brögger also notes a mineral associated with the rosenbuschite of Norway in orange-colored crystals showing the forms *a*, *z*, *r*, *e*, also *ω* (4·1·5·25, $\frac{3}{2}\frac{5}{5}\frac{5}{3}$), but in part developed with monoclinic symmetry. He refers it provisionally to eucolite.

**346. CATAPLEIITE.** Katapleiit *Weibye & Sjögren*, Pogg., **79**, 300, 1850. Katapleït. Kalknatronkatapleït. Natronkatapleït *Brögger*, G. För. Förh., **7**, 427, 1884, Zs. Kr., **16**, 434, 1890.

Hexagonal at 140° C.; pseudo-hexagonal and monoclinic at ordinary temperatures Brögger[1].

If hexagonal, axis $\grave{c}$ = 1·3629; 0001 ∧ 1011 = *57° 34′ Hj. Sjögren[1].

Common forms: *c* (0001, *O*); *m* $(10\bar{1}0$, *I*); *o* $(10\bar{1}2$, ½), *p* $(10\bar{1}1$, 1), *x* $(20\bar{2}1$, 2). Angles: *co* = 38° 12′, *cp* = 57° 34′, *cx* = 72° 22½′, *oo′* = 36° 1′, *pp′* = 49° 55½′, *xx′* = 56° 55′.

Dauber[1] gave $\grave{c}$ = 1·3593; Brögger, $\grave{c}$ = 1·3605 for natron-catapleiite.

Referred to the *monoclinic* system, Brögger's data give: Axes $\grave{a} : \overset{|}{b} : \grave{c}$ = 1·7356 : 1 : 1·3636; 001 ∧ 100 = *89° 48½′.

Angles: 100 ∧ 110 = *60° 3′, 001 ∧ 101 = 38° 5′, 001 ∧ 011 = 53° 44¾′. Also 110 ∧ $1\bar{1}0$ = 120° 6′, 001 ∧ $\bar{2}01$ = *57° 23½′ 001 ∧ $\bar{2}01$ = 57° 40′, 001 ∧ 111 = 57° 30′, 001 ∧ 110 = 89° 54′, 001 ∧ $\bar{1}11$ = 57° 38′, 111 ∧ $1\bar{1}1$ = 49° 50½′.

The following list gives the observed forms, referred first to the hexagonal system, and second with the proper monoclinic symbols, as interpreted by Brögger.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *c* (0001) | = 001 | | | | *y* $(10\bar{1}3)$ | = 203 | 203 | 113 | $\bar{1}13$ |
| *m* $(10\bar{1}0)$ | = 100 | 110 | | | *o* $(10\bar{1}2)$ | = 101 | 101 | 112 | $\bar{1}12$ |
| *a* $(11\bar{2}0)$ | = $\bar{3}10$ | 010 | | | *p* $(10\bar{1}1)$ | = 201 | 201 | 111 | $\bar{1}11$ |
| *π* $(1{\cdot}0{\cdot}\bar{1}{\cdot}72)$ | = 1·0·36 | $\bar{1}$·0·36 | 1·1·72 | $\bar{1}$·1·72 | *x* $(20\bar{2}1)$ | = 401 | $\bar{4}01$ | 221 | $\bar{2}21$ |
| *z* $(1{\cdot}0{\cdot}\bar{1}{\cdot}30)$ | = 1·0·15 | $\bar{1}$·0·15 | 1·1·30 | $\bar{1}$·1·30 | *ρ* $(1{\cdot}1{\cdot}\bar{2}{\cdot}24)$ | = $\bar{3}$·1·24 | 0·1·12 | | |
| *ζ* $(1{\cdot}0{\cdot}\bar{1}{\cdot}24)$ | = 1·0·12 | $\bar{1}$·0·12 | 1·1·24 | $\bar{1}$·1·24 | *u* $(11\bar{2}4)$ | = $\bar{3}14$ | 012 | | |
| *r* $(1{\cdot}0{\cdot}\bar{1}{\cdot}16)$ | = 108 | $\bar{1}08$ | 1·1·16 | $\bar{1}$·1·16 | *s* $(11\bar{2}2)$ | = $\bar{3}12$ | 011 | | |
| *v* $(1{\cdot}0{\cdot}\bar{1}{\cdot}12)$ | = 106 | $\bar{1}06$ | 1·1·12 | $\bar{1}$·1·12 | *ϑ* $(44\bar{8}1)$ | = $\overline{12}$·4·1 | 081 | | |

Also, less certain, *τ* $(11{\cdot}6{\cdot}\bar{17}{\cdot}2)$ = $\bar{8}31$ and 11·165·30, 40·12·5 and $\overline{11}$·165·30, $\overline{40}$·12·5; and *ψ* $(12{\cdot}9{\cdot}\overline{21}{\cdot}2)$ = 6·12·1, etc

Crystals usually thin tabular hexagonal prisms with replaced edges. Twins common: (1) tw. pl. *p* $(10\bar{1}1)$, with $c\underline{c}$ = 64° 52′; (2) tw. pl. $(30\bar{3}2)$ with $c\underline{c}$ = 45° 55′; (3) tw. pl. $(33\bar{6}2)$; (4) *m*; (5) $\underline{c}$.

Cleavage: *m* perfect; also *p* $(10\bar{1}1)$, *o* $(10\bar{1}2)$ imperfect, Dbr. Fracture conchoidal. Brittle. H. = 6. G. = 2·8. Luster nearly dull, weak vitreous on surface of fracture. Color light yellow to yellowish brown, grayish blue, violet. Streak pale yellow. Translucent to opaque. Optically +.

Brögger regards the crystals as originally rhombohedral (tetartohedral), but under a change of conditions they have suffered a secondary molecular rearrangement with the result of bringing them into the monoclinic system.

Sections ‖ *c* in polarized light show the crystals to be commonly trillings, also more complex, with the prism as tw. plane. Axial plane normal, or nearly so, to the edge *c*/*m*. Axial angle about 60°. Heated to 140° sections are isotropic, but become doubly refracting again on cooling. Optically analogous to tridymite, as also in habit of crystals, in twinning, etc.

**Comp.**—Empirical formula, $H_4(Na_2,Ca)ZrSi_3O_{11}$ or $H_2(Na_2,Ca)(Zr(OH)_2)(SiO_3)_3$ as suggested by Brögger. It may also be written $(Na_2,Ca)SiO_3.H_4Zr(SiO_4)_2$. If Na alone is present, the percentage composition is: Silica 46·1, zirconia 28·8, soda 15·9, water 9·2 = 100.

**Var.**—1. *Ordinary.* Contains both sodium and calcium. Color reddish, flesh-red, yellowish red to clear yellow and reddish white; seldom brownish red or dark brown.

2. *Natron-catapleiite,* or soda-catapleiite. Contains only sodium. Color blue to gray and white; on heating the blue color disappears.

**Anal.**—1, 2, Sjögren, l. c. 3, Rg., Min. Ch., 677, 1875. 4, Forsberg, quoted by Bgr., l. c. 5, 6, Weibull, G. För. Förh., **7**, 272, 1884. 7, Forsberg, ibid. 8, 9, Cleve, quoted by Bgr.

| | $SiO_2$ | $ZrO_2$ | $Al_2O_3$ | FeO | CaO | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. *Catapleiite.* | 46·83 | 29·81 | 0·45 | 0·63 | 3·61 | 10·83 | 8·86 | = 101·02 |
| 2. " | 46·52 | 29·33 | 1·40 | 0·49 | 4·66 | 10·06 | 9·05 | = 101·51 |
| 3. " | 39·78 | 40·12 | — | — | 3·45 | 7·59 | 9·24 | = 100·18 |
| 4. " | 41·56 | 32·53 | 1·02 | | 5·21 | 9·74 | 9·35 | = 99·41 |
| 5. " | 44·20 | 31·82 | — | 0·22 | 5·31 | 8·93 | 9·26 | = 99·74 |
| 6. " | 44·07 | 32·18 | — | 0·17 | 5·82 | 8·10 | 9·26 | = 99·60 |
| 7. *Natron-catapleiite* | 41·27 | 32·60 | 0·42 | 0·29 | 0·93 | 15·01 | 9·31 | = 99·83 |
| 8. " | 43·92 | 30·80 | — | 0·10 | 0·81 | 15·05 | 9·24 | = 99·92 |
| 9. " | 44·04 | 30·94 | — | 0·10 | 0·87 | 14·94 | 9·24 | = 100·13 |

**Pyr., etc.**—In the closed tube yields water. B.B. in the platinum forceps fuses at 3 to a white enamel; with borax a clear colorless glass. Easily soluble in hydrochloric acid without gelatinizing; the dilute acid solution colors turmeric paper orange-yellow (reaction for zirconia).

**Obs.**—From the island Låven (Lamö) in the Langesund fiord, Norway, with zircon, leucophanite, mosandrite, and tritomite; also on Stokö, Eikaholmen, the Arö islands. *Natron-catapleiite* is only known from the island Lille-Arö, where it occurs with feldspar, elæolite, sodalite, ægirite, låvenite, eucolite, astrophyllite, etc.

Named from *κατα πλεῖον* because always accompanied by a number of rare minerals.

**Alt.**—Pseudomorphs of zircon after catapleiite are noted by Brögger.

**Ref.**—[1] Sjögren, Norway, Öfv. Ak. Stockh., **39**, No. 7, 59, 1882. Dbr., Pogg., **92**, 239, 1854. Bgr., G. För. Förh., **7**, 427, 1884. Zs. Kr., **16**, 434, 1890. See also Götz, Mitth. Univ. Greifswald, 1886, and Jb. Min., **2**, 222 ref., 1888.

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## 6. Melanocerite Group.

### Hexagonal or Rhombohedral.

**347. Cappelenite** Hexagonal ċ = 1·2903

$RSiO_3.YBO_3$ or $3BaSiO_3.2Y_2(SiO_3)_3.5YBO_3$

**348. Melanocerite** Rhombohedral ċ = 1·2554

$12(H_2,Ca)SiO_3.3(Y,Ce)BO_3.2H_2(Th,Ce)O_2F_2.8(Ce,La,Di)OF$

**349. Caryocerite** Rhombohedral ċ = 1·1845

$6(H_2,Ca)SiO_3.2(Ce,Di,Y)BO_3.3H_2(Ce,Th)O_2F_2.2LaOF$

Steenstrupine

**350. Tritomite** Rhombohedral, hemimorphic $\frac{1}{4}$ ċ = 1·1138

$2(H_2,Na_2,Ca)SiO_3.(Ce,La,Di,Y)BO_3.H_2(Ce,Th)O_2F_2$

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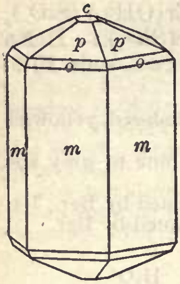
**347. CAPPELENITE.** *W. C. Brögger,* G. För. Förh., **7**, 599, 1885, **9**, 252, 1887; Zs. Kr., **16**, 462, 1890.

Hexagonal. Axis ċ = 1·2903; 0001 ∧ $10\bar{1}1$ = 56° 7¾′ Brögger.



**Forms:** *c* (0001, *O*), *m* ($10\bar{1}0$, *I*), *p* ($10\bar{1}3$, $\frac{1}{3}$), *o* ($10\bar{1}1$, 1).
Angles: *cp* = 26° 25′, *co* = 56° 8′, *pp′* = *25° 42′, *oo′* = 49° 3½′.

In thick prismatic crystals.

Cleavage none. Fracture conchoidal. Brittle. H. = 6–6·5. G. = 4·407 Cleve. Luster vitreous to greasy. Color greenish brown. Semi-transparent to translucent. Optically –. Double refraction rather strong.

**Comp.**—A boro-silicate of yttrium and barium, probably (Cleve, Bgr.) $RSiO_3.YBO_3$ with R = Ba and $Y_2$( = 3R) chiefly, also $Ca,Na_2,K_2$ in small amount, further Ce,Th( = 2R).

**Anal.**—1, P. T. Cleve, quoted by Brögger, l. c.

| $SiO_2$ | $B_2O_3$ | $\underbrace{CeO_2,ThO_2,Y_2O_3,La_2O_3}$ | BaO | CaO | $Na_2O$ | $K_2O$ | ign. |
|---|---|---|---|---|---|---|---|
| 14·21 | [17·16] | 57·68 | 8·02 | 0·67 | 0·25 | 0·20 | 1·81 = 100 |
| 14·11 | [16·96] | 57·52 | 8·29 | 0·56 | 0·53 | 0·22 | 1·81 = 100 |

Further the rare earths are present as follows: $Y_2O_3$ 91·23, $CeO_2$ 2·24, $La_2O_3$ 5·15, $ThO_2$ 1·38 = 100; or $Y_2O_3$ 52·62, $La_2O_3$ 2·97, $CeO_2$ 1·29, $ThO_2$ 0·80 = 57·68.

**Pyr.**—B.B. swells up and fuses with some difficulty to a white enamel. With fluorite and potassium bisulphate gives the green flame of boron. Easily soluble in hydrochloric acid.

**Obs.**—Occurs in a small vein in the augite-syenite on Lille Arö in the Langesund fiord, southern Norway; it is associated with wöhlerite, rosenbuschite, catapleiite, orangite, låvenite, elæolite, sodalite, etc.

Named after D. Cappelen of Holden, Norway.

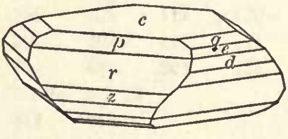
**348. MELANOCERITE.** Melanocerit *Brögger* and *Cleve*, Zs. Kr., **16**, 468, 1890.

Rhombohedral. Axis $\dot{c}$ = 1·25537; 0001 ∧ $10\bar{1}1$ = *55° 24′ Brögger.

**Forms:** *c* (0001, *O*), *ρ* ($10\bar{1}2$, $\frac{1}{2}$), *r* ($10\bar{1}1$, *R*), *z* ($40\bar{4}1$, 4), *q* ($01\bar{1}4$, – $\frac{1}{4}$), *e* ($01\bar{1}2$, – $\frac{1}{2}$), *d* ($02\bar{2}1$, – 2).

*cρ* = 35° 56′ *cq* = 19° 55′ *ρρ′* = 61° 5½′ *ee′* = 61° 5½′
*cr* = *55° 24′ *ce* = 35° 56′ *rr′* = 90° 56′ *dd′* = 109° 54½′
*cz* = 80° 13′ *cd* = 70° 58′ *zz′* = 117° 10′

Crystals tabular in habit; planes sometimes developed with monoclinic symmetry. The fundamental rhombohedron approximates closely to a cube in angle.



Cleavage none. Fracture conchoidal. Brittle. H. = 5–6. G. = 4·129 Cleve. Luster greasy to vitreous. Color deep brown to black. Streak light brown. Transparent with a bright wine-yellow color in splinters and thin sections. Optically uniaxial, negative. In part also isotropic and amorphous (by alteration).

**Comp.**—A fluo-silicate of the cerium and yttrium metals and calcium chiefly, with boron, tantalum, and other elements. Brögger interprets the composition by assuming the presence of the following compounds, which are present in the ratio given:

| $(H_2,Ca)_2Si_2O_6$ | $(Y,Ce)_2B_2O_6$ | $H_4(Ce,Th)_2O_4F_4$ | $(Ce,La,Di)_4O_4F_4$ | $CaTa_2O_6$ | $Ca_2C_2O_6$ |
|---|---|---|---|---|---|
| 0·436 | 0·092 | 0·064 | 0·144 | 0·034 | 0·080 |

The composition, following in the same line (largely hypothetical, to be sure), approximates closely to:

$$12(H_2,Ca)SiO_3.3(Y,Ce)BO_3.2H_2(Th,Ce)O_2F_2.8(Ce,La,Di)OF$$

**Anal.**—Cleve, l. c.

| $SiO_2$ | $ZrO_2$ | $ThO_2$ | $Ta_2O_5$ | $P_2O_5$ | $CO_2$ | $CeO_2$ | $B_2O_3$ | $Al_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 13·07 | 0·46 | 1·66 | 3·65 | 1·29 | 1·75 | 3·68 | [3·19] | 0·83 | 2·09 | 1·22 |

| $Ce_2O_3$ | $Di_2O_3$ | $La_2O_3$ | $Y_2O_3$ | CaO | MgO | $Na_2O$ | $H_2O$ | F |
|---|---|---|---|---|---|---|---|---|
| 20·76 | 7·67 | 12·94 | 9·17[a] | 8·62 | 0·14 | 1·45 | 3·01 | 5·78 = 102·43 |

[a] Atomic weight = 104·4.

**Pyr.**—B.B. becomes lighter in color and swells up without fusing. A green flame (boron) with fluorite and potassium bisulphate; with soda, a manganese reaction and with salt of phosphorus a reaction for cerium. Soluble in hot hydrochloric acid with separation of silica.

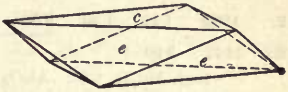
**Obs.**—Occurs very sparingly in the island Kjeö near Barkevik in the Langesund fiord, southern Norway; it is associated with ægirite, barkevikite (and pterolite), lepidomelane, wöhlerite, astrophyllite; also elæolite, leucophanite, spreustein, etc. Probably occurs also in the veins on the Arö-scheeren. Cf. Caryocerite.

**349. CARYOCERITE.** Karyocerit *W. C. Brögger*, Zs. Kr., **16**, 478, 1890.

Rhombohedral. Axis $\dot{c} = 1{\cdot}1845$; $0001 \wedge 10\bar{1}1 = 53° 49\frac{2}{3}'$ Brögger.

**Forms:** *c* (0001, *O*), *e* ($01\bar{1}2$, $-\frac{1}{2}$), *q* ($01\bar{1}4$, $-\frac{1}{4}$). Angles: *cq* = 18° 53′, *ce* = *34° 22′, *ee′* = 58° 32′.

In tabular rhombohedral crystals. Faces brilliant but striated and not yielding good measurements. The occurring rhombohedron is made $-\frac{1}{2}$ ($01\bar{1}2$) in order to bring it into correspondence with the related species melanocerite.



Cleavage none. Fracture conchoidal. Brittle. H. = 5–6. G. = 4·295 Cleve. Luster vitreous to greasy. Color nut-brown. Translucent. Optically isotropic (amorphous), in consequence of alteration.

**Comp.**—Near melanocerite, differing chiefly in containing much more thorium. Brögger, again, assumes the presence of the following compounds, in the ratio given:

| $(H_2,Ca)Si_2O_6$ | $(Ce,Di,Y)_2B_2O_6$ | $H_4(Th,Ce)_2O_4F_4$ | $(La, etc.)_4O_4F_4$ | $CaTa_2O_6$ | $Ca_2C_2O_6$ |
|---|---|---|---|---|---|
| 0·432 | 0·134 | 0·180 | 0 072 | 0·026 | 0·016 |

The composition then approximates closely to:

$$6(H_2,Ca)SiO_3.2(Ce,Di,Y)BO_3.3H_2(Ce,Th)O_2F_2.2LaOF$$

**Anal.**—Cleve, quoted by Brögger, l. c.

| $SiO_2$ | $ZrO_2$ | $ThO_2$ | $Ta_2O_5$ | $P_2O_5$ | $CO_2$ | $CeO_2$ | $B_2O_3$ | $Al_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 12·97 | 0·47 | 13·64 | 3·11 | 0·86 | 0·35 | 5·89 | [4·70] | 0·87 | 1·36 | 0·66 |

| $Ce_2O_3$ | $La_2O_3$ | $Di_2O_3$ | $Y_2O_3$ | CaO | MgO | $Na_2O$ | F | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 14·83 | 14·34 | 6·75 | 2·21[a] | 7·37 | 0·17 | 1·42 | 5·63 | 4·77 = 102·37 |

[a] Atomic weight 101·3.

From the analysis the oxygen-equivalent of the fluorine, 2·37, is to be deducted.

**Pyr.**—See melanocerite.

**Obs.**—Occurs very sparingly in a vein in the augite-syenite of the Langesund fiord, southern Norway, with ægirite, catapleiite, astrophyllite, etc.; stated to have come from the Aröscheeren, or the rock ledges off the west shore of the island Store-Arö.

Named from *κάρυον*, a *nut*, and *cerium*, in allusion to the nut-brown color.

STEENSTRUPINE. *J. Lorenzen*, Medd. Grönl., 1881, Min. Mag., 5, 67. 1882. A mineral allied to melanocerite and caryocerite. Rhombohedral. In indistinct crystals with rounded and roughened faces, somewhat resembling eudialyte. Combinations of *c* and *r*, with *cr* = 52° approx., were noted, with also a second positive, and perhaps also a negative, rhombohedron. Also massive. H. = 4. G. = 3·38. Luster dull. Color brown. Streak brownish, nearly white.

Analysis:

| $SiO_2$ | $TiO_2$ | $ThO_2$ | $Ce_2O_3$ | $(La,Di)_2O_3$ | $Al_2O_3$ | $Fe_2O_3$ | MnO | CaO | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 27·95 | 0·97 | 7·09 | 10·66 | 17·04 | 2·41 | 9·71 | 4·20 | 3·09 | 7·98 | 7·28 = 98·38 |

The separation of the thoria from the oxides of the cerium group is not regarded as very exact and the composition, consequently, is somewhat doubtful; the mineral, however, obviously approximates closely to the two species preceding, to which it is related also in form.

Entirely decomposed by acids; B.B. fuses easily to a dull gray bead.

Occurs with lepidolite and ægirite in the sodalite-syenite of Kangerdluarsuk, Greenland.

Named after the Danish geologist, K. J. V. Steenstrup of Copenhagen.

**350. TRITOMITE.** Tritomit *Weibye & Berlin*, Pogg., **79**, 299, 1850.

Rhombohedral; hemimorphic (?) Axis $\dot{c}$ = 4·4553. In crystals of acute triangular pyramidal form, approximating to a regular tetrahedron. They are bounded by the planes *c'* (000$\bar{1}$, *O*) and *z* (40$\bar{4}$1, 4). Angles: *c'z* = *101°, *zz'* = 116° 27'.

Cleavage indistinct. H. = 5·5. G. = 4·15–4·25 Bgr. Luster resinous. Color dark brown. Streak yellowish gray. Subtranslucent. Optically isotropic (amorphous[1] ?).

**Comp.**—A fluo-silicate of thorium, the cerium and yttrium metals and calcium, with boron. Essentially, $2(H_2,Na_2,Ca)SiO_3.(Ce,La,Di,Y)BO_3.H_2(Ce,Th,Zr)O_2F_2$, as interpreted by Brögger.

**Anal.**—1, 2, Engström, Inaug. Diss., Upsala, p. 32, 1877. 1, "Brevik," exact locality unknown. G. = 4·178; 2, Barkevig, G. = 4·045. 3, In typical tetrahedral-like crystals: for earlier analyses by Berlin, Forbes, Möller, see 5th Ed., p. 412.

| | $SiO_2$ | $Ta_2O_5$ | $ZrO_2$ | $ThO_2$ | $CeO_2$ | $Ce_2O_3$ | $La_2O_3$ | $Di_2O_3$ | $Y_2O_3$ | $Fe_2O_3$ | $B_2O_3$ | CaO | $Na_2O$ | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 13·54 | 1·15 | 1·09 | 9·51 | 11·69 | 10·65 | 16·31 | 5·57 | 2·97 | 3·52[a] | 7·31 | 7·04 | 1·40 | 6·40 | 4·29 | [= 102·44 |
| 2. | 13·59 | 1·11 | 1·03 | 8·58 | 11·26 | 8·14 | 21·56 | 4·76 | 2·58 | 2·77[b] | 8·37 | 6·97 | 0·71 | 6·48 | 3·15 | [= 101·06 |
| 3. | 14·71 | 3·09 | | 56·51 | | | | | | 5·45[c] | *undet.* | 6·59 | 0·91 | 7·69 | | |

[a] Incl. $Mn_2O_3$ 0·67, $Al_2O_3$ 1·18. [b] Incl. $Mn_2O_3$ 0·34, $Al_2O_3$ 0·88. [c] Also incl. $ZrO_2$.
Deduct from 1, 1·81 p. c. O = F; from 2, 1·33 p. c.

**Pyr., etc.**—Yields water and gives a weak fluorine reaction; with borax a reddish yellow glass, which is colorless on cooling. With hydrochloric acid in powder yields chlorine, and gelatinizes.

**Obs.**—From the island Låven (Lamö) in the Langesund fiord near Brevik, Norway, with leucophanite, analcite, mosandrite, also ægirite, catapleiite, etc., in a coarse elæolite-syenite; also on Stokö, Arö, the Aröscheeren and near Barkevik.

Named from τρίς, *three-fold*, and τέμνειν, *to cut*, alluding to the trihedral cavities which the crystals leave in the gangue.

**Ref.**—[1] Bgr., Zs. Kr., **16**, 487, 1890. The form has been previously assumed to be that of an isometric tetrahedron; Brögger shows that the isotropic character probably indicates an amorphous condition resulting from alteration, while the crystalline form is either that of a tetragonal sphenoid, or more probably rhombohedral and hemimorphic. The latter view brings it into correspondence with melanocerite, to which it is related in composition.

[2] Determinations of the specific gravity vary widely; Brögger regards 4·15–4·25 as most probably characteristic, and Engström, as noted, gives 4·045, 4·178; earlier results are 3·908 Forbes, 4·16–4·60 Berlin, 4·26 Möller.

Erdmannite. A complex mineral substance from the Langesund fiord, Norway, formerly referred to allanite but, according to Brögger (Zs. Kr., **16**, 497, 1890), in part a mixture of a mineral allied to melanocerite with homilite, in part an altered mineral near homilite. See further under the Datolite Group, p. 507.

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## Intermediate Silicates.

Silicates intermediate in acidic character between the metasilicates and orthosilicates; oxygen ratio of silicon to bases between 2 : 1 and 1 : 1.

A number of other species, strictly falling here, are included among the orthosilicates in order to exhibit their true group-relations; for example, nephelite obviously belongs with the hexagonal group, having the general composition $\overset{\text{I}}{R}AlSiO_4$, etc.

### 1. Leucophanite Group.

| | | | |
|---|---|---|---|
| **351.** | **Leucophanite**<br>$NaCaBeFSi_2O_6$ | Orthorhombic, hemihedral | $\breve{a} : \bar{b} : \dot{c}$ = 0·9939 : 1 : 0·6722 |
| **352.** | **Meliphanite**<br>$NaCa_2Be_2FSi_3O_{10}$ | Tetragonal, hemihedral | $\dot{c}$ = 0·6584 |

The form of leucophanite approximates closely to that of the tetragonal meliphanite

## 2. Iolite Group.

| | | | | $\breve{a}:\bar{b}:\acute{c}$ |
|---|---|---|---|---|
| 353. | **Iolite** | $H_2(Mg,Fe)_4Al_8Si_{10}O_{37}$ | Orthorhombic | 0·5871 : 1 : 0·5585 |

## 3. Barysilite Group.

Silicates containing lead.

| | | | |
|---|---|---|---|
| 354. | **Barysilite** | $Pb_3Si_2O_7$ | Hexagonal |
| 355. | **Ganomalite** | $Pb_3(Ca,Mn)_2Si_3O_{11}$ | Tetragonal |
| 356. | **Hyalotekite** | $R_{18}B_4Si_{24}O_{70}F$ or, approx., $Ca_3Ba_3Pb_3B_2(SiO_3)_{12}$ | |

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## 1. Leucophanite Group.

**351. LEUCOPHANITE.** Leukophan *Esmark*. Erdmann, Ak. H. Stockh., 191, 1840; Tamnau, Pogg., 48, 504, 1839. Leucophane. Leucofanite.

Orthorhombic; hemihedral. Axes $\breve{a}:\bar{b}:\acute{c}$ = 0·99391 : 1 : 0·67217 Brögger[1].

100 ∧ 110 = 44° 49½′, 001 ∧ 101 = 34° 4⅙′, 001 ∧ 011 = 33° 54½′.

Forms[1]:
*a* (100, $i\text{-}\bar{i}$)
*b* (010, $i\text{-}\breve{i}$)
*c* (001, *O*)
*k* (310, $i\text{-}\bar{3}$)
*m* (110, *I*)
*g* (106, $\frac{1}{6}\text{-}\bar{i}$)
*f* (105, $\frac{1}{5}\text{-}\bar{i}$)
*e* (104, $\frac{1}{4}\text{-}\bar{i}$)
*d* (103, $\frac{1}{3}\text{-}\bar{i}$)
*y* (101, $1\text{-}\bar{i}$)
*o* (201, $2\text{-}\bar{i}$)
*ω* (401, $4\text{-}\bar{i}$)
*r* (056, $\frac{5}{6}\text{-}\breve{i}$)
*q* (054, $\frac{5}{4}\text{-}\breve{i}$)
*δ* (021, $2\text{-}\breve{i}$)?
*ξ* (119, $\frac{1}{9}$)
*ψ* (118, $\frac{1}{8}$)
*χ* (117, $\frac{1}{7}$)
*φ* (116, $\frac{1}{6}$)
*u* (225, $\frac{2}{5}$)
*s* (223, $\frac{2}{3}$)
*v* (445, $\frac{4}{5}$)
*p* (111, 1)
*x* (221, 2)
*ξ*, ($1\bar{1}9$, $-\frac{1}{9}$)
*ψ*, ($1\bar{1}8$, $-\frac{1}{8}$)
*χ*, ($1\bar{1}7$, $-\frac{1}{7}$)
*φ*, ($1\bar{1}6$, $-\frac{1}{6}$)?
*s*, ($2\bar{2}3$, $-\frac{2}{3}$)
*p*, ($1\bar{1}1$, − 1)
*x*, ($2\bar{2}1$, − 2)
*t* (212, $1\text{-}\bar{2}$)
*t*, ($2\bar{1}2$, $-1\text{-}\bar{2}$)
*ρ* (8·7·12, $\frac{2}{3}\text{-}\frac{8}{7}$)
*τ* (122, $1\text{-}\breve{2}$)

Angles: *mm‴* = *89° 39′, *co* = 53° 31½′, *oo‴* = *72° 57⅙′, *cx* = 62° 20′, *bx* = 51° 22′, *ax* = 51° 5′, *mx* = 27° 40′, *ox* = 38° 38′, *mo* = 55° 14′.

In crystals usually tabular ∥ *c* and commonly showing sphenoidal hemihedrism in the distribution of the pyramidal planes; with this the form of the etching-figures agrees (Bgr.). Often twins with tw. pl. *m* and *c*; usually penetration-twins by which in each quadrant a right and left individual are brought together in twinning position and complementary to each other, with *c* as comp.-face. Also in prismatic crystals (∥ *m*) which are penetration-fourlings, analogous to harmotome, with tw. pl. *b*. Massive in columnar or laminated forms.

Cleavage: *c* perfect; *a*, *o* (201) distinct; also *b*, *δ* (021). Fracture conchoidal. Very brittle. H. = 4. G. = 2·959 Bgr.; 2·964 Rg. Luster vitreous. Color whitish green, greenish white, deep green with a yellow tinge, wine-yellow; thin fragments transparent and colorless. Strongly phosphorescent with a bluish light, whether heated or struck. Pyroelectric.

Optically −. Ax. pl. ∥ *a*. $Bx_a \perp c$. Dispersion $\rho > v$, weak. Axial angles, Bgr.:

$2E_r$ = 74° 24½′ Li   $2E_y$ = 74° 15′ Na   $2E_{gr}$ = 74° 8′

$\alpha_r = 1·5680$   $\beta_r = 1·5909$   $\gamma_r = 1·5948$
$\alpha_y = 1·5709$   $\beta_y = 1·5948$   $\gamma_y = 1·5979$   . $2V_y$ = 39° 2′

**Comp.**—$Na(BeF)Ca(SiO_3)_2$ = Silica 49·4, glucina 10·3, lime 23·0, soda 12·8, fluorine 7·9 = 103·4, deduct 3·4 (O = 2F) = 100.

This formula is that given by Brögger, see further under the following species, meliphanite.

Anal.—1, Erdmann, l. c. 2 Rg. Pogg., 98, 257, 1856. 3–5, Id., Zs. G. Ges., 28, 59, 1876. 6, Id. mean of 3–5 as given in Min. Ch., Erg., 152, 1886. 7, Bäckström, Zs. Kr., 16, 286, 1890.

| | $SiO_2$ | $Al_2O_3$ | BeO | CaO | $Na_2O$ | $K_2O$ | F | |
|---|---|---|---|---|---|---|---|---|
| 1. Norway | 47·82 | — | 11·51 | 25·00 | 10·20 | 0·31 | 6·17 | MnO 1·01 = 102·02 |
| 2. " | 47·03 | 1·03 | 10·70 | 23·54[a] | 11·26 | 0·30 | 6·57 | = 100·43 |
| 3. Låven | | | 12·25 | 23·52 | 10·27 | 0·30 | 6·53 | |
| 4. " | 47·07 | undet. | 11·25 | 22·92 | undet. | | 6·97 | |
| 5. " | 49·70 | " | 12·40 | 23·68 | " | | 6·91 | |
| 6. " | 48·38 | — | 11·97 | 23·37 | 10·27 | 0·30 | 6·77 | = 101·06 |
| 7. St.-Arö | 48·50 | 0·45 | 10·03 | 23·21[b] | 12·42 | — | 5·94 | $H_2O$ 1·08 = 101·63 |

[a] Incl. 0·17 MgO. [b] MgO 0·27.

**Pyr., etc.**—In the closed tube whitens and phosphoresces with a bluish light. B.B. in the forceps phosphoresces and fuses with intumescence at 3 to a clear colorless glass, which becomes opaque-white on flaming; imparts an intense yellow color to the flame. Fused with salt of phosphorus in the open tube gives the reaction for fluorine.

**Obs.**—Occurs in pegmatyte veins in augite-syenite with elæolite, ægirite, mosandrite, astrophyllite, etc., on the small islet Låven, near the mouth of the Langesund fiord in Norway; also from Stokö and other islands in the neighborhood.

Named from λευκός, *white*, and φαίνεσθαι, *to appear*, because it presents a whitish reflection in certain lights.

**Ref.**—[1] Bgr., Zs. Kr., **16**, 246, 1890. See also Greg, Phil. Mag., **9**, 510, 1855; Nd., Öfv. Ak. Stockh., **27**, 557, 1870; Lang, Min. Mitth., 82, 1871; Bertrand, Ann. Mines, 3, 24, 1873, and Phil. Mag., 3, 357, 1877; Groth, Zs. Kr., **2**, 199, 1878. The form, which approximates closely to the tetragonal type, has been regarded as monoclinic (cf. Btd., Groth).

**352. MELIPHANITE.** Melinophan *Scheerer*, J. pr. Ch., **55**, 449, 1852. Meliphane *Dana*, Am. J. Sc., **44**, 405, 1867.

Tetragonal and tetartohedral. Axis $\dot{c} = 0·65843$; $001 \wedge 101 = 33° 21\frac{3}{4}'$ Bertrand[1].

**Forms**: *c* (001, *O*), *a* (100, *i-i*), *k* (310, *i*-3), *e* (101, 1-*i*), *o* (201, 2-*i*), *p* (111, 1), *v* (214, ½-2).

Angles: *ee'* = 44° 14', *ee''* = 66° 43½', *co* = 52° 47', *pp'* = 57° 37', *pp''* = *85° 55'.

Commonly in obtuse octahedrons with *p* (111) prominent, but tetartohedral in the distribution of the planes, as also in the want of symmetry of the etching-figures (Bgr.). Also massive, and consisting sometimes of plates or lamellæ.

Cleavage: *c* distinct. Brittle. H. = 5–5·5. G. = 3·006 Bgr.; 3·018 Rg. Luster vitreous. Color sulphur-, citron-, or honey-yellow; also flesh-red, brick-red. Transparent to translucent. Optically —. Pleochroism distinct. Double refraction strong. Indices, Bgr.:

$\omega_r = 1·5912$ red glass $\omega_y = 1·5934$ Na $\omega_{gr} = 1·5975$ Tl
$\epsilon_r = 1·6097$ " " $\epsilon_y = 1·6126$ Na $\epsilon_{gr} = 1·6161$ Tl

**Comp.**—A fluo-silicate of beryllium, calcium, and sodium near leucophanite. Formula $NaCa_2Be_2FSi_5O_{10}$ = Silica 46·9, glucina 13·1, lime 29·1, soda 8·1, fluorine 5·0 = 102·2, deduct 2·2 (O = 2F) = 100. Aluminium may also be present.

The above formula is given by Brögger (with $3Be = Al_2$ which somewhat reduces the excess of silica), who further writes it $Ca_4Be_2(BeF)_2Na(SiO_3)_4.(SiO_4)_2$ or as a metasilicate, $Na_2(BeF)_2(Ca_2O)_2Be_2(SiO_3)_6$; that for leucophanite being written for sake of comparison $Al_2Na_3(BeF)_3Ca_3(SiO_3)_6$.

Rammelsberg suggests $6RSiO_3.R_2SiO_4 + 3NaF$ for leucophanite, and $RSiO_3.R_2SiO_4 + 6NaF$ for meliphanite.

**Anal.**—1, Rg., Pogg., **98**, 257, 1856. 2–5, Id., Zs. G. Ges., **28**, 61, 1876. 6, Bäckström, Zs. Kr., **16**, 288 1890.

| | $SiO_2$ | $Al_2O_3$ | BeO | CaO | $Na_2O$ | $K_2O$ | F | |
|---|---|---|---|---|---|---|---|---|
| 1. Fredriksvärn | 43·66 | 1·57[a] | 11·74 | 26·85[b] | 8·55 | 1·40 | 5·73 | $H_2O$ 0·30 = 99·80 |
| 2. Stoksund(?) | 41·40 | undet. | 13·81 | 29·05 | undet. | | 5·43 | |
| 3. " | 44·32 | " | 13·84 | 29·93 | " | | 6·39 | |
| 4. " | | " | 14·04 | 30·10 | 7·21 | 0·59 | | |
| 5. " | 42·50 | " | 13·62 | 30·56 | undet. | | | |
| 6. Arö | 43·60 | 4·61[c] | 9·80 | 29·56 | 7·98 | 0·23 | 5·43 | MgO 0·16 = 101·37 |

[a] With $Fe_2O_3$ ($Mn_2O_3$). [b] MgO 0·11. [c] With $Fe_2O_3$.

**Pyr., etc.**—B.B. in the forceps does not phosphoresce, fuses with intumescence to a white enamel; in other respects resembles leucophane.

**Obs.**—From the augite-syenite of southern Norway, near Fredriksvärn, with elæolite, mica, fluorite; also from several of the islands of the Langesund fiord, at Stoksund on Stokö, Langodden, etc. Often associated with elæolite, homilite, erdmannite, fluorite, zircon, löllingite, etc. It does not accompany leucophanite, but appears to take its place.

Named from μέλι, *honey*, and φαίνεσθαι, *to appear*, from the honey-yellow color. [Scheerer miswrote the word *melinophane*, which would come from μέλινος, *ashen*, or μελινη, *millet.*] The dropping of the *t* of the genitive, as done above, has classical authority.

**Ref.**—[1] C. R., **83**, 711, 1876; also Nd., Öfv. Ak. Stockh., **27**, 556, 1870, who describes tabular crystals with two pyramids, $cp = 47° 51'$, and $cq = 21° 42'$, not readily corresponding to Bertrand's form; Bgr., Zs. Kr., **16**, 279, 1890.

## 2. Iolite Group.

**353. IOLITE.** Spanischer Lazulith *v. Schlotheim*, Hoff, Mag. Min., **1**, 169, 1801. Iolith (fr. Spain) *Wern.; Karst.* (with descr.), Tab., 46, 92, 1808. Iolithe *H.*, Tabl., 61, 221, 1809. Dichroit *Cordier*, J. Mines, **25**, 129, 1809, J. Phys., **68**, 298, 1809. Steinheilite *Gadolin*, Mem. Ac. St. Pet., **6**, 565. Peliom (fr. Bodenmais) *Wern.*, Hoffm. Min., **4**b, 117, 1817. Cordierite *Lucas*, Tabl., **2**, 219, 1813; *H.*, Tr., **3**, 5, 1822. Hard Fahlunit. Luchssapphir, Wassersapphir, in Germ., Saphir d'eau in Fr., *of Ceylon Jewelry*. Jolith *Germ.* Cerasite *Y. Kikuchi*, J. Coll. Sc., Japan, **3**, 331, 1890.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}5871 : 1 : 0{\cdot}5585$ Miller[1].

$100 \wedge 110 = 30° 25'$, $001 \wedge 101 = 43° 34\frac{1}{6}'$, $001 \wedge 011 = {}^*29° 11'$.

**Forms**[2]:
*a* (100, *i*-$\bar{\imath}$)
*b* (010, *i*-$\breve{\imath}$)
*c* (001, *O*)
*m* (110, *I*)
*d* (130, *i*-$\breve{3}$)
*f* (102, $\frac{1}{2}$-$\bar{\imath}$)
*e* (101, 1-$\bar{\imath}$)
*l* (012, $\frac{1}{2}$-$\breve{\imath}$)
*n* (011, 1-$\breve{\imath}$)
*p* (021, 2-$\breve{\imath}$)
*q* (041, 4-$\breve{\imath}$)
*t* (114, $\frac{1}{4}$)
*s* (112, $\frac{1}{2}$)
*r* (111, 1)
*h* (221, 2)
*u* (134, $\frac{3}{4}$-$\breve{3}$)
*o* (131, 3-$\breve{3}$)

$mm''' = {}^*60° 50'$
$dd' = 59° 10'$
$ff' = 50° 52\frac{1}{2}'$
$ee' = 87° 8'$
$ll' = 31° 12'$
$nn' = 58° 22'$
$pp' = 96° 20'$
$qq' = 131° 46'$
$cs = 28° 53'$
$cr = 47° 48'$
$ch = 65° 37'$
$rr' = 79° 25'$
$uu' = 24° 45'$
$oo' = 51° 59'$
$ss''' = 28° 18\frac{1}{2}'$
$rr''' = 44° 4'$
$hh''' = 54° 55'$

Twins: (1) tw. pl. *m*, often repeated giving pseudo-hexagonal forms; also as enclosed twinning lamellæ. (2) Tw. pl. *d* (130)[3], also pseudo-hexagonal. Habit short prismatic; faces in zone *ab*, vertically striated. As embedded grains; also massive, compact.

Cleavage: *b* distinct; *a* and *c* indistinct. Crystals often show a lamellar structure ∥ *c*, especially when slightly altered. Fracture subconchoidal. Brittle. H. = 7–7·5. G. = 2·60–2·66. Luster vitreous. Color various shades of blue, light or dark, smoky blue. Transparent to translucent.

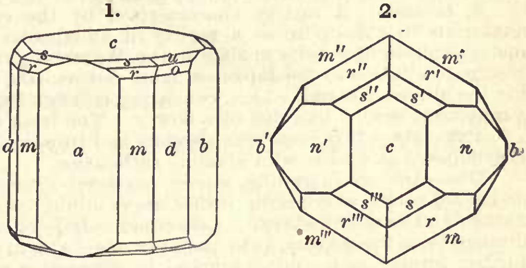

Fig. 1, Laach, Rath. 2, Miller.

[4] Pleochroism strongly marked except in thin sections. Axial colors variable, as given by Haidinger:

| | $\mathfrak{c} = \bar{b}$ | $\mathfrak{b} = \breve{a}$ | $\mathfrak{a} = \acute{c}$ |
|---|---|---|---|
| Bodenmais | dark Berlin-blue | light Berlin-blue | yellowish white |
| Arendal | dark blue | light blue | yellowish white |
| Orijärvi | dark Berlin-blue | plum-blue | reddish clove-brown |
| Ceylon | light Berlin-blue | bluish white | yellowish white |
| Haddam | pale blue | nearly white | light yellowish white |

Also for the planes: *a* bluish white, *b* yellowish white, *c* blue. Absorption $\mathfrak{c}\ (\bar{b}) > \mathfrak{b}\ (\breve{a}) > \mathfrak{a}\ (\acute{c})$. Pleochroic halos common, often bright yellow; best seen in sections ‖ $\dot{c}$. Exhibits idiophanous figures[5], analogous to andalusite, epidote, etc. Optically −. Ax. pl. ‖ *a*. Bx ⊥ *c*. Dispersion feeble, $\rho < v$. Refractive indices (for orange), Dx.[6]:

| | | | | | |
|---|---|---|---|---|---|
| Ceylon | $\alpha$=1·537 | $\beta$=1·542 | $\gamma$=1·543 | ∴ 2V=70° 23′ 2E=125° 16′. | Found $2E_r$=124° 44′ |
| Bodenmais | $\alpha$=1·535 | $\beta$=1·541 | $\gamma$=1·546 | ∴ 2V=84° 28′. | Found $2H_r$=89° 25′ $2V_r$= 83° 57′ |
| Orijärvi | $\alpha$=1·5337 | $\beta$=1·5375 | $\gamma$=1·5400 | ∴ 2V=77° 57′ 2E=150° 28′. | Found $2H_r$= 82° 21′,<br>[$2E_r$=149° 23′ |
| Haddam | $\alpha$=1·5523 | $\beta$=1·5615 | $\gamma$=1·5627 | ∴ 2V=39° 32′ 2E=63° 45′. | Found $2E_r$=63° to 64° |

Heat increases the axial angle perceptibly, *e.g.*, from 2E = 63° 56′ at 8°·8 C. to 69° 8′ at 95°·5, and 71° 40′ at 150°·8, for red rays, Dx.

**Comp.**—$H_2(Mg,Fe)_4Al_8Si_{10}O_{37}$ or $H_2O.4(Mg,FeO).4Al_2O_3.10SiO_2$ Farrington. If Mg : Fe = 7 : 2, the percentage composition is: Silica 49·4, alumina 33·6, iron protoxide 5·3, magnesia 10·2, water 1·5 = 100. Ferrous iron replaces part of the magnesium. There has been some doubt expressed (Rg.) as to the state of oxidation of the iron. Calcium is also present in small amount.

**Anal.**—1–4, Stromeyer, Unters., 1821, Rg., Min. Ch. 5. Scheerer, Pogg., **68**, 319, 1846. 6, Igelström, Jb. Min., 360, 1870. 7, Hermann, Min. Russl., **3**, 257, 1858. 8, T. Shimidsu, J. Coll. Sc., Japan, 3, 325. 1890. 9, Jackson, Dana Min., 406, 1844. 10, 11, Farrington, priv. contr. Also 5th Ed., p. 300.

| | G. | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Bodenmais | | 48·35 | 31·70 | 9·24[a] | 0·33 | 10·16 | 0·59 | — | = 100·37 |
| 2. Finland | | 48·54 | 31·37 | 6·31[a] | 0·70 | 11·30 | 1·69 | — | = 99·91 |
| 3. Falun | | 50·25 | 32·42 | 4·45[a] | 0·76 | 10·85 | — | 1·66 | = 100·39 |
| 4. Greenland | 2·60 | 49·17 | 33·10 | 4·82[a] | 0·04 | 11·45 | — | 1·20 | = 99·78 |
| 5. Kragerö | | $\frac{2}{2}$ 50·44 | 32·95 | 0·96 | *tr.* | 12·76 | 1·12 | 1·02 | = 99·36 |
| 6. Ramsberg | | 48·66 | 30·35 | 8·42 | — | 9·32 | 0·55 | 2·35 | = 99·65 |
| 7. Mursinka | 2·60 | 50·65 | 30·26 | 4·10 | 0·60 | 11·09 | — | 2·66 | $Li_2O$ 0·64 = 100 |
| 8. Japan | 2·642 | 48·43 | 32·36 | 8·55 | 1·32 | 7·81 | 0·46 | 1·55 | = 100·48 |
| 9. Unity, Me. | | 48·15 | 32·50 | 7·92 | 0·28 | 10·14 | — | 0·50 | = 100·37 |
| 10. Haddam, Ct. | 2·610 | $\frac{2}{2}$ 49·14 | 32·84 | 5·04 | 0·19 | 10·40 | — | 1·84 | $Fe_2O_3$ 0·63 = 100·08 |
| 11. Guilford, Ct. | 2·607 | 49·50 | 33·01 | 5·12 | 0·29 | 10·42 | — | 1·62 | $Fe_2O_3$ 0·38 = 100·34 |

[a] $Fe_2O_3$ as given by Rg.

**Var.**—1. *Ordinary.* In short prismatic crystals, six- or twelve-sided, often with rounded edges; also massive or in embedded grains.

2. *Cerasite.* A variety characterized by the constant and regular presence of inclusions, analogous to chiastolite as a variety of andalusite; pleochroism weak. Produced by contact metamorphism of granite in slate in the Watarase-gawa region, Japan. Named from κέρασος, *cherry*, in allusion to the Japanese name *Sakura-ishi*, or cherry-stone, given to the rock containing the altered mineral, which, consisting chiefly of mica, shows a hexagonal radiate structure in a transverse section like that of a flower. The fresh mineral (anal. 8) shows the same structure.

**Pyr., etc.**—B.B. loses transparency and fuses at 5–5·5. Only partially decomposed by acids. Decomposed on fusion with alkaline carbonates.

**Obs.**—Occurs in granite, gneiss (*cordierite-gneiss*), hornblendic, chloritic and talcose schist, and allied rocks, with quartz, orthoclase or albite, tourmaline, hornblende, andalusite, sillimanite, garnet, and sometimes beryl. Less commonly in or connected with igneous rocks, thus formed directly from the magma, as in andesyte, etc.; also in ejected masses (in fragments of older rocks); further formed as a contact-mineral in connection with cruptive dikes, as in slates adjoining granite (cf. cerasite above), or as microscopic crystals in vitrified sandstone near basalt (cf. Zirkel, Jb. Min., 1, 109, 1891).

At Bodenmais, Bavaria, it is met with in granite, in crystals, along with pyrrhotite, sphalerite, chalcopyrite; the variety is the *peliom* of Werner, named from πέλιος, in allusion to its smoky blue color. It occurs in the andesytes of Hungary (Szabó, Jb. Min., Beil., 1, 302, 1881). In quartz at Ujordlersoak in Greenland; in the andesytes of Cabo de Gata, in Spain; at Kragerö, in Norway; Orijärvi, in Finland (*steinheilite*); Tunaberg, in Sweden; Finspaong, in Ostgothland; Brunhult, in Södermanland; Falun (*hard fahlunite*); in ejected masses of gneiss at the Laacher See; at Campiglia Maritima, Tuscany, in a trachytic rock, containing also mica, quartz, and sanidine. In colorless crystals (G. = 2·67) from Brazil. Ceylon affords a transparent variety, in small rolled masses of an intense blue color, the *saphir d'eau* of jewellers. In Japan along the Watarase-gawa (*cerasite*), on the borders of the provinces Kōdsuke and Shimotsuke, as noted above and at other points; also altered to a micaceous mineral in a dark slate near Kameoka, in the province of Tamba; further in ejected masses from Asama-yama.

At Haddam, Conn., associated with tourmaline in a granitic vein in gneiss; sparingly at the chrysoberyl locality, in an altered or fahlunite condition; abundant in quartz with garnet and yellowish green feldspar, near the Norwich and Worcester Railway, between the Shetucket and

Quinnebaug, where the gneiss has been quarried for the road; in gneiss near Guilford, Conn. At Brimfield, Mass., on the road leading to Warren, near Sam Patrick's with adularia, in gneiss; also good at Richmond, N. H., in talcose rock, along with anthophyllite.

Named *Iolite* from ἴον, *violet*, and λίθος, *stone; Dichroite* (from δίχροος, *two-colored*), from its dichroism; *Cordierite*, after Cordier, the French geologist (1777–1861), who first studied the crystals of the species; *Steinheilite* by Gadolin after Mr. Steinheil.

**Alt.**—The alteration of iolite takes place so readily by ordinary exposure, that the mineral is most commonly found in an altered state, or enclosed in the altered iolite. This change may be a simple hydration; or a removal of part of the protoxide bases by carbon dioxide; or the introduction of oxide of iron; or of alkalies, forming pinite and mica. The first step in the change consists in a division of the prisms of iolite into plates parallel to the base, and a pearly foliation of the surfaces of these plates; with a change of color to grayish green and greenish gray, and sometimes brownish gray. As the alteration proceeds, the foliation becomes more complete; afterward it may be lost. The mineral in this altered condition has many names: as *hydrous iolite* (incl. *bonsdorffite* and *auralite*) from Åbo, Finland, anal. 2; *fahlunite* (and *weissite*?) from Falun, Sweden, anal. 1, also *pyrargillite* from Helsingfors; *esmarkite* and *praseolite* from near Brevik, Norway, also *raumite* from Raumo, Finland, and *peplolite* from Ramsberg, Sweden; *chlorophyllite* from Unity, Me., anal. 3; *aspasiolite*, anal. 4; and *polychroilite* from Kragerö, further, the alkaline kinds, *pinite, cataspilite, gigantolite, iberite*, which are mentioned more particularly, with analyses, under the Mica Group, wh. see. See further fahlunite, etc., 5th Ed., pp. 484–486, also a review of the subject by Wichmann, Zs. G. Ges., **26**, 675, 1874.

The following are analyses of some of the above mentioned alteration products of iolite: 1, Trolle Wachmeister, Ak. H. Stockh., 213, 1827. 2, Malmgren, Vh. Min. Ges., 152, 1862. 3, Rg., Min. Ch., 833, 1860. 4, Scheerer, Pogg., **68**, 323, 1846.

| | | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. *Fahlunite* | | 44·95 | 30·70 | 7·22 | 1·90 | 6·04 | 0·95 | 1·38 | 8·65 | = 101·79 |
| 2. *Auralite* | | 41·76 | 31·25 | 8·35 | 0·30 | 4·73 | 1·78 | 1·50 | 10·44 | = 100·11 |
| 3. *Chlorophyllite* | | 46·31 | 25·17 | 10·99[a] | *tr.* | 10·91 | 0·58 | — | 6·70 | = 100·66 |
| 4. *Aspasiolite* | G = 2·764 $\frac{2}{2}$ | 50·40 | 32·38 | 2·34 | — | 8·01 | — | — | 6·73 | = 99·86 |

[a] $Fe_2O_3$.

**Artif.**—Bourgeois obtained by fusion of the constituents a mass containing microlites of pyroxene and a mineral having the characters of iolite. Cf. Reprod. Min., 226, 1884.

**Ref.**—[1] Min., 325, 1852. [2] Mlr., l. c. Earlier Tamnau, Pogg., **12**, 495, 1828; Hausm., Min., **2**, 553, 1847, and "Ueber die Krystallformen des Cordierits von Bodenmais," Göttingen, 1859. Also Dx., Min., **1**, 354, 1862; Rath, Laach, Pogg., **152**, 40, 1874; Gdt., Index, **1**, 465, 1886. Gdt. notes as doubtful the forms of Hausmann: $\sigma$ (072), $\pi$ (132), $\rho$ (5·15·18). [3] Lsx., twins from Laacher See, Zs. Kr., **8**, 76, 1883. [4] Absorption phenomena Haid., Ber. Ak. Wien, **13**, 306, 1854, Lsx., l. c., Hussak, Ber. Ak. Wien, **87** (1), 333, 1883. [5] Idiophanous figures, Haid., l. c., Bertin, Ann. Ch. Phys., **15**, 396, 1878 (or Zs. Kr., **3**, 449, 1879), *et al.*, Bull. Soc. Min., **2**, 72–78, 1879. [6] Dx., l. c., and N. R., 53, 1867.

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## 3. Barysilite Group.

**354. BARYSILITE.** Barysil *A. Sjögren* and *C. H. Lundström*, Öfv. Ak. Stockh., **45**, 7, 1888.

Hexagonal. In embedded masses with curved lamellar structure.

Cleavage: basal, distinct; prismatic less so. H. = 3. G. = 6·11; 6·55. Fracture uneven. Brittle. Luster pearly on cleavage surface. Color white; tarnishing on exposure. Translucent. Optically uniaxial, negative.

**Comp.**—$Pb_3Si_2O_7$ or $3PbO.2SiO_2$ = Silica 15·2, lead protoxide 84·8 = 100. The lead is replaced in part by manganese, calcium, magnesium.

**Anal.**—Sjögren and Lundström.

| | | $SiO_2$ | PbO | MnO | FeO | CaO | MgO | ign. | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | G. = 6·11 | 17·85 | 73·39 | 4·14 | 0·44 | 1·29 | 1·09 | 1·20 | Cl *tr.* = 99·40 |
| 2. | G. = 6·55 $\frac{2}{2}$ | 16·98 | 77·84 | 3·49 | 0·16 | 0·41 | 0·58 | 0·66 | = 100·12 |
| 3. | | 16·83 | 77·64 | 3·67 | 0·12 | 0·23 | 0·57 | 0·54 | Cl *tr.* = 99·60 |

**Pyr.**—Decrepitates and fuses very easily B.B. to a clear brown glass; reacts for lead and manganese. Dissolves with gelatinization in nitric acid; also in hydrochloric acid with separation of lead chloride.

**Obs.**—Occurs scattered through iron ore with calcite, yellow garnet, tephroite, and galena at the Harstig mine, Pajsberg, Wermland, Sweden.

**355. GANOMALITE.** *A. E. Nordenskiöld,* G. För. Förh., **3**, 121, 1876, **3**, 382, 1877; *A. Sjögren,* ib., **6**, 531, 1883.

Tetragonal[1]. In prismatic crystals with the forms:

*c* (001, *O*), *m* (110, *I*), *h* (410, *i*-4)?, *p* (111, 1), *cp* = 45° approx., whence $\dot{c}$ = 0·707.

Also massive, granular.

Cleavage: *m* and *c* distinct. Fracture uneven. Very brittle. H.=3. G.=5·74 Lindström; 4·98 Nd. Luster resinous to vitreous. Colorless to gray. Optically positive. Double refraction strong.

**Comp.**—$Pb_3Si_2O_7.(Ca,Mn)_2SiO_4$ or $3PbO.2(Ca,Mn)O.3SiO_2$. If Ca : Mn = 5 : 1, this requires: Silica 18·7, lead protoxide 69·2, manganese protoxide 2·4, lime 9·7 = 100.

**Anal.**—1, 2, Wiborgh, G. För. Förh., **6**, 537, 1883. 3, G. Lindström, ib., p. 662; three determinations of the specific gravity gave: 5·722, 5·730, 5·762.

| | $SiO_2$ | PbO | MnO | CaO | |
|---|---|---|---|---|---|
| 1. | 20·22 | 69·95 | — | 9·27 | = 99·44 |
| 2. | 20·59 | 68·89 | — | 10·52 | = 100 |
| 3. Jakobsberg G. = 5·74 | 18·33 | 68·80 | 2·29 | 9·34 | ign. 0·57, X[a] 0·70 = 100·03 |

[a] X = $Al_2O_3$ 0·07, $Fe_2O_3$ 0·12, CuO 0·02, MgO 0·11, alk. 0·10, $P_2O_5$ 0·04, Cl 0·24.

**Pyr.**—B.B. fuses easily to a clear glass, which in R.F. is colored black by reduced lead. On charcoal with soda a lead globule, and a coating of lead oxide. Easily soluble in nitric acid, with the separation of gelatinous silica.

**Obs.**—Occurs very sparingly with tephroite (which it closely resembles), native lead, calcite, and jacobsite, at Långban, Wermland, Sweden. Also from Jakobsberg, Nordmark, mixed with a brown mica (manganophyllite), and associated with calcite and jakobsite. Named from *γάνωμα, luster*.

An earlier approximate analysis by Lindström of the Långban mineral (quoted by Nd.) gave: $SiO_2$ 34·55, PbO 34·89, MnO 20·01, CaO 4·89, MgO 3·68, alk. and loss 1·98 = 100. Cf. ref.[1]. It does not seem certain that the two minerals are identical.

Nordenskiöld (ib., p. 384) mentions the occurrence at Långban of a second lead silicate, very similar in appearance and blowpipe reactions to the above, but with two distinct cleavages, at an angle of 75° 27′. The material available was too scanty for full examination, but he suggests that it may be a more distinctly crystallized variety of ganomalite.

**Ref.**—[1] Nd., A. Sj., l. c.; biaxial with small angle, Dx., Bull. Soc. Min., **1**, 8, 1878.

**356. HYALOTEKITE.** *A. E. Nordenskiöld,* G. För. Förh., **3**, 382, 1877.

Massive. Coarsely crystalline.

Cleavage easy in two directions, at an angle of approximately 90°; also less easy in a third direction, in the same zone (Dx.). Brittle. H. = 5–5·5. G.=3·81. Luster vitreous to greasy. Color white to pearly gray. Transparent in very thin plates. Optically biaxial, positive. Ax. pl. ∥ zone-axis of the cleavages. $2H_r$=98°–99°, Dx.[1]

**Comp.**—Approximately $R_9B_2(SiO_3)_{12}$. Lindström's analysis gives $16RO.2B_2O_3.24SiO_2.F$. Here R=Pb : Ba : Ca = 0·225 : 0·262 : 0·279; also small quantities of BeO, $K_2O$, etc. Groth suggests $HR_4B(SiO_3)_6$ with F replacing most of the (OH).

**Anal.**—G. Lindström, Öfv. Ak. Stockh., **44**, 589, 1887.

| $SiO_2$ | $B_2O_3$ | PbO | BaO | CaO | F |
|---|---|---|---|---|---|
| 39·47 | 3·73 | 25·11 | 20·08 | 7·82 | 0·99 ign. 0·59, X[a] 2·58 = 100·37 |

[a] X = CuO 0·09, MnO 0·29, BeO 0·75, MgO 0·09, $K_2O$ 0·89, Cl 0·06, $Na_2O$ 0·17, $Al_2O_3$ 0·18, $Fe_2O_3$ 0·06.

An earlier incomplete analysis (Nd.) gave: $SiO_2$ 39·62, PbO 25·30, BaO 20·66, CaO 7·00, ign. 0·82, $Al_2O_3$, $K_2O$, etc., *tr*.

**Pyr., etc.**—B.B. fuses to a clear glass, which in R.F. becomes blackened with reduced lead. On charcoal with soda in small amount fuses to a clear glass; with more soda in R.F. gives a lead globule and a coating of lead oxide. In salt of phosphorus dissolves, leaving a skeleton of silica. Insoluble in hydrochloric or sulphuric acids.

**Obs.**—Occurs sparingly in a grayish white feldspar, with hedyphane and schefferite, at Långban, Wermland, Sweden. Named from *ὕαλος, glass,* and *τήκειν, to melt.*

**Ref.**—[1] Bull. Soc. Min., **1**, 9, 1878.

## III. Orthosilicates. $R_2SiO_4$.

Salts of Orthosilicic Acid, $H_4SiO_4$; characterized by an oxygen ratio of 1 : 1 for silicon to bases.

The following list includes the prominent groups among the Orthosilicates.

A number of basic orthosilicates are here included, which yield water upon ignition; also others which are more or less basic than a normal orthosilicate, but which are of necessity introduced here in the classification, because of their relationship to other normal salts. The MICA GROUP is so closely related to many Hydrous Silicates that (with also Talc, Kaolinite, and some others) it is included under the latter head.

1. **Nephelite Group.** Hexagonal.
2. **Sodalite Group.** Isometric.
3. **Helvite Group.** Isometric, tetrahedral.
4. **Garnet Group.** Isometric.
5. **Chrysolite Group.** Orthorhombic.
6. **Phenacite Group.** Rhombohedral.
7. **Scapolite Group.** Tetragonal.
8. **Melilite Group.** Tetragonal.
9. **Vesuvianite Group.** Tetragonal.
10. **Zircon Group.** Tetragonal.
11. **Danburite Group.** Orthorhombic.
12. **Datolite Group.** Monoclinic.
13. **Epidote Group.** Monoclinic.
14. **Axinite Group.** Triclinic.

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### 1. Nephelite Group. Hexagonal.

Typical formula $\overset{\mathrm{I}}{\dot{R}}AlSiO_4$.

| | | | |
|---|---|---|---|
| 357. | **Nephelite** | $K_2Na_6Al_8Si_9O_{34}$ | $\dot{c} = 0{\cdot}8389$ |
| | Soda-nephelite (artif.) | $NaAlSiO_4$ | |
| 358. | **Eucryptite** | $LiAlSiO_4$ | |
| 359. | **Kaliophilite** | $KAlSiO_4$ | |

| | | | |
|---|---|---|---|
| 360. | **Cancrinite** | $H_6Na_6Ca(NaCO_3)_2Al_8(SiO_4)_9$ | $2\dot{c} = 0{\cdot}8448$ |
| 361. | **Microsommite** | $(Na,K)_{10}Ca_4Al_{12}Si_{12}O_{62}SCl_4$ | $2\dot{c} = 0{\cdot}8367$ |

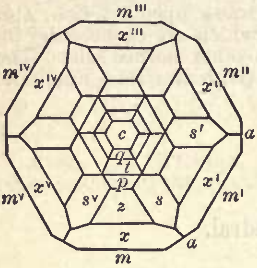
357. **NEPHELITE.** Sechsseitige weisse durchsichtige Schörlsäuler mit oder ohne Pyramide an der Spitze, etc. (fr. Vesuvius (Somma)), *J. J. Ferber*, Briefe aus Wälschland, 166, 1773; = Basaltes crystallisatus albus crystallis prismaticis *v. Born*, Lithoph., **2**, 73, 1775; = Sommite *Delameth.*, T. T., **2**, 271, 1797; = Nepheline *H.*, Tr., **3**, 1801. Pseudo-sommite, Pseudo-nepheline (fr. C. di Bove), *Fl. Bellevue*, J. Phys., **51**, 458, 1800; id., var. of Sommite, *Delameth.*, l. c. Nefelina, Cavolinite, Davina, *Mont. & Covelli*, Min. Vesuv., 1825.

Fettstein *Wern.*, 1808, Klapr. Beitr., **5**, 176, 1810, Steffen's Orykt., **1**, 472, 1811. Elæolith (fr. Norway) *Klapr.*, Mag. Ges. Fr. Berl., **3**, 43. 1809. Beitr., **5**, 176, 1810. Pierre grasse *H.*, Tabl., 65, 228, 1809. Phonite (fr. Norway) Dx. Min., **1**, 289, 1863.

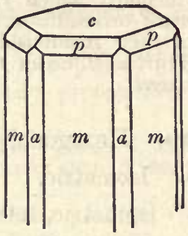
Hexagonal. Axis $\dot{c} = 0{\cdot}838926$; $0001 \wedge 10\bar{1}1 = 44° 5' 22''$ Koksharov[1].

**Forms**[2]: *m* $(10\bar{1}0, I)$ *g* $(20\bar{2}5, \frac{2}{5})$ *p* $(10\bar{1}1, 1)$ *x* $(40\bar{4}1, 4)$ *e* $(11\bar{2}2, 1\text{-}2)$
*c* $(0001, O)$ *a* $(11\bar{2}0, i\text{-}2)$ *q* $(10\bar{1}2, \frac{1}{2})$ *z* $(20\bar{2}1, 2)$ *y* $(60\bar{6}1, 6)$ *s* $(11\bar{2}1, 2\text{-}2)$
*n* $(21\bar{3}0, i\text{-}\frac{3}{2})$ *t* $(20\bar{2}3, \frac{2}{3})$

1.



2.



*cg* = 21° 11′
*cq* = 25° 51′
*ct* = 32° 51′
*cp* = 44° 5′
*cz* = 62° 42′
*cx* = 75° 32′
*cy* = 80° 14′
*ce* = 40° 0′
*cs* = 59° 12′
*gg′* = 20° 49′

*qq′* = 25° 11′
*tt′* = 31° 29′
*pp′* = *40° 43′
*zz′* = 52° 45½′
*xx′* = 57° 55′
*yy′* = 59° 3′
*ee′* = 37° 29′
*ss′* = 50° 52′
*ms* = 41° 56′
*ap* = 52° 57′

1. *Nephelite*, Vesuvius, Scc. 2. *Elæolite*, Is. Låven, Norway, Klein.

Usually in thick six- or twelve-sided prisms with plane or modified summits. Also massive compact, and in embedded grains; structure sometimes thin columnar.

Cleavage: *m* distinct; *c* imperfect. Fracture subconchoidal. Brittle. H. = 5·5–6. G. = 2·55–2·65. Luster vitreous to greasy; a little opalescent in some varieties. Colorless, white, or yellowish; also when massive, dark green, greenish or bluish gray, brownish red and brick-red. Transparent to opaque. Optically −. Indices:

| | | | |
|---|---|---|---|
| Mte. Somma | $\omega_y = 1·539 - 1·542$ | $\epsilon_y = 1·534 - 1·537$ | Dx.[4] |
| " " | $\omega_y = 1·5416$ | $\epsilon_y = 1·5376$ | Wolff[5]. |
| " " | $\omega_y = 1·5427$ | $\epsilon_y = 1·5378$ | Wadsworth[5]. |
| Arkansas | $\omega_y = 1·5469$ | $\epsilon_y = 1·5422$ | Penfield[5]. |

Etching experiments seem to prove the existence of pyramidal hemihedrism with hemimorphism in the direction of $\dot{c}$; also of twinning with *a* and *c* as tw.-planes, Baumh.[3]

**Var.**—1. *Nephelite, Glassy.* Usually in small glassy crystals or grains, transparent with vitreous luster, first found on Mte. Somma. G. = 2·56, Vesuvius, Scheerer; 2·637, ib., Breith. Characteristic particularly of younger eruptive rocks and lavas; often in crystals also forming an unindividualized ground-mass (*nephelinitoid*).

2. *Elæolite.* In large coarse crystals, or more commonly massive, with a greasy luster, and reddish, greenish, brownish or gray in color. Usually clouded by minute inclusions. G. = 2·597 Miask, Breith.; 2·617 Brevik, Scheerer; 2·612 Laurvik, Bgr.; 2·65 Arkansas, Smith & Brush. Characteristic of granular crystalline rocks, syenite, etc.

**Comp.**—$\overset{\text{I}}{R}_8Al_8Si_9O_{34}$; if $\overset{\text{I}}{R}$ = Na : K = 3 : 1, this is equivalent to $3Na_2O.K_2O.4Al_2O_3.9SiO_2$ = Silica 44·0, alumina 33·2, soda 15·1, potash 7·7 = 100. In most analyses Na : K = 4 : 1 or 5 : 1.

The above is the formula of Scheerer. Cf. also Rg., Ber. Ak. Berlin, 695, 1876, Min. Ch., Erg., 170, 1886; Rauff, Zs. Kr., **2**, 454, 1878; Doelter, ib., **9**, 321, 1884.

From synthetic experiments, yielding crystals like nephelite, with the composition $NaAlSiO_4$ or $Na_2O.Al_2O_3.2SiO_2$. Doelter decides that a natural soda-nephelite would be an orthosilicate with this formula, while the higher silica in the potash varieties may be explained by the presence, in molecular combination, of $KAlSi_2O_6$ or $K_2O.Al_2O_3.4SiO_2$ (= leucite). This was also suggested by Rammelsberg, and seems very probable, although not agreeing strictly with Scheerer's formula above. It is to be noted that the other species of the group are normal orthosilicates, viz., eucryptite $LiAlSiO_4$, and kaliophilite $KAlSiO_4$.

**Anal.**—1–3, Scheerer, Pogg., **49**, 359, 1840, also other analyses. 4, Rg., Min. Ch., 446, 1875. 5, Rg., l. c., 1876. 6, Rauff, l. c. 7, Jannettaz, Bull. Soc. Min., **5**, 322, 1882. 8, 9, Scheerer, Pogg., **46**, 291, 1839. 10, F. Koch, Jb. Min., Beil., **1**, 143, 1880 (cf. also Min. Mitth., 335, 1877). 11, 12, Lorenzen, Min. Mag., **5**, 59, 1882. 13, Clarke, Am. J. Sc., **31**, 262, 1886. 14, 15, Lemberg, Zs. G. Ges., **28**, 548–9, 1876. Also 5th Ed., p. 328.

*Nephelite.*

| | | G. | | $SiO_2$ | $Al_2O_3$ | $Na_2O$ | $K_2O$ | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Vesuvius | 2·56 | | 44·03 | 33·28 | 15·44 | 4·94 | 1·77 | 0·21 | $Fe_2O_3$,$Mn_2O_3$ 0·65=100·32 |
| 2. | " | | | 44·29 | 33·04 | 14·93 | 4·72 | 1·82 | 0·21 | $Fe_2O_3$,$Mn_2O_3$ 0·39= 99·40 |
| 3. | " | | | 44·04 | 34·06 | 15·91 | 4·52 | 2·01 | 0·21 | MgO *tr.*, $Fe_2O_3$ 0·44 = [101·19 |
| 4. | " | | | 43·56 | 32·18 | 16·25 | 7·14 | 0·45 | — | = 99·58 |
| 5. | " | 2·608 | 4/4 | 44·98 | 34·49 | 15·60 | 4·65 | 0·43 | — | = 100·15 |
| 6. | " | | 5/5 | 44·08 | 33·28 | 16·00 | 4·76 | 1·85 | 0·15 | = 100·12 |
| 7. | Denise | 2·71 | | 43·18 | 33·50 | 18·61 | 0·90 | 1·50 | 0·80 | = 98·49 |
| 8. | Katzenbuckel | | | 43·70 | 32·31 | 15·83 | 5·60 | 0·84 | 1·39 | $Fe_2O_3$ 1·07 = 100·74 |

*Elæolite.*

| | | G. | | $SiO_2$ | $Al_2O_3$ | $Na_2O$ | $K_2O$ | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 9. | Brevik | 2·617 | 3/3 | 44·45 | 31·92 | 15·71 | 5·17 | 0·28 | 2·07 | $Fe_2O_3$ 1·10 = 100·70 |
| 10. | Ditró | | | 45·25 | 29·41 | 14·36 | 6·84 | 1·69 | 2·11 | = 99·66 |
| 11. | Greenland, *cryst.* | 2·60 | | 43·39 | 32·28 | 16·52 | 5·62 | 0·70 | — | $Fe_2O_3$ 0·92, Cl *tr.* = 99·43 |
| 12. | " *mass.* | 2·63 | | 41·87 | 33·94 | 15·03 | 6·68 | 0·47 | 0·94 | $Fe_2O_3$ 0·70, Cl *tr.* = 99·63 |
| 13. | Litchfield, Me. | | | 43·74 | 34·48 | 16·62 | 4·55 | *tr.* | 0·86 | MgO *tr.* = 100·25 |
| 14. | Fredriksvärn | | | 45·10 | 33·28 | 16·36 | 5·05 | — | 0·70 | = 100·49 |
| 15. | Miask | | | 43·42 | 33·46 | 16·44 | 5·43 | — | 1·21 | = 99 96 |

**Pyr., etc.**—B.B. fuses quietly at 3·5 to a colorless glass. Gelatinizes with acids.

**Obs.**—Nephelite occurs both in ancient and modern volcanic rocks, and also in crystalline rocks allied to granite and gneiss; in recent volcanic rocks it is in glassy crystals or grains often associated with glassy feldspar or sanidine, as in phonolyte, or with a triclinic feldspar in teschenyte, etc., or without feldspar in nephelinyte and nephelinbasalt, as that of Katzenbuckel, near Heidelberg. In the older igneous rocks the variety elæolite is present, often with orthoclase, as in elæolite-syenite. No sharp distinction can be made, however, between the plutonic or intrusive granitoid rocks carrying nephelite (elæolite) and surface or effusive rocks; thus Derby shows that in Brazil (Minas Geraes, São Paulo, etc.) both types pass into each other (Q. J. G. Soc., **43**, 457, 1887, and Dec. 19, 1890).

A granitoid rock found near Miask, in which elæolite is prominent, has been named *miascyte*, from its locality. A rock composed of orthoclase, elæolite, and sodalite, from Ditró in Transylvania, is the *ditröyte* of Tschermak. The zircon-syenite or augite-syenite of Norway contains much elæolite, and is hence often called also elæolite-syenite.

Nephelite occurs in crystals in the older lavas of Mte. Somma, with mica, vesuvianite, etc.; at Capo di Bove, near Rome (the locality of the *pseudo-nepheline*); in the basalt of Katzenbuckel, near Heidelberg; at Meiches in Hesse; Aussig in Bohemia; Löbau in Saxony; in granular masses embedded in the basalt of Denise near Puy, Haute Loire. Phonolytes carrying nephelite occur on Fernando de Noronha and also, with the granitoid foyaytes, extensively in Brazil in the provinces of Minas Geraes, São Paulo, Rio de Janeiro (cf. Derby, l. c., *et al.*).

Elæolite is found at Stavern and Fredriksvärn, Norway, and at many points in the region of the Langesund fiord, where the elæolite-syenite is characterized by the number and variety of rare minerals which it contains (see Brögger, Zs. Kr., **16**, 1890); in the Ilmen Mts., Ural, along with white feldspar, brown hexagonal mica, zircon, pyrochlore, etc.; in the Tunkinsk Mts., Siberia, with graphite, cancrinite, zircon. In the sodalite-syenite of Tunugdliarfik and Kangerdluarsuk in south Greenland. In the elæolite-syenite or *foyayte* of Sierra de Monchique, southern Portugal.

Elæolite occurs massive and crystallized at Litchfield, Me., with cancrinite; in the Ozark Mts., near Magnet Cove, Arkansas, with brookite, schorlomite, eudialyte, and many rare species; in a boulder, with sodalite, at Salem, Mass. Elæolite-syenite is also found near Beemersville, northern N. J. A nephelite-basalt forms the mass of Pilot Knob, near Austin, Tex. Other nephelite rocks occur in the Kawsoh Mts., Nev.; Elkhead Mts., Col.; and the Peloncillo Mts., Arizona. A granular crystalline rock (theralite Rosenb.), consisting of nephelite and plagioclase, forms intrusive masses in the Crazy Mts., Montana. An elæolite-syenite containing sodalite occurs in Brome Mt., Brome Co.; also near Montreal and at Belœil, Rouville Co., Quebec, Canada; further stated (Hunt) to occur in boulders on Pic island, L. Superior.

Named *nepheline* by Haüy (1801), from νεφελή, *a cloud*, in allusion to its becoming cloudy when immersed in strong acid; *elæolite* (by Klaproth), from ἐλαίον, *oil*, in allusion to its greasy luster, the variety having been made a distinct species earlier by Werner (1808), under the German name of *Fettstein*. The name *sommite*, derived from the Vesuvian locality, given in 1797 by Delamétherie, has the priority, but Werner early adopted Haüy's name, and later authors have all taken the same course. Moreover sommite probably included some of the related species occurring at Vesuvius, as microsommite, etc.

The *gabronite* (gabbronite) of Schumacher, 1801, the dichter Wernerit of Hausmann, 1811, which has been referred to the scapolites (see 5th Ed., p. 324) was elæolite according to Brögger.

A mineral from Norway, of a yellowish brown color, called *phonite*, is very much like elæolite (Dx.).

**Alt.**—Nephelite or elæolite is liable to ready alteration, and usually produces a zeolite, as thomsonite or analcite. The *ozarkite* of Shepard, according to Smith and Brush, is thomsonite (q.v.), and its situation in cavities in elæolite shows that it is a product of alteration.

Brögger describes the change of the elæolite of the augite-syenite of southern Norway into sodalite; into analcite; natrolite and hydronephelite (or ranite) incl. spreustein; into thomsonite; also into potash mica (pinite) and kaolin. See further under these species, and Zs. Kr., **16**, 223–238, 1890. To the alteration into analcite is referred the euthallite of Esmark from the island Sigtesö (cf. Dx., Min., **2**, xxxix, 1874).

*Gieseckite* is shown by Blum to be a pseudomorph after this species. It differs mainly in containing several per cent of water. It occurs in Greenland in six-sided greenish gray prisms of greasy luster, with basal plane and pyramid *p*, having *cp* = 45° nearly; and also at Diana, in Lewis Co., N. Y., with the same angles, for the most part, although the results of measurement vary rather widely (41° to 49°). The crystals of Diana are hexagonal in cleavage; yet the planes of cleavage are often separated by layers of a waxy appearance, without luster or cleavage. According to Des Cloizeaux, the material of the crystals acts on polarized light like a gum or colloid, and is evidently a result of alteration. *Dysyntribite* Shepard from Diana is similar to gieseckite. *Liebenerite*, from the valley of Fleims, in Tyrol, is a similar pseudomorph. Gieseckite was named for Ch. Giesecke who early in the century brought it from Greenland. See further PINITE under the MICA GROUP.

J. Francis Williams has proved (priv. contr.) that elæolite, with orthoclase, may be formed by the alteration of leucite. Crystals of altered leucite from Magnet Cove, Arkansas (mentioned on p. 343), gave the results under 1, while the soluble and insoluble portions (calculated to 100) gave 2 and 3. Of these 2 is elæolite, 3 is orthoclase.

| | $SiO_2$ | $Al_2O_3$[a] | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Total | 55·06 | 24·85 | 0·59 | 0·28 | 10·34 | 7·60 | 1·78 | $SrO, Li_2O$ *tr.* = 100·40 |
| 2. *Soluble* | 42·17 | 34·90 | 0·87 | 0·21 | 5·06 | 16·79 | — | = 100 |
| 3. *Insol.* | 63·84 | 19·61 | 0·44 | 0·33 | 13·78 | 2·00 | — | = 100 |

[a] Incl. some $Fe_2O_3$.

**Artif.**—Made artificially by Fouqué and Lévy by fusion of a mixture of the elements of the mineral, C. R., **87**, 961, 1878; also by Hautefeuille by fusing a mixture of silica and sodium aluminate with an excess of sodium vanadate; later by Doelter, as already noted. Further, Lemberg has obtained the potash nephelite, $KAlSiO_4$, by digesting elæolite with potassium hydrate, Zs. G. Ges., **37**, 966, 1885, cf. also ib., **28**, 547 *et seq.*, 1876, **40**, 627, 1888. Ch. & G. Friedel have obtained nephelite by heating finely divided muscovite and potash to 500° in the presence of water, Bull. Soc. Min., **13**, 129, 1890.

**Ref.**—[1] Mte. Somma, Min. Russl., **2**, 160, 1854; **9**, 247, 1885; cf. Strüver, who gives *cp* = 43° 50⅔', Albani Mts., Zs. Kr., **1**, 240. 1877. [2] See Scc., Rend. Accad. Napoli, 1842, Pogg., Erg.-Bd., **3**, 478, 1851; Svr., Att. Acc. Torino, **3**, 123, 1867; Klein, Norway, Jb. Min., 532, 1879. [3] Baumh., Zs. Kr., **6**, 209, 1881. [4] Min., **1**, 286, 1862. [5] Quoted by Rosenbusch, Mikr. Phys., 358, 1885.

## 358. EUCRYPTITE. *G. J. Brush* and *E. S. Dana*, Am. J. Sc., **20**, 266, 1880.

Lithionnephelin *Germ.*

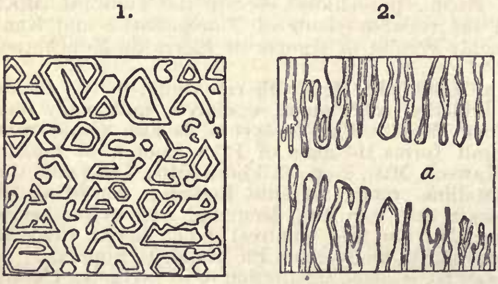


Fig. 1, Section ⊥ fibers; 2, ∥ fibers, showing eucryptite embedded in albite.

Hexagonal. In symmetrically arranged crystals, embedded in albite.

Cleavage: basal. G. = 2·667. Colorless or white. Transparent.

**Comp.**—An orthosilicate of lithium and aluminium, $LiAlSiO_4$ or $Li_2O.Al_2O_3.2SiO_2$ = Silica 47·6, alumina, 40·5, lithia 11·9 = 100.

**Anal.**—S. L. Penfield, l. c.

| $SiO_2$ | $Al_2O_3$ | $Li_2O$ | $K_2O$ |
|---|---|---|---|
| 48·13 | 40·50 | 10·90 | 0·47 = 100 |

An analysis of "β spodumene" (see p. 368) gave: Insoluble portion 67·56, soluble 32·10 = 99·66; the analysis of the soluble portion, reduced to 100, gave the results above. The latter (eucryptite) gelatinizes with hydrochloric acid.

**Obs.**—Eucryptite is known only as forming with albite an apparently homogeneous substance, derived from the alteration of spodumene at Branchville, Conn. The microscope shows the two minerals of which this substance is made up, and chemical analysis serves to separate them.

Named from εὐ, *well*, and κρυπτός, *concealed.*

**359. KALIOPHILITE.** *Mierisch*, Min. Mitth., **8**, 160, 1886. Facellite *E. Scacchi*, Rend. Acc. Napoli, Dec., 1888. Phacellite. Phacelite *Hintze*, Min., **2**, 96, 1889. Kalinephelin *Germ.*

Hexagonal. In bundles of slender acicular crystals, also in fine threads filling the rock cobweb-like.

Cleavage: basal, perfect. Brittle. H. = 6. G. = 2·493 Scc.; 2·602 M. Luster silky, brilliant. Colorless. Transparent. Optically uniaxial, negative.

**Comp.**—$KAlSiO_4$ or $K_2O.Al_2O_3.2SiO_2$ = Silica 38·0, alumina 32·3, potash 29·7 = 100.

**Anal.**—1, Mierisch. 2, Bischoff, ibid. 3, E. Scc., l. c.

| | $SiO_2$ | $Al_2O_3$ | CaO | $K_2O$ | $Na_2O$ | |
|---|---|---|---|---|---|---|
| 1. | $\frac{2}{2}$ 37·45 | 32·43 | 2·18 | 27·20 | 2·26 | = 101·52 |
| 2. | 37·05 | 29·47 | 1·01 | 28·49[a] | 1·10[a] | $Fe_2O_3$ 2·73, ign. 1·08 = 100·93 |
| 3. | 37·73 | 33·09 | — | 29·30 | 0·37 | = 100·49 |

[a] Determined separately.

**Pyr.**—Decomposed by hydrochloric acid with gelatinization.

**Obs.**—Described by Mierisch (*kaliophilite*) as occurring in ejected masses from Mte. Somma; by Scacchi (*facellite*) as occurring in a rock consisting of augite with more or less mica, less often in a gray granular calcite associated with dark colored augite and yellow melilite. The needles are often coated with a grayish incrustation of calcium carbonate.

There can be no question as to the identity of these two minerals, although some authors have failed to recognize it.

Named from *kalium*, and *φίλος*, *friend*, in allusion to the potash present, it being essentially a potash nephelite. Phacelite is from *φάκελος* (or *φάκελλος*), a *bundle*.

**Artif.**—A crystalline potash nephelite has been formed by Lemberg by digesting elæolite with potassium hydrate as noted on p. 426.

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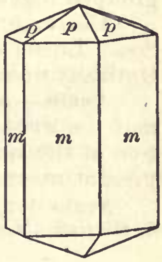
**360. CANCRINITE.** *G. Rose*, Pogg., **47**, 379, 1839.

Hexagonal. Axis $\dot{c}$ = 0·4224; 0001 ∧ 10$\bar{1}$1 = 26°, and *mp* = *64°, *pp'* = 25° 58' Törnebohm[1]. Rarely in prismatic crystals with a low terminal pyramid. Usually massive.



Cleavage: prismatic (*m*) perfect; *a* less so. H. = 5–6. G. = 2·42–2·5; 2·404 Sæmann & Pisani. Color white, gray, yellow, green, blue, reddish. Streak uncolored. Luster sub-vitreous, or a little pearly or greasy. Transparent to translucent. Optically uniaxial, negative, Btd.

**Comp.**—$H_6Na_6Ca(NaCO_3)_2Al_8(SiO_4)_9$ or $3H_2O.4Na_2O.CaO.4Al_2O_3.9SiO_2.2CO_2$ = Silica 38·7, carbon dioxide 6·3, alumina 29·3, lime 4·0, soda 17·8, water 3·9 = 100.

The formula is often written as if the compound consisted of a silicate of sodium and aluminium analogous to nephelite, with calcium carbonate and water. This, however, has been repeatedly shown to be an incorrect view of the chemical constitution; the $CO_2$ must be present as a radical, probably ($NaCO_3$). The early view that cancrinite was simply an altered form of nephelite has long since been disproved.

**Anal.**—1, Rauff, Zs. Kr., **2**, 456, 1878. 2, A. Koch, Jb. Min., Beil., **1**, 144, 1880. 3, Lemberg, Zs. G. Ges., **39**, 598, 1887, also **35**, 594, 1883. 4, Lindström, G. För. Förh., **6**, 549, 1883. 5, 6, 7, F W. Clarke (and Riggs), Am. J. Sc., **31**, 263, 1886. Also 5th Ed., p. 329.

| | | | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $CO_2$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Miask | G. = 2·450 | $\frac{2}{2}$ 37·28 | 28·20 | 6·95 | 17·75 | 0·20 | 6·16 | 4·03 | $Fe_2O_3$ 0·44 = [101·01 |
| 2. | Ditró | | 38·58 | 28·72 | 5·24 | 12·22 | 5·23 | 8·78 | | = 98·77 |
| 3. | "Brevik" | | 37·01 | 26·42 | 7·19 | 18·36 | — | 7·27 | 3·12 | = 99·37 |
| 4. | Siksjöberg | G. = 2·45 | 38·25 | 26·16 | 4·78 | 20·36 | 0·71 | 6·42 | 3·31 | $Fe_2O_3$ 0·35, MgO [0·14, $SO_3$ 0·54, $P_2O_5$ 0·03, Cl 0·08 = 101·13 |
| 5. | Litchfield, Me., *orange yellow* | | 36·29 | 30·12 | 4·27 | 19·56 | 0·18 | 6·96 | 2·98 | = 100·36 |
| 6. | " " *pale* " | | 35·83 | 29·45 | 5·12 | 19·33 | 0·09 | 6·50 | 3·79 | = 100·11 |
| 7. | " " *bright* " | | 37·22 | 28·32 | 4·40 | 19·43 | 0·18 | 6·22 | 3·86 | MgO 0·07 = 99·70 |

**Pyr., etc.**—In the closed tube gives water. B.B. loses color, and fuses (F. = 2) with intumescence to a white blebby glass, the very easy fusibility distinguishing it readily from nephelite. Effervesces with hydrochloric acid, and forms a jelly on heating, but not before.

**Obs.**—Found at Miask in the Ural; of citron-yellow color at the Mariinsk graphite mine in the Tunkinsk Mts., 400 versts west of Irkutsk, in a coarse granite, with zircon, calcite, and magnetite; at Barkevig and other points in the Langesund fiord, Norway, whitish and pale yellowish, wax-yellow, less often blue, associated with blue sodalite and "bergmannite;" at Ditró in Transylvania, pale flesh-red, in the rock called *ditroyte*, consisting of orthoclase, elæolite, and sodalite.

At Litchfield and West Gardiner, Me., with elæolite and blue sodalite.

Named after Count Cancrin, Russian Minister of Finance.

**Alt.**—Occurs altered (but sparingly, Bgr.) to natrolite (*bergmannite*) or spreustein. Cf. Sæmann and Pisani, Ann. Ch. Phys., **67**, 350, 1863.

Lemberg describes the transformation of cancrinite by boiling with a $CaCl_2$ solution at 180°–190° into a "Kalk-cancrinit;" also by action of $K_2CO_3$ into $KAlSiO_4$; while that was changed by $Na_2CO_3$ to a cancrinite; also cancrinite to a hydrated Mg-Al silicate by the action of $MgSO_4$. See further Zs. G. Ges., **35**, 593, 1883, **39**, 598, 1887, **40**, 627, 1888.

**Ref.**—[1] Elfdalen, G. För. Förh., **6**, 390, 1883. Brögger measured on crystals (fig. above) from the Langesund fiord, $mp = 60°$ to $66°$, the best mean value being 63° 1′; this gives $\dot{c} = 0·4409$.

KALK-CANCRINITE *Lemberg*, Zs. G. Ges., **28**, 582, 1876.

Granular massive. H. = 6. Cleavage none. Colorless. Doubly-refracting. Analysis:

$SiO_2$ 39·82 $Al_2O_3$ 33·54 CaO 17·63 $Na_2O$ 0·76 $CaCO_3$ 9·09 = 100·84

Gives off no $CO_2$ in the cold with concentrated hydrochloric acid only on heating, when the silica separates as a jelly.

From Vesuvius, associated with calcite, wollastonite, and brown garnet. On the lime-cancrinite formed by digesting cancrinite with a hot solution of $CaCl_2$, see Lemberg above, and Zs. G. Ges., **35**, 594, 1883.

**361. MICROSOMMITE.** *Scacchi*, Rend. Accad. Napoli, Oct., 1872, and Zs. G. Ges., **24**, 506, 1872. Mikrosommit.

Hexagonal. Axis $\dot{c} = 0·41834$; $0001 \wedge 10\bar{1}1 = {}^*25° \, 47'$ Scacchi[1].

**Forms:** *c* (0001, *O*): *m* ($10\bar{1}0$, *I*), *a* ($11\bar{2}0$, *i*-2), *n* ($21\bar{3}0$, *i*-$\frac{3}{2}$); *p* ($10\bar{1}1$, 1). Angles: $pp' = 25° \, 7'$, $mp = 64° \, 13'$, $ap = 67° \, 52'$.

In minute prismatic crystals, faces striated vertically; *c* dull. Crystals often grouped together.

Cleavage: *m* perfect; *c* less distinct. H. = 6. G. = 2·444 Rauff; 2·42–2·53 Scc. Luster on *m* silky, brilliant; otherwise vitreous. Colorless. Transparent. Optically uniaxial, positive, Btd.

**Comp.**—According to Rauff's analyses, nearly $(Na,K)_{10}Ca_4Al_{12}Si_{12}O_{52}SCl_4$; this may be written $4(Na,K)CaAl_3(SiO_4)_3.4(Na,K)Cl.(Na,K)SO_4$. The true constitution of the mineral is, however, complex and uncertain; carbon dioxide is also present in small amount.

**Anal.**—1, 2, Scacchi, Rend. Acc. Napoli, April, 1876. 3, 4, Rauff, Zs. Kr., **2**, 468, 1878. 5, Mierisch, Min. Mitth., **8**, 161, 1886.

| | | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | Cl | $SO_3$ | $CO_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. *Large cryst.* | $\frac{2}{2}$ | 32·21 | 29·22 | 12·60 | 10·14 | 6·79 | 6·71 | 4·43 | — | = 102·10 |
| 2. *Micr.* " | $\frac{3}{3}$ | 31·42 | 30·34 | 10·93 | 9·37 | 7·90 | 7·82 | 5·26 | — | = 103·04 |
| 3. *Cryst. colorless* G. = 2·444 | $\frac{3}{3}$ | 32·21 | 28·37 | 10·59 | 11·30 | 7·14 | 7·09 | 3·86 | 1·55 | S *tr.* = 102·11 |
| 4. " *yellow* | | 32.23 | 28·98 | 10·36 | 11·01 | 7·11 | 6·25 | 4·11 | 1·26 | S *tr.* = 101·31 |
| 5. | | 34·30 | 28·59[a] | 9·70 | *undet.* | | 0·84 | 2·02 | — | ign. 4·22 |

[a] $Fe_2O_3$ in small amount

Deduct oxygen equivalent of the chlorine, viz. in 1, 1·51 p. c., 2, 1·76, 3, 1·60, 4, 1·56 p. c.

**Pyr., etc.**—B.B. fusible with difficulty. In hydrochloric acid decomposed with separation of gelatinous silica.

**Obs.**—Occurs at Vesuvius on Monte Somma in ejected masses, and in the leucitic lava.

**Ref.**—[1] Scc., l. c. Cf. Rath, Pogg., Erg., **6**, 372, 1873; Rauff, l. c.

DAVYNE. Davina *Monticelli* and *Covelli*, Min. Vesuv., 1825.

Hexagonal; in crystals resembling nephelite. Cleavage: basal and prismatic, perfect. Fracture conchoidal. H. = 5·5. G. = 2·40 Haid., 2·43 Breith. Luster vitreous to pearly on cleavage. Colorless to white. Translucent. Optically uniaxial, positive, Btd. Indices: $\omega_y = 1·515$, $\epsilon_y = 1·519$, Dx. (see Btd., Bull. Soc. Min., **5**, 141, 1882). Composition near cancrinite. Anal.—Rg., Pogg., **109**, 579, 1860.

| | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $CO_2$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. | 38·76 | 28·10 | 9·32 | 15·72 | 1·10 | 5 63 | 1·96 Cl *tr.* = 100·59 |
| 2. | 36·81 | 28·66 | 10·33 | 15·85 | 1·21 | 6·01 | *undet.* |
| 3. | 36·96 | 28·31 | 9·39 | *undet* | | 6·04 | ·· |

Fuses with intumescence to a clear slightly blebby glass coloring the flame yellow (soda). From Monte Somma with nephelite, etc. Much so-called davyne is only microsommite; the existence of a cancrinite-like mineral, however, can hardly be doubted. Groth includes davyne and microsommite under sommite, Tab. Ueb., 123, 1889.

CAVOLINITE. *Monticelli* and *Covelli*, Min. Vesuv., 1825. From Monte Somma with davyne, etc. Generally assumed to be identical with nephelite, but perhaps rather belonging to microsommite (Scc.) like which it is optically positive (Btd.), Bull. Soc. Min., 5, 141, 1882.

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## 2. Sodalite Group. Isometric.

| | | |
|---|---|---|
| **362.** | **Sodalite** | $Na_4(AlCl)Al_2(SiO_4)_3$ |
| **363.** | **Haüynite** | $(Na_2,Ca)_2(NaSO_4.Al)Al_2(SiO_4)_3$ |
| **364.** | **Noselite** | $Na_4(NaSO_4.Al)Al_2(SiO_4)_3$ |
| **365.** | **Lazurite** | $Na_4(NaS_3.Al)Al_2(SiO_4)_3$ |

The formulas are written above in the form suggested by Brögger, who shows that this group and the one following may be included with the garnets in a broad group characterized by isometric crystallization and a close resemblance in composition. See further under the GARNET GROUP proper, p. 437.

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**362. SODALITE.** Sodalite (fr. Greenland) *Thomson*, R. Soc. Ed. Tr., 6, 387, read Nov. 5, 1810; Phil. Mag., 36, 471, 1810. Glaukolith *Weibye*, Karst. Arch., 22, 532, 1848.

Isometric. Observed forms[1]:

*a* (100, *i-i*); *d* (110, *i*); *o* (111, 1)[2]; *n* (211, 2-2), *μ* (411, 4-4)[2].

Twins: tw. pl. *o*, forming hexagonal prisms by elongation in the direction of an octahedral axis. Common form the dodecahedron. Also massive, in embedded grains; in concentric nodules resembling chalcedony, formed from elæolite.

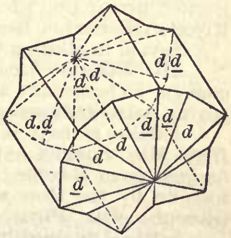
Cleavage: dodecahedral, more or less distinct. Fracture conchoidal to uneven. Brittle. H. = 5·5–6. G. = 2·14–2·30. Luster vitreous, sometimes inclining to greasy. Color gray, greenish, yellowish, white; sometimes blue, lavender-blue, light red. Transparent to translucent. Streak uncolored. Refractive indices:

Bolivia $n_r$ = 1·4796 Li $n_y$ = 1·4827 Na $n_{gr}$ = 1·4855 Tl $n_v$ = 1·496 violet, Feussner[3].

Brögger[4] finds the etching-figures triangular in form. and symmetrical to a dodecahedral face normal to the face etched, but not symmetrical to the cubic planes normal to this. From this it is concluded that the crystals are tetrahedral and twinned with the cube as tw. plane

**Var.**—1. Ordinary, varying in color from bright azure blue to gray, yellow or greenish. Crystals not common; usually in dodecahedrons.

2. In reniform or nodular forms with concentric structure, often resembling chalcedony. Fracture conchoidal to even. Luster dull. Color blue to gray or green. Formed from elæolite in the elæolite-syenite of southern Norway. This mineral is called *glaukolith* by Weibye, Jb. Min., 775, 1849. Karst. Arch., 22, 532, 1848. This name was earlier given to a blue mineral from the L. Baikal region, which is a massive kind of scapolite (see p. 469). A so-called "glaucolite" from L. Baikal, investigated by Brögger and Bäckström, proved to be sodalite, anal. 4.



Mte. Somma, Sbk.

**Comp.**—$Na_4(AlCl)Al_2Si_3O_{12}$ = Silica 37·6, alumina 31·6, soda 25·6, chlorine 7·3 = 101·7, deduct (O = 2Cl) 1·7 = 100. Potassium replaces a small part of the sodium.

The above is the formula of Brögger, which not only agrees well with the best analyses, but also brings out the relation to the garnet group, cf. p. 437.

The formula may also be written $3NaAlSiO_4 + NaCl$.

**Anal.**—1, 2, Rg., Pogg., **109**, 574, 1860. 3, Hofmann, ib., **47**, 377, 1839. 4, Brögger and Bäckström. Zs. Kr., **18**, 223, 1890. 5, Bäckström, Zs Kr., **16**, 180, 1890. 6, Lorenzen, Min. Mag., **5**, 58, 1882. 7, Fleischer, quoted by Rath, Ber. nied. Ges., March 13, 1876. 8, Bamberger, Zs. Kr., **5**, 583, 1881. 9, F. W. Clarke, Am. J. Sc., **31**, 264, 1886. 10, 11, Harrington, Trans. Roy. Soc., Canada, **4** (3), 81, 1886. 12, Ch. and G. Friedel, Bull. Soc. Min., **13**, 185, 1890. See also 5th Ed., p. 330.

| | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | Cl |
|---|---|---|---|---|---|---|---|
| 1. Vesuvius, *colorless* | 2·136 | 38·12 | 31·68 | — | 24·37 | — | 6·69 = 100·86 |
| 2. " *green* | | 38·76 | 34·62 | — | 23·43 | — | 2·55 = 99·36 |
| 3. Ilmen Mts., *blue* | 2·288 | 38·40 | 32·04 | 0·32 | 24·47 | *tr.* | 7·10 = 102·33 [102·15 |
| 4. L. Baikal, *blue* | 2·301 | 36·74 | 31·96 | 0·11 | 25·95 | *tr.* | 7·11 $SO_3$ 0·11, ign. 0·17 = |
| 5. L. Arö, *concentr. mass* | | 38·12 | 30·35 | 0·44 | 24·77 | 1·14 | 5·65 ign. 2·28 = 102·75 |
| 6. Greenland, *green* | 2·31 | 36·50 | 31·53 | 0·25 | 26·30 | 0·18 | 7·30 $Fe_2O_3$ 0·19 = 102·25 |
| 7. Ditró | 2·322 | 38·66 | 32·81 | 0·95 | 18·54 | 1·04 | 6·08 $H_2O$ 2·36 = 100·44 |
| 8. Bolivia, *blue* | 2·341 | 37·96 | 30·96 | 0·46 | 22·93 | 0·74 | 5·34 $H_2O$ 1·10, $Fe_2O_3$ 0·85, [$CO_2$ *tr.* = 100·34 |
| 9. Litchfield, Me., *blue* | | 37·33 | 31·87 | — | 24·56 | 0·10 | 6·83 $H_2O$ 1·07 = 101·76 |
| 10. Montreal | 2·20 | 37·52 | 31·38 | 0·35 | 25·16 | 0·78 | 6·91 $Fe_2O_3$. MgO *tr.* = [102·10 |
| 11. Ice R., Rocky Mts. | 2·293 | 37·50 | 31·82 | — | 25·55 | 0·27 | 7·12 = 102·26 |
| 12. *Artificial* | 2·32 | 36·65 | 32·24 | — | 25·70 | 0·67 | 6·32 = 101·58 |

From the above analyses the oxygen-equivalent of the chlorine is to be deducted.

A green sodalite from Vesuvius gave Lemberg (Zs. G. Ges., **28**, 550, 1876) 8·98 $Na_2SO_4$ possibly from admixture of haüynite.

**Pyr., etc.**—In the closed tube the blue varieties become white and opaque. B.B. fuses with intumescence, at 3·5–4, to a colorless glass. Decomposed by hydrochloric acid, with separation of gelatinous silica.

**Obs.**—Occurs most commonly in syenite, also basalt and other volcanic rocks often associated with nephelite (or elæolite), cancrinite, and eudialyte. With sanidine it forms a *sodalite-trachyte* at Scarrupata in Ischia, in which also occur augite, titanite, and magnetite in crystals. In Sicily, Val di Noto, with nephelite and analcite. At Vesuvius, in bombs on Monte Somma (cf. Mierisch, Min. Mitth., **8**, 163, 1886), in white, translucent, dodecahedral crystals, with haüynite, sanidine, pyroxene, mica, and rarely in green dodecahedrons, with cubic planes, in limestone along with vesuvianite and nephelite; massive and of a gray color at the Kaiserstuhl; also near Lake Laach. At Ditró, Transylvania, in an elæolite-syenite with cancrinite, etc. In the foyayte of southern Portugal. At Miask, in the Ilmen Mts., blue in the granite-like rock called *miascyte*, with elæolite and feldspar: Sedlovaty, in the White Sea, with eudialyte; in the augite-syenite of the Langesund-fiord region in Norway, in the islands Låven, Lövö, Lille Arö, Sigtesö, etc., of a lavender-blue color, with elæolite, ægirite, wöhlerite, and rarely eudialyte, but for the most part altered to spreustein (p. 602); also in the same region formed as a later product from the alteration of elæolite, in compact form, sometimes resembling chalcedony (anal. 5). Further in West Greenland in sodalite-syenite on both sides of the fiords Tunugdliarfik and Kangerdluarsuk, along with a greenish feldspar, arfvedsonite, and eudialyte: the crystals are often dodecahedrons and inclose microscopic crystals of arfvedsonite, thus gaining a greenish color. Found among the ruins of Tiahuanaco, Bolivia, exact locality unknown.

A blue variety occurs at Litchfield and West Gardiner, Me., massive, with distinct cleavage, associated with elæolite, zircon, and cancrinite, and the alteration-product, hydronephelite; in a vein in syenite, at Salem, Mass., violet to azure blue, with elæolite, orthoclase, biotite, and zircon. In the "theralite" of the Crazy Mts., Montana. Occurs also in the elæolite-syenite of Brome, Brome Co., of Montreal and Belœil, province of Quebec; in fine large masses on Ice River, a tributary of Beaver-Foot, in the Rocky Mts. near Kicking Horse Pass, British Columbia.

Named in allusion to its containing soda.

**Alt.**—Sodalite occurs altered to kaolin, like the feldspars, and also in conditions of partial change. Thomsonite and hydronephelite (a soda-thomsonite) are alteration products; also muscovite, natrolite (spreustein, wh. see), and diaspore, see Bgr., Zs. Kr., **16**, 184, 1890.

Sodalite is itself in part derived from nephelite (elæolite) and pseudomorphs after nephelite from Mte. Somma have been described. Also occurs in Norway in compact massive forms derived from elæolite. Further Mügge has shown that nephelite can be transformed into sodalite by the slow action of fused sodium chloride, with the addition of vaporized NaCl (Rosenb., Mikr. Phys., 284, 1886); cf. also Lemberg's experiments, Zs. G. Ges., 1883, 1885, 1888.

**Artif.**—Obtained by Ch. and G. Friedel by heating to 500° muscovite with soda in the proportions to form nephelite, with the addition of sodium chloride. The crystals, mixed also with crystals of nephelite, were rhombic dodecahedrons with cubic faces, in part twins with tw. pl. *o*, often elongated in the direction of an octahedral axis. The composition of these crystals is given in anal. 12. By heating with water 6 grams of $SiO_2$, 5·15 $Al_2O_3$, 3·6 $Na_2O$, and 1·95 NaCl, radiated globules were obtained, inferred to have the composition of sodalite. Bull. Soc. Min., **13**, 183, 1890.

**Ref.**—[1] Mlr., Min., 398, 1852. [2] Klein, Langesund fiord, Jb. Min., 534, 1879. [3] Zs. Kr., **5**, 581, 1881, Vesuvius crystals gave identical results. [4] Bgr., Zs. Kr., **18**, 215, 1890.

**363. HAÜYNITE** or HAÜYNE. Latialite (fr. the Campagna, ancient Latium) *Gismondi*, in Mem. read in 1803, before the Accad. de Lincei at Rome, but unpublished. Haüyne *Bruun-Neergard*, Gehlen J., **4**, 417, 1807, J. Mines, **21**, 365, 1807. Berzeline, *L. A. Necker*, Bibl. Univ., **46**, 52, 1831, Regne Min. Paris, 1835; *Rath*, Zs. G. Ges., **18**, 546, 1866 = Marialite *Ryllo* = Gismondina ottaedrica *Med. Spada.* Auina, Lazialite *Ital.*

Isometric. Observed forms[1]:

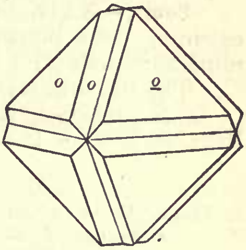
*a* (100, *i-i*); *d* (110, *i*); *o* (111, 1); *e* (210, *i*-2; *n* (211, 2-2).

Twins: tw. pl. *e*; contact-twins, also polysynthetic; penetration-twins. Sometimes in dodecahedrons, octahedrons, etc.; but commonly in rounded grains, often looking like crystals with fused surfaces.

Cleavage: dodecahedral, rather distinct. Fracture flat conchoidal to uneven. Brittle. H. = 5·5–6. G. = 2·4–2·5. Luster vitreous, to somewhat greasy. Color bright blue, sky-blue, greenish blue; asparagus-green, red, yellow. Streak slightly bluish to colorless. Subtransparent to translucent; often enclosing symmetrically arranged inclusions. Refractive index, Niedermendig[2], $n_{y}$ = 1·4961.

**Comp.**—$Na_2Ca(NaSO_4.Al)Al_2Si_3O_{12}$. This is analogous to the garnet formula (Brögger) where the place of the $R_3$ is taken by $Na_2$,Ca and the group $Na-O-SO_2-O-Al$. The percentage composition is: Silica 32·0, sulphur trioxide 14·2, alumina 27·2, lime 10·0, soda 16·6 = 100. The ratio of $Na_2$ : Ca also varies from 3 : 2; potassium may be present in small amount.

1.



Albano, Rath.

The formula may also be written $2(Na_2,Ca)Al_2(SiO_4)_2 + (Na_2,Ca)SO_4$.

**Anal.**—1, Rg., Pogg., **109**, 577, 1860. 2, Rath, Zs. G. Ges., **18**, 547, 1866. 3, 4, Ricciardi [Gazz. Ch., **17**, 216, 1857], Zs. Kr., **14**, 519. 5, Rath, Zs. G. Ges., **16**, 84, 1864. 6, Bäckström, Zs Kr., **18**, 230, 1890. 7, Whitney, Pogg., **70**, 440, 1847. 8, Sauer, Inaug. Diss., Halle, 20, 1876. 9, 10, Doelter, Min. Mitth., **4**, 461, 1881. Also 5th Ed., p. 332.

| | G. | | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $SO_3$ | Cl | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Mte. Somma, *blue* | 2·464 | $\frac{3}{2}$ | 34·06 | 27·64 | 10·60 | 11·79 | 4·96 | 11·25 | *tr.* | — | = 100·30 |
| 2. Albano, *white berzeline* | 2·486 | | 32·70 | 28·17 | 10·85 | 11·71 | 4·64 | 12·15 | 0·66 | 0·48 | = 101·36 |
| 3. Vultur, *whitish* | 2·448 | | 34·58 | 27·59 | 11·55 | 13·57 | *tr.* | 8·09 | — | 5·38 | = 100·76 |
| 4. " *blue* | 2·456 | | 33·78 | 27·42 | 10·08 | 13·26 | 3·23 | 12·31 | — | — | = 100·08 |
| 5. Laach, *blue* | 2·481 | $\frac{3}{2}$ | 33·11 | 27·35 | 11·70 | 15·39 | 1·12 | 12·54 | 0·33 | 0·20 | $Fe_2O_3$ 1·05,<br>[MgO 0 22 = 103·01 |
| .6. | | | 32·30 | 27·38 | 8·21 | 18·03 | 0·35 | 12·62 | 0·31 | — | MgO 0·11,<br>[S 0·44 = 99·75 |
| 7. Niedermendig | | $\frac{3}{2}$ | 34·36 | 28·29 | 7·37 | 18·92 | — | 12·07 | *tr.* | — | $Fe_2O_3$ 0·16<br>[= 101·07 |
| 8. Isleta, Canaries | | | 33·25 | 28·21 | 7·54 | 17·21 | | 13·25 | 0·17 | — | = 99·63 |
| 9. Cape Verde | | | 31·99 | 28·93 | 9·88 | 15·53 | — | 12·04 | *tr.* | 1·59 | $Fe_2O_3$ 0·45<br>[= 100·41 |
| 10. Covao, Cape Verde | | | 34·95 | 29·41 | 4·40 | 19·01 | 0·33 | 8·11 | 0·86 | 1·83 | $Fe_2O_3$ 1·38<br>[= 100·28 |

*Berzeline* of Necker is the white variety from near Albano according to Rath (anal. 2, and fig. 1).

**Pyr., etc.**—In the closed tube retains its color. B.B. in the forceps fuses at 4·5 to a white glass. Fused with soda on charcoal affords a sulphide, which blackens silver. Decomposed by hydrochloric acid with separation of gelatinous silica.

**Obs.**—Common in certain igneous rocks, thus in haüynophyre, in phonolyte, tephryte; very commonly associated with nephelite and leucite. Occurs in the Vesuvian lavas, on Mte. Somma; at Melfi, on Mt. Vultur, Naples, of black, green, blue, red, and brown colors, and also white, and sometimes red inside and blue outside; in the lavas of the Campagna, Rome, and also in the peperino of Marino and Lariccia near Albano, sky-blue, bluish green, and sometimes opaline, also white (*berzeline*); at Niedermendig, Mayen, Olbrück, in the Eifel; the phonolytes of Hohentwiel; at Mt. Dore in Puy-de-Dôme; at St. Michael's, Azores; the Canary islands; the Cape Verde islands. In the theralyte of the Crazy Mts., Montana. Also in the lapis-lazuli of Siberia (p. 433).

Named in honor of the Abbé Haüy (1743–1822).

**Ref.**—[1] Cf. Mlr., Min., 399, 1852; Dx., Min., 524, 1862; Rath, l. c.; Hbg., Min. Not., **8**, 43, 1868; Svr., Zs. Kr., **1**, 235, 1877; in Dana, Min., 5th Ed., 332, 1868, the planes 311, 331 are added, source unknown to author. [2] Tschihatscheff, quoted by Rosenb., Mikr. Phys., 286, 1885.

**364. NOSELITE,** or NOSEAN. In ripis (L. Laach) lapillos elegantiores et sapphiros reperire est, *Freherus,* Orig. Palatinarium, **2**, 36, 1612. Spinellan *Nose*, Nöggerath's Min. Stud. Geb. Niederrhein, 109, J. Phys., **69**, 160, 1809. Spinellan, Nosian, *Klapr.*, Beitr., **6**, 371, 1815. Haüyne pt. Nosean, Nosin, *some authors.* Nosite. Noseanite. Natron-haüyne *Vogelsang.*

Isometric. In dodecahedrons. Often granular massive. In twins like sodalite[1].

H. = 5·5. G. = 2·25–2·4. Color grayish, bluish, brownish; sometimes black. Translucent; sometimes nearly opaque from the presence of inclusions.

**Comp.**—$Na_4(NaSO_4.Al)Al_2Si_3O_{12}$ like haüynite (p. 431), but with little or no calcium. The percentage composition is: Silica 31·7, sulphur trioxide 14·1, alumina 26·9, soda 27·3 = 100.

The formula may be written $2Na_2Al_2Si_2O_8 + Na_2SO_4$.

**Anal.**—1–4, Rath, Zs. G. Ges., **16**, 81, 1864; also ib., **14**, 670, 1862. 5, Sauer, Inaug. Diss. Halle, 18, 1876. 6, Doelter, Min. Mitth., **4**, 461, 1881. Also 5th Ed., p. 333.

| | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $SO_3$ | Cl | $H_2O$ | $Fe_2O_3$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Laach, *dk. bn.* | 2·281 | 36·72 | 29·08 | 1·20 | 23·33 | 0·34 | 7·52 | 0·71 | 0·83 | 0·75 | = 100·48 |
| 2. " *bh. gy.* | 2·299 | 36·69 | 28·45 | 0·63 | 23·90 | — | 7·30 | 1·05 | 2·15 | 0·47 | = 100·64 |
| 3. " *gnh.* | 2·336 | 36·46 | 29·61 | 2·37 | [20·59] | — | 7·34 | 0·70 | 2·02 | 0·91 | = 100 |
| 4. " *clear* | 2·399 | 36·87 | 26·60 | 4·05 | [20·75] | *tr.* | 10·00 | 1·08 | 0·37 | 0·28 | = 100 |
| 5. Canary Is. | | 36·50 | 28·56 | 0·99 | 22·95 | — | 7·64 | 0·76 | 1·87 | 0·98 | = 100·25 |
| 6. Cape Verde Is. | | 35·99 | 29·41 | 0·21 | 20·91 | — | 10·58 | 0·57 | 1·63 | 0·31 | = 99·61 |

**Pyr., etc.**—B B. like haüynite. Gelatinizes in acids, yielding no hydrogen sulphide.

**Obs.**—From near Andernach on the Rhine; at the Laacher See, in loose blocks consisting largely of sanidine or glassy feldspar, with mica, magnetite, and occasionally zircon, occupying cavities in the feldspar, in small grains or crystals; also found at Rieden and Volkersfeld in a leucite rock. In the phonolytes of the Hegau at Hohentwiel; also of the Kaiserstuhl; the Canary and the Cape Verde islands, and at other localities.

Named after K. W. Nose of Brunswick (1753–1835).

**Ref.**—[1] Hubbard, Min. Mitth., **8** 362, 1887.

ITTNERITE *Gmelin*, Schw. J., **36**, 74, 1822. Skolopsite *Kbl.*, Gel. Anzeig., **28**, 638, 1849. Alteration products of haüynite and noselite as shown by Rammelsberg, Ber. Ak. Berlin, 172, 1864, Min. Ch., 459, 1875; also confirmed by Van Werweke, Jb. Min., **2**, 264, 1880. Cf. also Fischer, Mikr. Min., 36, 1869, Lemberg, Zs. G. Ges., **28**, 610, 1876. For analyses, see 5th Ed., p. 333.

Ittnerite contains 10 to 12 p. c. of water, and scolopsite varies in the water from none to 10 p. c. Ittnerite occurs in translucent dodecahedrons or granular massive, with H. = 5·5; G. = 2·37–2·40; color dark bluish or ash-gray to smoky gray; luster resinous. It comes from the Kaiserstuhl near Freiburg, Baden, at Sasbach and Endingen.

Scolopsite occurs granular massive; H. = 5; G. = 2·53, color grayish white to pale reddish gray, and is also from the Kaiserstuhl, and occurs in the same rock with ittnerite (Fischer, Ber. Ges. Freiburg, 1862). Scolopsite was named from *σκόλοψ, a splinter,* from its splintery fracture.

**365. LAZURITE.** Lasurit *Brögger*, Zs. Kr., **18, 231, 1890.**

LAPIS-LAZULI. *Σαπφειρος Theophr.* Sapphiros *Plin.*, **37**, 39. Sapphirus *Agric.*, Foss., 288, 1546. Cyaneus, Lapis Lazuli (Lapis Azul *Arab.*, unde nomen Asuri, aut Lazuli), *B. de Boot*, Lap., 273, 1636. Lapis-Lazuli, Lazur-Sten, Jaspis colore cœruleo cuprifer, *Wall.*, Min., 97, 1747. Lapis-Lazuli, ou Pierre d'Azur, *Fr. Trl.* Wall., **1**, 186, 1753. Zeolites Bloa (= Blue Zeolite), Lapis Lazuli, *Cronst.*, 100, 1758. Zeolithus cæruleus *v. Born.*, Lithoph., **1**, 46, 1772. Lasurstein *Germ.* Native Ultramarine. Outremer *Fr.*

Isometric. In cubes and more commonly dodecahedrons. Also massive, compact.

Cleavage: dodecahedral, imperfect. Fracture uneven. H. = 5–5·5. G. = 2·38–2·45. Luster vitreous. Color rich Berlin-blue or azure-blue, violet-blue greenish blue. Translucent.

**Comp.**—Essentially $Na_4(NaS_3.Al)Al_2Si_3O_{12}$ as shown by Brögger, but containing also in molecular combination $(Na_2,Ca)_2(NaSO_4.Al)Al_2Si_3O_{12}$ or haüynite (in varying amount), and $Na_4(AlCl)Al_2Si_3O_{12}$ or sodalite. The percentage composition of this ultramarine compound (Bgr.) is as follows: Silica 31·7, ~~alumina~~ 26·9, soda 27·3, sulphur 16·9 = 102·9, or deduct (O = S) 2·9 = 100.

**Anal.**—Brögger and Bäckström, Zs. Kr., **16**, 236, 1890.

| | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $SO_3$ | S | Cl |
|---|---|---|---|---|---|---|---|---|
| Central Asia | 32·52 | 27·61 | 6·47 | 19·45 | 0·28 | 10·46 | 2·71 | 0·47 = 99·57 |

This is interpreted as equivalent to haüynite, ultramarine, and sodalite in the ratio of 77 : 16 : 7. It may also be explained by assuming the presence of $Na_4(NaS_2.Al)Al_2Si_3O_{12}$.

Earlier analyses are the following: 1, Köhler, Rg., Min. Ch., 710, 1860. 2, Schultz, ib. 3, Varrentrapp, Pogg., **49**, 519, 1840. 4, Hauer, Vh. G. Reichs., 86, 1860. 5, Schultz, l. c.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | $Na_2O$ | $H_2O$ | $SO_3$ |
|---|---|---|---|---|---|---|---|
| 1. Orient | 45·33 | 12·33 | 2·12 | 23·56 | 11·45 | 0·35 | 3·22 Cl 0·42, S ? = 98·78 |
| 2. “ | 43·26 | 20·22 | 4·20 | 14·73 | 8·76 | — | 5·67 S 3·16 = 100 |
| 3. Bucharei | 45·50 | 31·76 | *tr.* | 3·52 | 9·09 | 0·12 | 5·89 Fe 0·86, Cl 0·42, S 0·95 [= 98·11 |
| 4. Ditró | 40·54 | 43·00 | 0·86 | 1·14 | [12·54] | 1·92 | — = 100 |
| 5. Andes | 45·70 | 25·34 | 1·30 | 7·48 | 10·55 | — | 4·32 S 3·96, $K_2O$ 1·35 = 100 |

From 1, 6·7 $CaCO_3$, from 2, 32·69 p. c. $CaCO_3,MgCO_3$, and from 5, 28·77 $CaCO_3$ have been deducted.

The heterogeneous character of what had long passed as a simple mineral under the name Lapis-lazuli was shown by Fischer (1869), Zirkel (1873), and more fully by Vogelsang (1873). The latter showed the presence of an isometric, ultramarine mineral, which is generally blue, or violet, sometimes also colorless, and in the last case assumes a blue color on heating. This is intermixed with granular calcite and scapolite (paralogite). Fischer, Mikr. Stud., 36, 1869; Zirkel, Mikr. Besch. Min., 165, 1873; Vogelsang, Med. Akad., Amsterdam, 161, 1873.

It has remained for Brögger and Bäckström to separate the essential part of this mineral mixture (lazurite) and determine its composition, as given above. The ordinary natural lapis lazuli (Lasurstein) is shown to contain lazurite or haüynite (sometimes changed to a zeolite), a diopside free from iron, amphibole (koksharovite), mica (muscovite), calcite, pyrite; also in some varieties in relatively small amount scapolite, plagioclase, orthoclase (microperthite?), apatite, titanite, zircon, and an undetermined mineral optically + and probably uniaxial.

**Pyr., etc.**—Heated in the closed tube gives off some moisture; the variety from Chili glows with a beetle-green light, but the color of the mineral remains blue on cooling. Fuses easily (3) with intumescence to a white glass. Decomposed by hydrochloric acid, with separation of gelatinous silica and evolution of hydrogen sulphide.

**Obs.**—Occurs in Badakshan in the valley of the Kokcha, a branch of the Oxus, a few miles above Firgamu; the quarries are in limestone, and the mineral occurs in three varieties, indigo-blue (nili), light blue (asmani), and green (sabzi). Cf. Ball., Geol. India, III, 528. 1881. Also at the south end of L. Baikal at various points on the rivers Talaya, Malaya-Bystraya, and Sliudianka (see Bull. Soc. Mosc., **30** (2), 518, 1857), where it occurs in a dolomitic limestone in connection with granite. Also reported from other points in Eastern Asia, but uncertain. Further, in Chili in the Andes of Ovalle, near the sources of the Cazadero and Vias, tributaries of the Rio Grande, in a granitic rock. In ejected masses at Monte Somma, rare (Pogg., **138**, 491, 1869), and in limestone inclusions in the peperino of Latium (Svr., Zs. Kr., **1**, 238, 1877). Probably always (Bgr.) a result of contact metamorphism in limestone.

The richly colored varieties of lapis lazuli are highly esteemed for costly vases and ornamental furniture; also employed in the manufacture of mosaics; and when powdered constitutes the rich and durable paint called *ultramarine*. This has been replaced, however, by artificial ultramarine, now an important commercial product.

**Artif.**—The following are typical analyses of artificial ultramarine, quoted in the form given by Brögger and Bäckström. The original references are:

1. Heumann (Hoffmann), Lieb. Ann., **203**, 174, 1880. 2, Id., ib., **194**, 1 *et seq.*, 1878. 3, Szilasi, ib., **251**, 100, 1889.

| | $SiO_2$ | $Al_2O_3$ | $Na_2O$ | S |
|---|---|---|---|---|
| 1. *blue* | 39·3 | 30·7 | 23·1 | 8·4 |
| 2. “ | 40·7 | 24·0 | 23·5 | 13·6 |
| 3. *green* | § 37·30 | 31·07 | 25·34 | 7·24 |

In explaining the composition of the various forms of artificial ultramarine, the following compounds are assumed: $Na_3Al_3Si_3O_{12}$, $Na_2Al_2Si_4O_{12}$, $Na_4(NaS.Al)Al_2Si_3O_{12}$, $Na_4(NaS_2\ Al)$ $Al_2Si_3O_{12}$, $Na_4(NaS_3.Al)Al_2Si_3O_{12}$. The compound causing the blue color in both the natural lazurite and the artificial ultramarine is probably one belonging to the sodalite group, viz., $Na_4(NaS_3.Al)Al_2(SiO_4)_3$.

## 3. Helvite Group. Isometric, tetrahedral.

| | | |
|---|---|---|
| **366.** | **Helvite** | $(Mn,Fe)_2(Mn_2S)Be_3(SiO_4)_3$ |
| **367.** | **Danalite** | $(Fe,Zn,Mn)_2((Zn,Fe)_2S)Be_3(SiO_4)_3$ |
| **368.** | **Eulytite** | $Bi_4(SiO_4)_3$ |
| **369.** | **Zunyite** | $(Al(OH,F,Cl)_2)_6Al_2(SiO_4)_3$ |

On the relation of the above species to the GARNET GROUP, see p. 437.

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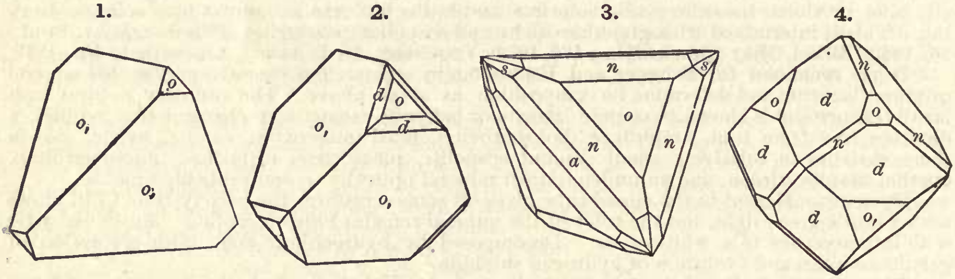
**366. HELVITE.** Ein Fossil w. Aehnlichk. m. d. Granat hat, aber nicht Granat zu seyn scheint, *Mohs*, Null Kab., **1**, 92, 1804. Helvin *Wern.*, 1816, Breith. in Hoffm. Min., **4**, b. 112, 1817. Wern., Letztes Min. Syst., 2, 29, 1817; Tetrahedral Garnet *Mohs*, Char. Syst. Min., 71, 1820, Edinb. Tetraëdrischer Granat *id.*, Grundr., 412, 1824.

Isometric; tetrahedral. Observed forms[1]:

*a* (100, *i-i*), *d* (110, *i*); *o* (111, 1); $o_{,}$ ($\bar{1}$11, – 1); *r* (332, $\frac{3}{2}$); *n* (211, 2-2); *s* (321, 3-$\frac{3}{2}$).

Commonly in tetrahedral crystals, rarely dodecahedral in habit; also in spherical masses.

Cleavage: octahedral in traces. Fracture uneven to conchoidal. Brittle. H. = 6–6·5. G. = 3·16–3·36; 3·216, Breith. Luster vitreous, inclining to resinous. Color honey-yellow, inclining to yellowish brown, and siskin-green, reddish brown. Streak uncolored. Subtransparent. Refractive index $n = 1·739$ Lévy-Lcx.[2] Pyroelectric[3].


1. 2. 3. 4.

Figs. 1–4. Langesund fiord, Norway, Brögger.

**Comp.**—$(Be,Mn,Fe)_7Si_3O_{12}S$. This may be written $(Mn,Fe)_2(Mn_2S)Be_3Si_3O_{12}$ as suggested by Brögger[4], analogous to the Garnet Group, the bivalent group –Mn–S–Mn (also assumed by Groth) taking the place of a bivalent element, R, and 3Be corresponding to 2Al, cf. p. 437. Assuming Mn present alone, the percentage composition is: Silica 32·5, glucina 13·6, manganese protoxide 51·0, sulphur 5·8 = 102·9, deduct (O = S) 2·9 = 100.

Composition also written $3(Be,Mn,Fe)_2SiO_4.(Mn,Fe)S$.

**Anal.**—1, Gmelin, Pogg., **3**, 53, 1825, corrected by Rg., Min. Ch., 701, 1860. 2, Rg., ibid., Pogg., **93**, 453, 1854. 3, Bäckström, Zs. Kr., **16**, 176, 1890. 4, 5, Teich, Min. Russl., **7**, 322, 323, 1866. 6, R. Haines, Proc. Ac. Philad., 101, 1882. 7, B. E. Sloan, Ch. News, **46**, 195, 1882.

| | G. | | $SiO_2$ | BeO | MnO | FeO | Mn | S | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Schwarzenberg | 3·166 | | 33·26 | 12·03 | 30·57 | 8·00 | 8 67 | 5·05 | 1·15 | = 98·73 |
| 2 Norway | 3·165 | | 33·13 | 11·46 | 36·50 | 4·00 | 9·77 | 5·71 | — | = 100·57 |
| 3. Sigtesö | | | 32·85 | 11·19 | 39·68 | 13·02 | (—) | 5·71 | — | CaO 0·40, AlO 1·00 [= 103·85 |
| 4. Ilmen Mts. | 3·333 | $\frac{2}{2}$ | 32·49 | 13·52 | 35·41 | 15·12 | (—) | 5·77 | — | $Al_2O_3$ 0·77 = 103·08 |
| 5. Lupikko | 3·23–3·37 | $\frac{2}{2}$ | 30·34 | 10·46 | 37·88 | 10·37 | (—) | 5·95 | 0·22 | Mg 0·68, CaO 4·07 = [99·97 |
| 6. Amelia Co., Va. | | | 25·48 | 12·63 | 39·07 | 2·26[a] | 8·66 | 4·96 | — | $Al_2O_3$ 2·95, CaO 0·71, [$K_2O$ 0·43, $Na_2O$ 1·01 = 98·16 |
| 7. " " " | 3·25 | | 31·42 | 10·97 | 40·56 | 2·99 | 8·59 | 4·90 | — | $Al_2O_3$ 0·36 = 99·79 |

[a] $Fe_2O_3$.

From anals. 3, 4, 5, the oxygen-equivalent of the sulphur is to be deducted.

**Pyr., etc.**—Fuses at 3 in R.F. with intumescence to a yellowish brown opaque bead, becoming darker in R.F. With the fluxes gives the manganese reaction. Decomposed by hydrochloric acid, with evolution of hydrogen sulphide and separation of gelatinous silica.

**Obs.**—Occurs in gneiss at Schwarzenberg in Saxony, associated with garnet, quartz, fluorite, and calcite; at Breitenbrunn, Saxony; at Kapnik, Hungary, on quartz and rhodochrosite; at Hortekulle near Modum, Norway, also in the pegmatyte veins of the augite-syenite of the Langesund fiord, on the islands Sigesö, Stokö, Ovre-Arö, associated with ægirite, elæolite, etc. (Bgr., l. c.). In the Ilmen Mts. near Miask in pegmatyte, large spherical masses with topaz, phenacite, monazite, pyrochlore, etc.; also at Lupikko, Finland, with magnetite, fluorite, the crystals sometimes 1½ inches through.

In the U. S., in cracks in spessartite at the mica mines near Amelia Court House, Amelia Co., Va., associated with monazite, microlite, allanite, etc.

Named by Werner, in allusion to its yellow color, from ἥλιος, *the sun.*

**Ref.**—[1] Eremeyev, Finland, Min. Russl., **5**, 320, 1866; Zs. Kr., **15**, 552, 1889; Bgr., Zs. Kr., **16**, 173, 1890. [2] Min. Roches, 222, 1888. [3] J. & P. Curie, C. R., **91**, 383, 1880, also Hankel, Abh. Sächs. Ges., 1882. [4] Brögger and Bäckström, Zs. Kr., **18**, 211, 1890; the relation to the garnets was earlier suggested, cf. Am. J. Sc., **14**, 272, 1852, also 5th Ed., 1868.

ACHTARAGDITE *Russian*, prior to 1847, Glocker's Syn., 305, 1847. Achtarandit *Breith.*, B. H. Ztg., **12**, 370, 1853. Achtaryndit *Auerbach*, Vh. Min. Ges., **3**, 113, 1868.

Isometric; tetrahedral, but probably pseudomorphous. Form a hemi-trisoctahedron, *n* (211), occasionally penetration-twins with parallel axes, like f. 2, p. 436. Crystals sometimes 2 mm. or more in diameter, often having a shining crust but within earthy, adhering to the tongue, and giving a clay-like odor. Soft, soiling the fingers. G. = 2·32 Hermann. Luster dull. Color ash-gray, within white. Opaque.

Anal.—1, Hermann, Bull. Soc. Mosc., **40** (2), 481, 1867. 2, 3, W. v. Beck, Kk., Min. Russl., **5**, 327, 1866.

| | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | CaO | MgO | $H_2O$ | $CO_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | G. = 2·32 | 28·27 | 13·06 | 14·07 | 0·42 | 14·41 | 20·07 | 8·64 | 1·00 | = 99·94 |
| 2. | | 39·25 | 11·11 | 17·09 | — | 12·54 | 3·60 | 10·09 | — | = 93·68 |
| 3. | | 40·10 | 12·36 | *undet.* | | 11·27 | *undet.* | 12·27 | | |

Occurs on the Achtaragda (or Achtarynda), a tributary of the Vilui River in Siberia, with vesuvianite and grossular garnet. These crystals are obviously pseudomorphs and perhaps after helvite, as suggested by Breithaupt. Cf. also Rose, Reis. Ural., **1**, 48, 1837, who referred them to grossularite; Kk., Min. Russl., **5**, 324, 1866. Prendel regards them as more probably pseudomorphous after boracite, since a reaction for boron was obtained from the crystals and the steatite-like substance resembles a common alteration product of boracite (Zs. Kr., **17**, 94, 1889). It is to be remembered, however, that the occurrence of boracite is extremely limited.

### 367. DANALITE. *J. P. Cooke*, Am. J. Sc., 42, 73, 1866.

Isometric. In octahedrons; also with dodecahedral faces, striated longitudinally.

Cleavage not observed. Fracture subconchoidal to uneven. Brittle. H. = 5·5–6. G. = 3·427. Luster vitreo-resinous. Color flesh-red to gray. Streak similar, but lighter. Translucent.

**Comp.**—$(Be,Fe,Zn,Mn)_7Si_3O_{12}S$, which may be written as suggested by Brögger. $(Fe,Zn,Mn)_2((Zn,Fe)_2S)Be_3Si_3O_{12}$, cf. helvite, p. 434.

**Anal.**—J. P. Cooke, l. c.

| | | $SiO_2$ | FeO | MnO | ZnO | BeO | S | |
|---|---|---|---|---|---|---|---|---|
| 1. Rockport | ⅔ | 31·73 | 27·40 | 6·28 | 17·51 | 13·83 | 5·48 | = 102·23, less (O = S) 2·74 = 99·49 |
| 2. Gloucester | | 29·88 | 28·13 | 5·71 | 18·15 | 14·72[a] | 4·82 | CaO 0·83, MgO *tr.* = 102·24, less (O = S) 2·41 = 99·83 |

[a] With $Al_2O_3$.

**Pyr., etc.**—B.B. fuses readily on the edges to a black enamel. With soda on charcoal gives a slight coating of zinc oxide. Perfectly decomposed by hydrochloric acid, with evolution of hydrogen sulphide and separation of gelatinous silica.

**Obs.**—Occurs in the Rockport granite, Cape Ann, Mass., small grains being disseminated through this rock; also near Gloucester, Mass.; in both localities associated with a lithia mica, in the latter with green feldspar and fluorite. Also with magnetite and quartz at the iron mine, at Bartlett, N. H. (Wadsworth). In El Paso Co., Colorado, p. 1032.

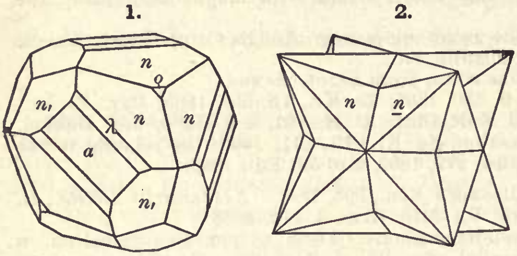
Named after J. D. Dana.

**368. EULYTITE.** Wismuthblende, Eulytin, *Breith.*, Pogg., **9**, 275, 1827; Handb., **2**, 303, 1841. Wismutisches Blende-Erz *Breith.*, Uib., 66, 1830, Char., 239, 1832. Kieselwismuth *Kersten*, Pogg., **27**, 81, 1833. Silicate of Bismuth.

Isometric; tetrahedral. Observed forms[1]:

*a* (100, *i-i*), *d* (110, *I*), *o* (111, 1), *n* (211, 2-2), $n_{,}$ ($2\bar{1}1$, − 2-2), λ (511, 5-5).

Twins: with parallel axes like tetrahedrite, f. 2. Crystals usually minute; common form the hemi-tetragonal trisoctahedron *n* (211); often with rounded edges and in groups; also in spherical forms.


1.
2.

Figs. 1, 2, Schneeberg, Rath.

Cleavage: dodecahedral, very imperfect(?). Fracture uneven. Rather brittle. H. = 4·5. G. = 6·106 Rath. Luster resinous or adamantine. Color dark hair-brown, yellowish gray, grayish white, straw-yellow, colorless. Streak yellowish gray or uncolored. Subtransparent to opaque. Shows anomalous double refraction, and then optically negative, uniaxial, axis ⊥ *o*, Btd.[2]

**Comp.**—$Bi_4Si_3O_{12}$ or $2Bi_2O_3.3SiO_2$ = Silica 16·3, bismuth 83·7 = 100.

**Anal.**—1, 2, Rath, Pogg., **136**, 416, 1869.

| | $SiO_2$ | $Bi_2O_3$ | $Fe_2O_3$ | $P_2O_5$ | | |
|---|---|---|---|---|---|---|
| 1. Schneeberg | 16·52 | 82·23 | 1·15 | | = | 99·90 |
| 2. " | 15·93 | 80·61 | 0·28 | 0·52 | = | 97·34 |

**Pyr., etc.**—In a matrass decrepitates and affords a trace of water. B.B. fuses to a dark yellow mass, and gives out inodorous fumes. Fuses and froths on charcoal, staining it yellowish brown, sometimes with a tinge of green. Fuses readily with soda to a button, at first greenish yellow and then reddish yellow, and finally affords metallic bismuth. With salt of phosphorus it fuses to a yellow globule, with a silica skeleton, which becomes colorless on cooling.

**Obs.**—Found with native bismuth near Schneeberg, Saxony, in quartz; also at Johanngeorgenstadt in crystals on quartz.

Named from εὔλυτος, *easily dissolved*, or *fusible*.

**Ref.**—[1] Rath, l. c. [2] Bull. Soc. Min., **4**, 61, 1881; Klein, Jb. Min., **2**, 196 ref., 1882.

**369. ZUNYITE.** *W. F. Hillebrand*, Proc. Col. Soc., **1**, 124, 1884.

Isometric; tetrahedral. In minute tetrahedrons (*o*) with also planes of the negative tetrahedron ($o_{,}$), the cube (*a*), and perhaps those of the dodecahedron (*d*).

Cleavage: *o* and $o_{,}$. Luster vitreous. H. = 7. G. = 2·875. Clear, transparent, but sometimes opaque from inclusions. Optically isotropic.

**Comp.**—A highly basic orthosilicate of aluminium; formula (Groth, Bgr.) $(Al(OH,F,Cl)_2)_6Al_2Si_3O_{12}$, and hence analogous to the garnet group, where the bivalent element, $R_3$, of the latter is replaced by the univalent radicals $Al(OH)_2$, $AlF_2$, $AlCl_2$. Hillebrand deduced the empirical formula $H_{18}Al_{15}Si_6(O,F,Cl)_{45}$.

**Anal.**—Hillebrand, l. c., mean of several partial analyses.

| $SiO_2$ | $Al_2O_3$ | $Na_2O$ | $K_2O$ | $Li_2O$ | $H_2O$ | F | Cl | |
|---|---|---|---|---|---|---|---|---|
| 24·33 | 57·88 | 0·24 | 0·10 | *tr.* | 10·89 | 5·61 | 2·91 | $Fe_2O_3$ 0·20, $P_2O_5$ 0·60 = 102·76[a] |

[a] Deduct 3·02 (O = F,Cl) = 99·74.

**Pyr.**—B.B. infusible, but becomes opaque and porcelain-like. Heated in a closed tube yields acid water. Not attacked by acids.

**Obs.**—Occurs at the Zuñi mine, Anvil Mountain, near Silverton, San Juan Co., Colorado. It is intimately mixed with the sulphide of arsenic and lead, guitermanite (p. 131) and pyrite; also embedded in a white earthy material consisting in part of lead sulphate, and derived from the alteration of the associated ores.

## 4. Garnet Group. Isometric, holohedral.

$$\overset{\text{II}}{R}_3\overset{\text{III}}{R}_2(SiO_4)_3 \text{ or } 3RO.R_2O_3.3SiO_2.$$

$$\overset{\text{II}}{R} = Ca,Mg,\overset{\text{II}}{Fe},\overset{\text{II}}{Mn}. \qquad \overset{\text{III}}{R} = Al,\overset{\text{III}}{Fe}(\overset{\text{III}}{Mn})Cr\overset{\text{III}}{Ti}.$$

| | | |
|---|---|---|
| **370.** | **Garnet** | |
| | A. GROSSULARITE | $Ca_3Al_2(SiO_4)_3$ |
| | B. PYROPE | $Mg_3Al_2(SiO_4)_3$ |
| | C. ALMANDITE | $Fe_3Al_2(SiO_4)_3$ |
| | D. SPESSARTITE | $Mn_3Al_2(SiO_4)_3$ |
| | E. ANDRADITE | $Ca_3Fe_2(SiO_4)_3$<br>Also $(Ca,Mg)_3Fe_2(SiO_4)_3$ and $Ca_3Fe_2((Si,Ti)O_4)_3$ |
| | F. UVAROVITE | $Ca_3Cr_2(SiO_4)_3$ |
| **371.** | **Schorlomite** | $Ca_3(Fe,Ti)_2((Si,Ti)O_4)_3$ |

Closely related to the GARNET GROUP proper are the species of the Sodalite and Helvite Groups (p. 429, p. 434). All are characterized by isometric crystallization, and all are orthosilicates, and as developed by Brögger with similar chemical structure. Thus the formula of the Garnet Group is $\overset{\text{II}}{R}_3\overset{\text{III}}{R}_2(SiO_4)_3$; to this Sodalite conforms if written $Na_4(AlCl)Al_2(SiO_4)_3$, where $Na_4$ and the bivalent radical AlCl are equivalent to $R_3$ and similarly for Noselite (Haüynite) if the presence of the bivalent group $NaSO_4$–Al is assumed.

In the Helvite Group, which is characterized by the tetrahedral character of the species (perhaps true also of the Sodalites), the chemical relation is less close, but probably exists as exhibited by writing the formula of Helvite $(Mn,Fe)(Mn_2S)Be_3(SiO_4)_3$ where the bivalent group –S–Mn–S– enters, and 3Be may be regarded as taking the place of 2Al. For a further discussion of the subject, with exhibition of structural formulas, etc., see Brögger, Zs. Kr., **16**, 176, 181, 1890, and Brögger and Bäckström, ibid., **18**, 209–276, 1890.

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**370. GARNET.** *῎Ανθραξ* pt. [rest Ruby Spinel and Sapphire] *Theophr.* Carbunculus pt. [rest id.] *Plin.*, **37**, 25; Carchedonius, Garamanticus [= Carthaginian or Garamantic Carbuncle], Alabandicus [cut at Alabanda], Anthracitis, *Plin.*, ib., 25–27. Granatus *Albertus Magnus*, 232, 1270. Carbunculus Carchedonius = *Germ.* Granat, C. Alabandicus and Troezenius = *Germ.* Almandin, *Agric.*, Foss., 272, Interpr., 463, 1546. Granat *Wall.*, Min., 120, 1747. Grenat *Fr.*

A. GROSSULARITE. Kanelstein [= Cinnamon Stone] fr. Ceylon [sp., placed near Zircon] *Wern.*, 1803, Ludwig's Wern., **2**. 209, 1804; Essonite *H.*, Tr. Pierres préc., 1817; Hessonite *Leonh.*, Handb., 433, 1821; Essonite [var. of Garnet] *Beud.*, 170, 1824. Romanzovit *Nordenskiöld*, Schw. J., **31**, 380. Grossularite *Wern.*, 1808–9, Hofm. Min., **1**, 479, 1811; Granat *Pallas*, N. Nord. Beytr. St. Pet., 1793; Wiluit pt., Viluit, *Severgin.* Grenat du chaux, ou Grossulaire, *Beud.*, 337, 1824. Tellemarkit *Weisbach*, Synops. Min., 13, 1875.

B. PYROPE. Carbunculi Carchedonii in Boëmorum agris *Agric.*, Foss., 272, 1546. Bohemian Garnet. Böhmischer Granat *Wern.*, Bergm J., 424, 1789; Klaproth, **2**, 16, 1747. Pyrop *Wern.*, 1800, Ludw. Wern., **1**, 48, 1803. Karfunkel *Germ.*, Escarboucle pt. Vogesit *Weisbach*, Synops. Min., 13. 1875.

C. ALMANDITE. Precious or Oriental Garnet. Orientalischer Granat, Sirianischer (fr. Siriam in Pegu) Granat *Klapr.*, Beitr., **2**, 22, 1798. Alamandin (Alabandicus Plin.) *Karst.*, Tab., 20, 69, 1800. Common Garnet pt. Fahlungranat *Berz.*, Löthr.

D. SPESSARTITE. Granatförmiges Braunsteinerz (fr. Spessart) *Klapr.*, Beitr., **2**, 239, 1797 = Braunsteinkiesel (near Garnet) *Karst.*, Tab., 20, 69, 1800. Manganesian Garnet *Seybert.* Am. J. Sc., **6**, 155, 1823. Mangangranat *Germ.* Broddbogranat *Berz.* Spessartine *Beud.*, 52, 1832.

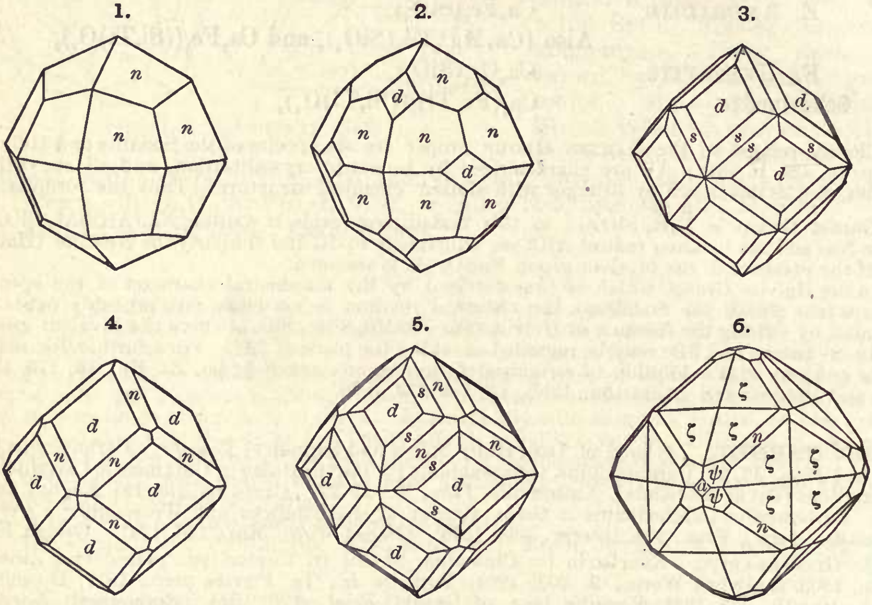
E. ANDRADITE. Common Garnet, pt. Allochroite *d'Andrada*, J. Phys., **51**, 243, 1800, Scherer's J., **4**, 32. Black Garnet: Melanit *Wern.*, 1800, Ludw. Wern., **1**, 48, 64, 1803. Aplome *H.*, Tr., **4**, 239, 1801. Kolophonit *d'Andrada; Simon*, Gehl. J., **4**, 405, 1807. Grénat résinite = Colophonite *H.*, Cours 1804, *Lucas*, Tabl., 265, 1806; Pech-Granat *Karst.*, Tab., 32, 89, 1808. Topazolite *Bonvoisin*, J. de Phys., **62**, 1806. Pyreneit *Wern.*, 1811–12, Hoffm., Min., **2**. 373, 1815. Kalkgranat *Berz.*, Löthr. Granat v. Långban *Rothoff*, Afh., **3**, 329, 1810; Rothoffite *Berz.*, N. Syst. Min., 218, 1819. Polyadelphite *Thom.*, Min., **1**, 154, 1836. Jelletite *Apjohn*, J. G. Soc., Dublin, **5**. 119, 1853. Yttergranat *Bergemann*, Ber. nied. Ges., July, 1854. Demantoid *N. Nordenskiöld*, quoted by Kk., Min. Russl., **8**, 310. Bredbergite *Dana*, Min., 270, 1868. Andradite *Dana*, Min., 268, 1868.

F. UVAROVITE. Ouvarovite. Uwarowit *Hess*, Pogg., **24**, 388, 1832.

Isometric. Observed forms[1]:

*a* (100, *i-i*) rare
*d* (110, *i*)
*o* (111, 1)
*δ* (610, *i*-6)[5]
*f* (310, *i*-3)[5]
*k* (520, $i\text{-}\frac{5}{2}$)[5]
*e* (210, *i*-2)
*l* (530, $i\text{-}\frac{5}{3}$)[6]
*g* (320, $i\text{-}\frac{3}{2}$)
*ϵ* (540, $i\text{-}\frac{5}{4}$)[6]
*r* (332, $\frac{3}{2}$)
*p* (221, 2)
*q* (331, 3)[3]
*φ* (511, 5-5)
*ψ* (722, $\frac{7}{2}\text{-}\frac{7}{2}$)[4]
*m* (311, 3-3)
*n* (211, 2-2)
*ω* (744, $\frac{7}{4}\text{-}\frac{7}{4}$)[5]
*τ* (533, $\frac{5}{3}\text{-}\frac{5}{3}$)[5]
*χ* (433, $\frac{4}{3}\text{-}\frac{4}{3}$)
*u* (853, $\frac{8}{3}\text{-}\frac{8}{5}$)[9]
*s* (321, $3\text{-}\frac{3}{2}$)
*v* (10·7·3, $\frac{10}{3}\text{-}\frac{10}{7}$)[11]
*x* (432, $2\text{-}\frac{4}{3}$)[5]
*y* (431, $4\text{-}\frac{4}{3}$)
*z* (541, $5\text{-}\frac{5}{4}$)[8]

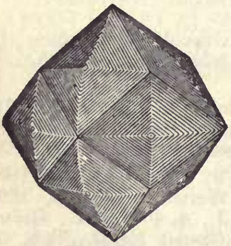
Also the vicinal forms: *λ* (20·19·0, $i\text{-}\frac{20}{19}$) Breith., *Φ* (41·40·0, $i\text{-}\frac{41}{40}$)[10]. *Ω* (64·63·0, $i\text{-}\frac{64}{63}$)[2]. *ϑ* (86·85·0, $i\text{-}\frac{86}{85}$)[7], *ζ* (64·63·1, $64\text{-}\frac{64}{63}$) Naum., and others more complex noted by Rath[5].



Figs. 1–5, Common forms. 6, Mill Rock, New Haven.

Twins: tw. pl. *e* (210)[12]. The dodecahedron and tetragonal trisoctahedron, (*n*, 211, f. 1), the most common simple forms; also these in combination, f. 2, 4; or with also the hexoctahedron *s* (321) as in f. 3, 5. Faces *d* often striated ∥ longer diagonal; sometimes built up of successive plates (f. 7). Cubic faces very rare; octahedral also, but sometimes in complete octahedrons (Elba). In irregular embedded grains. Also massive; granular, coarse, or fine, and sometimes friable; lamellar, lamellæ thick and bent. Also very compact, cryptocrystalline like nephrite.

7.



Heddle.

Cleavage (or parting): *d* sometimes rather distinct[13]. Fracture subconchoidal to uneven. Brittle, sometimes friable when granular massive; very tough when compact cryptocrystalline. H. = 6·5–7·5. G. = 3·15–4·3, varying with the composition. Luster vitreous to resinous. Color red, brown, yellow, white, apple-green, black; some red and green, colors often bright. Streak white. Transparent to subtranslucent. Asterism observed in some garnets having striated faces (Dx.). Often exhibits anomalous double refraction. Refractive indices[15].

| | | | |
|---|---|---|---|
| *Grossularite*, yw.-brown, Auerbach | $n_r$ = 1·7368 Li | $n_y$ = 1·7468 Na | $n_{gr}$ = 1·7593 Tl |
| " red, " | " = 1·7645 " | " = 1·7714 " | " = 1·7796 " |
| *Pyrope*, Oriental | " = 1·7776 | " = 1·8141 " | $n_v$ = 1·8288 |
| *Almandite*, Ceylon | " = 1·7716 red | Also, Zillerthal | $n_y$ = 1·7670 |

Red-brown dodecahedrons from Taberg, with strong double refraction, gave, for rays ⊥ *d* and ∥ longer diagonal respectively, $n_y$ = 1·8389 and 1·8328, $n_{gr}$ = 1·8436 and 1·8387, G. Nordenskiöld.[15]

The anomalous double refraction of many garnets,[14] early noted by Brewster, was fully studied by Mallard and later by Bertrand, by whom it has been explained as due to the complex twinning of triclinic individuals, producing at times forms which are apparently orthorhombic and isometric. The exhaustive studies of Klein have not only developed the various types of structure, but have served to prove that the structure is immediately connected with the external form, not dependent upon the chemical composition, and doubtless of secondary origin.

In general the molecular structure may be explained by regarding the crystal as made up of a series of similar pyramids whose vertices meet at the center; many garnets show an easy mechanical separation into parts corresponding to these pyramids. Several types of forms are distinguished by Klein: (1) the *octahedral*, where the structure corresponds to eight triangular pyramids, each uniaxial and negative with the optical axis normal to the octahedral face which forms its base; this is illustrated by the octahedrons from Elba. (2) *Dodecahedral*, corresponding to the grouping of twelve rhombic pyramids, whose bases coincide with the dodecahedral faces; the axial plane is parallel to the longer diagonal, to which the bisectrix (usually −) is normal; this is the more common type. (3) *Icositetrahedral*, corresponding to twenty-four pyramids whose bases are formed by the faces of the tetragonal trisoctahedron *n* (211) to which the optic axis, or bisectrix (+ or −) of the uniaxial (or biaxial) pyramid is normal; ax. pl. ⊥ symmetric diagonal of each face of the form 211. (4) *Hexoctahedral*, corresponding to forty-eight triangular pyramids, the bases having the position of the faces of the vicinal hexoctahedron of topazolite. Each pyramid is biaxial; bisectrix (−) inclined to the hexoctahedral face; ax. pl. variable.

Besides the distinct types mentioned, many garnets show optical characters more or less intermediate between them. Klein's observations prove that the normal form of the garnet is isometric, while the anomalous optical structure is secondary. Brögger calls attention to the fact that garnets in igneous rocks which have been formed direct from the magma, or embedded crystals in rocks formed by regional metamorphism, are uniformly isotropic, while those which have apparently crystallized from hot solutions in crevices or have been formed by contact metamorphism, for example in crystallized limestone, exhibit double refraction.

**Comp., Var.**—An orthosilicate having the general formula $\overset{\text{II}}{R}_3\overset{\text{III}}{R}_2(SiO_4)_3$ or $3RO.R_2O_3.3SiO_2$. The bivalent element is calcium, magnesium, ferrous iron or manganese; the trivalent element, aluminium, ferric iron and chromium, and rarely titanium; further, silicon is also sometimes replaced by titanium.

There are three prominent groups, and various subdivisions under each, many of these blending into each other.

I. *Aluminium Garnet*, including

| | | |
|---|---|---|
| A. GROSSULARITE | Calcium-Aluminium Garnet | $Ca_3Al_2Si_3O_{12}$ |
| B. PYROPE | Magnesium-Aluminium Garnet | $Mg_3Al_2Si_3O_{12}$ |
| C. ALMANDITE | Iron-Aluminium Garnet | $Fe_3Al_2Si_3O_{12}$ |
| D. SPESSARTITE | Manganese-Aluminium Garnet | $Mn_3Al_2Si_3O_{12}$ |

II. *Iron Garnet*, including

| | | |
|---|---|---|
| E. ANDRADITE | Calcium-Iron Garnet | $Ca_3Fe_2Si_3O_{12}$ |

(1) Ordinary. (2) Magnesian. (3) Titaniferous. (4) Yttriferous

III. *Chromium Garnet.*

| | | |
|---|---|---|
| F. UVAROVITE | Calcium-Chromium Garnet | $Ca_3Cr_2Si_3O_{12}$ |

The name Garnet is from the Latin *granatus*, meaning *like a grain*, and directly from *pomegranate*, the seeds of which are small, numerous, and red, in allusion to the aspect of the crystals.

A. GROSSULARITE. Essonite or Hessonite. Cinnamon Stone. Kaneelstein. *Calcium-aluminium Garnet.* Kalkthongranat *Germ.* Formula $3CaO.Al_2O_3.3SiO_2$ = Silica 40·0, alumina 22·7, lime 37·3 = 100. Often containing ferrous iron replacing the calcium, and ferric iron replacing aluminium, and hence graduating to groups C and E. G = 3·55 to 3·66. Color (*a*) white; (*b*) pale green; (*c*) amber-and honey-yellow; (*d*) wine-yellow, brownish yellow, cinnamon-brown; (*e*) pale rose-red; rarely (*f*) emerald-green from the presence of chromium.

The original *grossularite* (*wiluite* pt.) included the pale green from Siberia, and was so named from the botanical name for the gooseberry; G. =3·42–3·72. *Cinnamon-stone*, or *essonite* (more properly *hessonite*), included a cinnamon-colored variety from Ceylon, there called *hyacinth*; but under this name the yellow kinds are usually included; named from *ἥσσων*, *inferior*, because of less hardness than the true hyacinth which it resembles. *Succinite* is an amber-colored kind from the Ala valley, Piedmont. *Romanzovite* is brown. A garnet from R. Iset, Govt. Perm, is compact, grayish green to greenish white in color, and much resembles nephrite; anal. 22, 23.

Pale green, yellowish, and yellow-brown garnets are not invariably grossularite; some (including topazolite, demantoid, etc.) belong to the group of Calcium-Iron Garnet, or Andradite.

**Anal.**—1, A. E. Nordenskiöld, Öfv. Ak. Stockh., **27**, 565, 1870. 2, Bullman, Am. J. Sc., **27**, 306, 1884. 3, M. D. Munn, priv. contr. 4, Hunt, Rep. G. Canada, 447, 1847, 496, 1863. 5, Nicolayev, Min. Russl., **8**, 320, 1881. 6, Chipman, Proc. Ac. Philad., 82, 1878. 7, Koenig, ibid., p. 81. 8, Dmr., C. R., **73**, 1041, 1871. 9, Jannasch, Jb. Min., **1**, 135, 1883. 10, Gmelin, Berz. JB., **5**, 224, 1826. 11, Websky, Zs. G. Ges., **23**, 755, 1869. 12, J. L. Smith, Am. J. Sc., **4**, 434, 1874. 13, Jannasch, l. c., p. 109. 14, Id., p. 119. 15, Id., p. 135. 16, Loczka, Zs. Kr., **11**, 261, 1885. 17, Wachmeister, Ak. H. Stockh., 141, 1823. 18, Lemberg, Zs. G. Ges., **24**, 249, 1872. 19, Nd., Schw. J., **31**, 380, 1821. 20, Rath, Zs. G. Ges., **22**, 639, 1870. 21, Heddle, Trans. R. Soc. Ed., **28**, 299, 1878. 22, Liversidge, Min. N. S. W., 204, 1888. 23, 24, Beck and Mushketov, Nikolayev, Vh. Min. Ges., **18**, 26, 28, 1883. 25, Gerichten, Lieb. Ann., **171**, 191, 1874.

Other earlier analyses of this and the following kinds are given in 5th Ed., pp. 267–270; see also Rg., Min. Ch., pp. 473–482, 1865.

| *Grossularite.* | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Frugård, *colorless* | | 39·14 | 21·27 | 2·37 | — | — | *tr.* | 36·83 | = 99·61 |
| | | 39·42 | 21·06 | 2·41 | — | — | *tr.* | 37·08 | = 99·97 |
| 2. Wakefield, *white* | 3·525 | 38·80 | 22·66 | 1·75 | — | 0·30 | 0·68 | 35·00 | = 99·19 |
| 3. Hull, *colorless* | | $\frac{2}{2}$ 39·85 | 22·07 | 1·13 | — | — | 0·68 | 36·31 | = 100·04 |
| 4. Orford, *white* | 3·525 | 38·60 | 22·71 | — | 1·60 | | 0·49 | 34·83 | ign. 1·10, $Na_2O$, $K_2O$ 0·47 = 99·80 |
| 5. R. Iset, Perm, *green* | 3·482 | 38·60 | 24·18 | — | — | — | 0·97 | 35·03 | ign. 1·18 = 99·96 |
| 6. Leiperville, *green* | 3·238 | 39·08 | 23·26 | 0·80 | 0·80 | 7·60 | — | 28·50 | ign. 0·32 = 100·42 |
| 7. " *yellow* | 3·637 | 39·80 | 21·16 | 3·14 | 0·72 | 1·80 | *tr.* | 34·00 | = 100·62 |
| 8. Mexico, *pale red* | 3·57 | 39·46 | 21·69 | 1·36 | — | 0·96 | 0·67 | 35·75 | ign. 0·40 = 100·29 |
| 9. Vesuvius, *yellow* | 3·572 | 39·83 | 20·16 | 1·03 | 1·21 | 0·46 | 0·97 | 35·42 | $Na_2O$ 0·33, ign. 1·04 = 100·45 |
| 10. Ceylon, *Cinnamon-stone* | | 40·01 | 23·00 | 3·67 | — | — | — | 30·57 | $K_2O$ 0·59, ign. 0·33 = 98·17 |
| 11. Jordansmühl, *white* | 3·609 | 37·88 | 21·13 | — | 4·19 | 0·45 | 2·88 | 31·28 | NiO 0·28, $H_2O$ 1·08 = 99·17 |
| 12. San Carlos, Cal., *cinn.* | 3·59 | 42·01 | 17·76 | 5·06 | — | 0·20 | 0·13 | 35·01 | = 100·17 |
| 13. Auerbach, *white* | 3·47 | 41·80 | 20·91 | — | 2·01 | 0·18 | 0·82 | 33·48 | $Na_2O$ 0·42, ign. 0·38 = 100 |
| 14. Mussa Alp, *brn.-red* | 3·633 | $\frac{2}{2}$ 38·53 | 17·88 | 7·39 | | 0·35 | 0·20 | 35·08 | $Na_2O$ 0·38, ign. 0·63 = 100·44 |
| 15. Cziklowa, *yellow* | 3·571 | 39·74 | 19·23 | — | 5·14 | 0·13 | 0·56 | 35·48 | $Na_2O$ 0·61, ign. 0·53 = 101·42 |
| 16. " | 3·610 | 39·65 | 18·85 | 5·36 | — | 0·21 | 0·82 | 35·65 | $Na_2O$, $K_2O$ 0·19, $H_2O$ 0·56 = 101·29 |
| 17. Vilui, *grossular* | 3·64 | 40·55 | 20·10 | 5·00 | — | 0·48 | — | 34·86 | = 100·99 |
| 18. Monzoni, *yellow* | | 39·53 | 20·15 | 4·94 | — | — | 1·72 | 33·88 | = 100·22 |
| 19. *Romanzovite* | 3·61 | 41·21 | 24·08 | 7·02 | — | 0·92 | | 24·76 | ign. [2·01] = 100 |
| 20. S. Piero, Elba, *green* | 3·286 | 39·29 | 16·16 | 10·05 | | — | 5·85 | 29·23 | ign. 0·64 = 101·22 |
| 21. Craig Mohr, " | 3·545 | 39·83 | 9·74 | 15·07 | 0·11 | 0·35 | 1·01 | 33·57 | $H_2O$ 0·04 = 99·72 |
| 22. Mudgee, *brown* | | 40·52 | 19·91 | 0·28 | 3·16 | 3·70 | *tr.* | 32·25 | $CO_2$ 0·25 = 100·07 |
| 23. R. Iset, *mass.* | 3·482 | 37·99 | 24·05 | 0·53 | — | — | 1·27 | 35·20 | $H_2O$ 0·28 = 100·32 |
| 24. " " | 3·522 | 36·60 | 24·28 | *tr.* | — | — | *tr.* | 36·67 | $H_2O$ 1·80 = 99·35 |
| 25. Eppenreuth, *brn.-red.* | | 43·37 | 23·13 | — | 14·63 | 0·98 | 4·78 | 13·48 | = 100·37 |

Anals. 21, 22 are of two specimens closely resembling nephrite, massive, compact, of a grayish green or grayish white color.

B. PYROPE. Precious garnet pt. *Magnesium-aluminium Garnet.* Magnesiathongranat *Germ.* Formula $3MgO.Al_2O_3.3SiO_2$ = Silica 44·8, alumina 25·4, magnesia 29·8 = 100. Magnesia predominates, but calcium and iron are also present, and the original pyrope contained chromium. G. = 3·70–3·75. Color deep red to nearly black. Often perfectly transparent and then prized as a gem. The name *pyrope* is from *πυρωπός, fire-like.*

**Anal.**—1, Moberg, J. pr. Ch., **43**, 122, 1847. 2, Kbl., Kast. Arch. Nat. [**9**, 344]. 3, Scharizer, Zs. Kr., **6**, 333, 1882. 4, Lemberg, Zs. G. Ges., **27**, 534, 1875. 5, Id., ibid., p. 540. 6, Heddle, Trans. R. Soc. Edinburgh, **28**, 311, 1878. 7, Genth, Am. J. Sc., **33**, 196, 1862. 8, Chatard, Am. J. Sc., **32**, 125, 1886. 9, Wachtmeister, Ak. H. Stockh., 138, 1823. 10, Delesse, Ann. Mines, **18**, 314, 1850. 11, 12, Fischer, Jb. Min., **1**, 393 ref., 1890. 13, Knap, Ch. News, **38**, 109, 1878.

| *Pyrope, etc.* | G. | $SiO_2$ | $Al_2O_3$ | $Cr_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Meronitz, Bohemia | | 41·35 | 22·35 | 4·45 | — | 9·94 | 2·59 | 15·00 | 5·29 | = 100·97 |
| 2. " " | | 42·08 | 20·00 | 3·01 | 1·51 | 9·09 | 0·32 | 10·20 | 1·99 | = 98·20 |
| 3. Krems | 3·66 | 40·45 | 19·67 | 2·60 | 4·05 | 6·90 | — | 20·79 | 5·78 | = 100·24 |
| 4. Zöblitz | | 39·62 | 20·72 | 2·24 | 10·96 | — | — | 21·24 | 4·40 | $H_2O$ 0·82 [= 100 |
| 5. Greifendorf | | 40·92 | 21·68 | 1·20 | 9·26 | — | — | 20·94 | 4·52 | $H_2O$ 1·48 [= 100 |
| 6. Elie Ness | 4·124 | 40·92 | 22·45 | — | 5·46 | 8·11 | 0·46 | 17·85 | 5·04 | $H_2O$ 0·10 [= 100·39 |
| 7. Santa Fé | 3·738 | 42·11 | 19·35 | 2·62 | — | 14·87 | 0·36 | 14·01 | 5·23 | ign. 0·45 [= 99·00 |
| 8. Elliot Co., Ky. | 3·673 | 41·32 | 21·21 | 0·91 | 4·21 | 7·93 | 0·34 | 19·32 | 4·94 | $TiO_2$ 0·16, [alk. 0·07. $H_2O$ 0·17 = 100·58 |
| 9. Arendal, *black* | 3·157 | 42·45 | 22·47 | — | — | 9·29 | 6·27 | 13·43 | 6·53 | = 100·44 |
| 10. Narouel, Vosges | 3·15 | $\frac{2}{2}$ 41·56 | 19·84 | 0·35 | 10·17 | | *tr.* | 22·00 | 4·25 | ign. 1·58 [= 99·75 |
| 11. S. Africa, *wine-red* | | 41·34 | 22·75 | 2·96 | — | 12·12 | 0·36 | 16·20 | 5·17 | = 100·90 |
| 12. " " *hyacinth-red* | | 40·90 | 22·81 | 1·48 | — | 13·34 | 0·38 | 16·43 | 4·70 | = 100·04 |
| 13. "Cape ruby" | 3·86 | 39·06 | 21·02 | — | 2·69 | 18·70 | 0·58 | 12·09 | 5·02 | = 99·16 |

C. ALMANDITE. Almandine. Precious garnet pt. Common garnet pt. *Iron-aluminium Garnet.* Eisenthongranat *Germ.* Formula $3FeO.Al_2O_3.3SiO_2$ = Silica 36·2, alumina 20·5, iron protoxide 43·3 = 100. Ferric iron replaces the aluminium to a greater or less extent (cf. anals. 13–19). Magnesium also replaces the ferrous iron, and thus it graduates toward pyrope. G. = 3·9–4·2. Color fine deep red, transparent, in *precious garnet;* brownish red, translucent or subtranslucent, in *common garnet;* black. Part of *common garnet* belongs to *Andradite.*

The Alabandic carbuncles of Pliny were so called because cut and polished at Alabanda. Hence the name almandine, now in use. Pliny describes vessels of the capacity of a pint, formed from carbuncles, "non claros ac plerumque sordidos ac semper fulgoris horridi," devoid of luster and beauty of color, which probably were large common garnets of the latter kind.

**Anal.**—1, Hisinger, Schw. J., **21**, 258, 1817. 2, Kjerulf, Nyt Mag., **8**, 190, 1853. 3, 4, Kbl., Schw. J., **64**, 283, 1832. 5, Kurlbaum, Am. J. Sc., **19**, 20, 1855. 6, 7, Penfield and Sperry, ib., **32**, 308, 311, 1886. 8, Liversidge, Roy. Soc. N. S. W., Sept. 1, 1880. 9, Keller, Proc. Acad. Philad., 54, 1882. 10, E. F. Smith, Am. Ch. J., **5**, 276, 1883. 11, Schrauf, Zs. Kr., **6**, 323, 1882. 12, Niedzwiedzki, Min. Mitth., 163, 1872. 13–19, Heddle; 13, Min. Mag., **5**, 75, 1882; 14–19, Trans. R. Soc. Ed., **28**, 312 *et seq.*, 1878. 20, Websky, Zs. G. Ges., **20**, 256, 1868. 21, A. F. Kountze, priv. contr.

| *Almandite.* | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Falun, *almandite* | | 39·66 | 19·66 | — | 39·68 | 1·80 | — | — | = 100·80 |
| 2. Orawitza | | 37·52 | 20·01 | — | 36·02 | 1·29 | 2·51 | 0·89 | = 98·24 |
| 3. Hungary(?), *prec.* | | 40·56 | 20·61 | 5·00 | 32·70 | 1·47 | — | — | = 100·34 |
| 4. Zillerthal, *brown* | 4·04 | 39·12 | 21·08 | 6·00 | 27·28 | 0·80 | — | 5·76 | = 100·04 |
| 5. Delaware Co., Penn., *prec.* | | 40·15 | 20·77 | — | 26·66 | 1·85 | 8·08 | 1·83 | = 99·34 |
| 6. L. Superior, *red* | 4·11 | 38·03 | 20·83 | — | 36·15 | 2·14 | 0·97 | 2·73 | = 100·85 |
| 7. Salida, Col., *red* | 4·163 | 37·61 | 22·70 | — | 33·83 | 1·12 | 3·61 | 1·44 | = 100·31 |
| 8. Balade mine | 4·011 | $\frac{2}{2}$ 38·15 | 22·18 | — | 21·26 | 5·54 | 4·74 | 7·78 | ign. 0·31 = [99·96 |
| 9. Darby, Pa., *black* | 4·25 | 36·92 | 26·54 | 3·74 | 27·36 | 0·33 | 1·66 | 2·76 | $TiO_2$ 1·14= [100·45 |
| 10. Shimersville, *dark red* | 4·03 | 35·92 | 19·18 | 4·92 | 29·47 | 4·80 | 3·70 | 2·38 | = 100·37 |
| 11. Budweis | 4·156 | 40·96 | 25·57 | 12·46 | 11·07 | 5·11 | 1·93 | 3·26 | = 100·36 |
| 12. Saualpe | 4·12 | 38·59 | 17·57 | 16·43 | 21·12 | — | 4·27 | 2·27 | = 100·25 |

| *Almandite.* | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|---|
| 13. Leiter Mussel | 4·127 | 35·00 | 21·54 | 2·82 | 26·54 | 4·46 | 2·31 | 7·11 | $H_2O$ 0·14 [= 99·92 |
| 14. Killiecrankie, *brn.-red* | 3·688 | 37·59 | 13·66 | 3·66 | 32·31 | 4·47 | 3·46 | 4·12 | $H_2O$ 0·32 [= 99·59 |
| 15. Meall Luaidh, *red-brown* | | 37·66 | 14·80 | 4·56 | 32·97 | 2·37 | 1·81 | 5·89 | = 100·06 |
| 16. Is. Yell, *pink-red* | 3·997 | 37·30 | 21·09 | 7·47 | 24·02 | 2·14 | 3·53 | 4·43 | = 99·98 |
| 17. Knock Hill, *wine-red* | 4·116 | 37·11 | 14·90 | 10·12 | 32·41 | 1·21 | 2·93 | 2·17 | = 100·85 |
| 18. Clach an Eòin, *brown-red* | | 39·92 | 19·81 | 13·69 | 13·29 | 1·00 | 3·31 | 9·13 | = 100·15 |
| 19. Loch Garve | | 36·15 | 21·93 | 15·15 | 15·08 | 7·85 | 1·62 | 2·07 | $H_2O$ 0·31 [= 100·16 |
| 20. Schreiberhau | 4·197 | 35·83 | 20·65 | — | 31·52 | 8·92 | — | 0·76 | $Y_2O_3$ 2·64 [= 100·32 |
| 21. Ft. Wrangel, Alaska | 4·093 | $\frac{2}{2}$ 39·29 | 21·70 | *tr.* | 30·82 | 1·51 | 5·26 | 1·99 | = 100·57 |

D. SPESSARTITE. Spessartine. *Manganese-aluminium Garnet.* Mangangranat. Manganthongranat *Germ.* Formula $3MnO.Al_2O_3.3SiO_2$ = Silica 36·4, alumina 20·6, manganese protoxide 43·0 = 100. Ferrous iron replaces the manganese to a greater or less extent, and ferric iron also the aluminium. G. = 4·0–4·3. Color dark hyacinth-red, sometimes with a tinge of violet, to brownish red.

**Anal.**—1, C. M. Bradbury, Ch. News, **50**, 120, 1884; also quoted by Fontaine, Am. J. Sc., **25**, 335, 1883; also Seamon, Ch. News, **46**, 195, 1882. 2, Pisani, C. R., **83**, 167, 1876. 3, Rg., J. pr. Ch., **55**, 487, 1852. 4, Eakins, Am. J. Sc., **31**, 435, 1886. 5, Penfield, priv. contr. 6, Koenig, Proc. Ac. Philad., 53, 1876. 7, Genth, Geol. N. C., Min., p. 44, 1881. 8, 9, Kbl., Ber. Ak. München, 292, 1868. 10, Nicolajev, Vh. Min. Ges., **17**, 268, 1882. 11, Id., l. c. 12, Id., Bull. Ac. St. Pet., **31**, 484, 1887. 13. Weibull, G. För. Förh., **6**, 503, 1883. 14, Heddle, Min. Mag., **2**, 85, 1878, also other analyses. 15, Klement, Min. Mitth., **8**, 18, 1887. 16, Koninck, Bull. Ac. Belg., **33**, No. 4, 1872. 17, Gorgeu, Bull. Soc. Min., **6**, 283, 1883.

| *Spessartite.* | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Amelia Co., Va. | 4·20 | 36·34 | 12·63 | — | 4·57 | 44·20 | 0·47 | 1·49 | ign. *tr.* = 99·70 |
| 2. St. Marcel | 4·01 | 38·50 | 18·40 | 2·70 | — | 34·25 | — | 5·87 | = 99·72 |
| 3. Haddam | 4·273 | 36·16 | 19·76 | — | 11·10 | 32·18 | 0·22 | 0·58 | = 100 |
| 4. Nathrop, Col. | 4·23 | 35·66 | 18·55 | 0·32 | 14·25 | 29·48 | — | 1·15 | alk. 0·48 ign. 0·44 |
| 5. Branchville, Conn. | | 35·65 | 20·93 | — | 5·67 | 37·21 | — | 0·48 | = 99·94 [= 100·33 |
| 6. Yancey Co., N.C. | 4·14 | 35·80 | 19·06 | 6·25 | 4·49 | 28·64 | 0·60 | — | = 99·84 |
| 7. Salem, N. C. | | 36·74 | 16·55 | — | 14·26 | 25·80 | 2·56 | 4·09 | = 100 |
| 8. Aschaffenburg | 4·17 | 38·70 | 18·50 | 1·53 | 13·32 | 27·40 | — | — | = 99·45 |
| 9. Pfitsch, *mass.* | 4·3 | 37·50 | 18·90 | 2·03 | 6·37 | 34·00 | — | 2·00 | = 100·80 |
| 10. Ilmen Mts. | | 36·60 | 21·46 | 6·48 | 10·90 | 20·86 | 0·24 | 2·27 | ign. 0·28 = 99·09 |
| 11. Scheich-Dzeli | | 35·21 | 23·32 | 5·71 | 15·43 | 16·41 | 1·13 | 1·39 | $H_2O$ 0·14 = 98·74 |
| 12. Bagaryak, Ural | | 37·12 | 21·31 | — | 8·82 | 25·83 | 0·94 | 5·72 | = 99·74 |
| 13. Vester-Silfberg | | 36·03 | 20·91 | — | 21·26 | 17·79 | — | 4·43 | = 100·42 |
| 14. Glen Skiag | 4·125 | 35·99 | 16·22 | 8·64 | 23·27 | 15·24 | 0·47 | 0·40 | ign. 0·25 = 100·48 |
| 15. Ourt. Belg. | 3·976 | 37·58 | 20·45 | 3·21 | 15·53 | 14·72 | 0·68 | 10·03 | = 102·20 |
| 16. Salm Chateau | 4·05 | 36·24 | 20·08 | 1·98 | 4·49 | 37·89 | *tr.* | — | = 100·68 |
| 17. *Artificial* | | 36·10 | 21·25 | — | — | 42·70 | *tr.* | *tr.* | = 100·05 |

E. ANDRADITE. Common Garnet, Black Garnet, etc. *Calcium-iron Garnet.* Kalkeisengranat *Germ.* Formula $3CaO.Fe_2O_3.3SiO_2$ = Silica 35·5, iron sesquioxide 31·5, lime 33·0 = 100. Aluminium replaces the ferric iron; ferrous iron, manganese and sometimes magnesium replace the calcium. G. = 3·8–3·9. Colors various: wine-, topaz-, and greenish yellow, apple-green to emerald-green; brownish red, brownish yellow; grayish green, dark green; brown; grayish black, black.

Named *Andradite* after the Portuguese mineralogist, d'Andrada, who in 1800 described and named one of the included subvarieties, Allochroite. The included kinds vary so widely in color and other respects that no one of the names in use will serve for the group.

Chemically there are the following subvarieties: 1. Simple *Calcium-iron Garnet,* in which the protoxides are wholly or almost wholly lime. Includes: (*a*) *Topazolite,* having the color and transparency of topaz, and also sometimes green; although resembling hessonite, Damour has shown that it belongs here. *Demantoid* is a grass-green to emerald-green variety with brilliant luster and occurring in massive forms; it is used as a gem, and its name refers to its high luster, resembling that of the diamond. (*b*) *Colophonite,* a coarse granular kind, brownish yellow to dark reddish brown in color, resinous in luster, and usually with iridescent hues; named after the resin *colophony.* Part of what has been called colophonite is vesuvianite. (*c*) *Melanite* (from *μέλας, black*), black, either dull or lustrous; but all black garnet is not here included. *Pyreneite* is grayish black melanite; the original afforded Vauquelin 4 p. c. of water, and was iridescent, indicating incipient alteration. (*d*) Dark green garnet, not distinguishable from some allochroite, except by chemical trials. *Jelletite* is green garnet, light or dark, and yellowish green, from the moraine of the Findelen glacier near Zermatt; named after Jellet, one of its describers. *Calderite* is a massive garnet from India; one kind, resembling colophonite, occurs in beds in the Hazáribágh district, anal. 22.

2. *Manganesian Calcium-iron Garnet.* (*a*) *Rothoffite.* The original ~~*allochroite*~~ was a manganesian iron-garnet of brown or reddish brown color, and of fine-grained massive structure. The *Rothoffite*, from Långban, first analyzed by Rothoff, is similar, with the color yellowish brown to liver-brown. Other common kinds of manganesian iron-garnet are light and dark, dusky green and black, and often in crystals. Thomson's *Polyadelphite* was a massive brownish yellow kind, from Franklin, N. J. (anal. 19, 20). The same locality affords another in dark green crystals, containing still more manganese. Bredbergite is a variety from Sala analyzed by Bredberg (anal. 21) which contains a large amount of magnesium.

(*b*) *Aplome* (properly haplome) has its dodecahedral faces striated parallel to the shorter diagonal, whence Haüy inferred that the fundamental form was the cube; and as this form is simpler than the dodecahedron, he gave it a name derived from ἁπλόος, simple. Color of the original aplome (of unknown locality) dark brown; also found yellowish green and brownish green at Schwarzenberg in Saxony, and on the Lena in Siberia.

3. *Titaniferous.* Contains titanium and probably both TiO$_2$ and Ti$_2$O$_3$; formula hence 3CaO.(Fe,Ti,Al)$_2$O$_3$.3(Si,Ti)O$_2$. It thus graduates toward schorlomite. Color black. Cf. Knop, Rg., Koenig (refs. under analyses beyond).

4. *Yttriferous Calcium-iron Garnet; Yttergarnet.* Contains yttria. A Norwegian garnet analyzed by Bergemann yielded 6·66 p. c. of the yttrium earths; later analyses (anal. 26) from the same locality (Stokö) afforded very little, thus throwing doubt over Bergemann's results. Websky found 2·6 p. c. of yttrium earths in an almandite from Schreiberhau, anal. 20, p. 442.

**Anal.**—1. Rg., Zs. G. Ges., **29**, 819, 1877. 2, Waller, G. För. Förh., **4**. 187, 1878. 3, Lösch, Jb. Min., 785, 1879. 4, 5, Nicolayev, Kk., Min. Russl., 8, 319, 1881. 6, Cossa, Trans. Acc. Linc., **4**, 234, 1880. 7, Treumann, Rg., Min. Ch., 477, 1875. 8, Fellenberg, Jb. Min., 745, 1868. 9, Lundström, G. För. Förh., **4**, 161, 1878. 10, E. S. D., Am. J. Sc., **14**, 215, 1877. 11, E. F. Smith, Am Ch. J., **5**, 276, 1883. 12–14, Wachtmeister, Ak. H. Stockh., 1823. 15, Rose, Karst. Tab., 33, 1808. 16, Wright, Ann. Mines, 3, 707, 1853. 17, Lindström, Zs. Kr., **16**, 160, 1890. 18, Forbes, Ed. N. Phil. J., **3**, 59, 1856. 19, Weber, Rg., Min. Ch., 693, 1860. 20, Thomson, Ann. Lyc. N. Y., 3, 9, 1829. 21, Bredberg, Ak. H. Stockh., 63, 1822. 22, Tween, Mallet, Min. India, 89, 1887. 23, Dmr., L'Institut, Dec. 1876. 24, Knop, Zs. Kr., **1**, 62, 1877. 25, Stromeyer, JB. Hannover [18, 23, 1864]. 26, Petersson, Zs. Kr., **16**, 171, 1890. 27–29, Knop, l.c. 30, Koenig, Proc. Ac. Philad., 355, 1886. 31, Genth, Am. J. Sc., **40**, 117, 1890. 32, Sauer, JB. Ch., 1956, 1884.

| | *Andradite.* | G. | | SiO$_2$ | Al$_2$O$_3$ | Fe$_2$O$_3$ | FeO | MnO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Sisersk, *grn.*, *Demantoid* | 3·828 | | 35·44 | — | 32·85 | — | — | 0·20 | 32·85 | = 101·34 |
| 2. | " " " | | $\frac{3}{3}$ | 35·69 | 0·09 | 29·96 | 1·25 | — | 0·08 | 32·33 | K$_2$O 0·25, Na$_2$O 0·63 = 100·28 |
| 3. | " *grass-grn.* " | | | 35·56 | 0·57 | 30·80 | 0·64 | — | 0·16 | 33·05 | = 100·78 |
| 4. | " *em.-grn.* " | 3·838 | | 35·50 | 0·70[a] | 31·51 | — | — | 0·21 | 32·90 | = 100·82 |
| 5. | " " | 3·847 | | 35·33 | 2·22 | 30·44 | 0·27 | — | *tr.* | 31·52 | = 99·78 |
| 6. | Val Malenco, *grn.* | 3·81 | | 34·91 | *tr.* | 31·69 | 1·19 | *tr.* | | 32·18 | = 99·97 |
| 7. | Dobschau, *grn.* | | | 36·69 | — | 32·26 | — | — | | 31·45 | = 100·40 |
| 8. | Zermatt, *apple-grn.* | 3·797 | | 35·80 | 0·85 | 29·50 | 1·04 | — | 0·90 | 32·10 | ign. 0·52 = 100·71 |
| 9. | Nordmark, *grn.-yw.* | | | 34·04 | — | 30·29 | 1·20 | — | 2·05 | 30·10 | ign. 1·63 = 99·31 |
| 10. | East Rock, N. Hav., *blk.* | 3·740 | $\frac{2}{2}$ | 35·09 | *tr.* | 29·15 | 2·49 | 0·36 | 0·24 | 32·80 | ign. 0·35 = 100·48 |
| 11. | Hosensack, Pa., *yw.* | | | 35·25 | — | 32·17 | 0·92 | — | — | 30·80 | = 99·14 |
| 12. | Altenau, *aplome* | | | 35·64 | — | 30·00 | — | 3·02 | — | 29·21 | K$_2$O 2·35 = 100·22 |
| 13. | Långban, *yellow* | | | 35·10 | — | 29·10 | — | 7·08 | — | 26·91 | K$_2$O 0·98 = 99·17 |
| 14. | Arendal, *bnh.-bk.* | | | 40·20 | 6·95 | 20·50 | — | 4·00 | — | 29·48 | = 101·13 |
| 15. | Drammen, *Allochr.* | | | 37·00 | 5·00 | 18·50 | — | 6·25 | — | 30·00 | = 96·75 |
| 16. | Mt. Rosa, *Jelletite* | | | 38·09 | — | 33·41 | — | — | — | 28·61 | = 100·11 |
| 17. | Stokö, *brown* | | | 36·63 | 9·97 | 13·45 | 2·28 | 0·63 | 0·28 | 35·90 | H$_2$O 0·16 = 99·20 |
| 18. | " *blk.-grn.* | 3·64 | | 34·96 | 8·73 | 20·55 | — | 2·40 | *tr.* | 32·09 | Na$_2$O 1·27 = 100 |
| 19. | Franklin Furn., N. J. *Polyadelphite* | | | 34·83 | 1·12 | 28·73 | — | 8·82 | 1·42 | 24·05 | = 98·97 |
| 20. | Franklin Furn., N. J., *bn.* | | | 33·72 | 7·97 | 17·64 | — | 16·70 | — | 25·88 | ign. 0·08 = 101·99 |
| 21. | Sala, *Bredbergite* | 3·746 | | 36·73 | 2·78 | 25·83 | — | — | 12·44 | 21·79 | = 99·57 |
| 22. | *Calderite* | 3·735 | | 37·44 | 6·27 | 19·38 | 5·24 | *tr.* | 1·40 | 30·93 | = 100·66 |

[a] CrO$_3$.

| *Titaniferous.* | G. | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|---|---|
| 23. Frascati | | 35·84 | 1·04 | 6·24 | 23·12 | — | — | 1·04 | 32·72 | = 100 |
| 24. " | | 35·09 | 3·02 | 8·80 | 19·27 | 1·80 | — | 0·47 | 32·61 | = 101·06 |
| 25. Magnet Cove, Ark. | | 31·25 | 3·19 | — | 31·80 | — | — | 0·46 | 33·30 | = 100 |
| 26. Stokö | 3·85 | 31·51 | 3·52 | 2·01 | 26·68 | — | 2·15[a] | 0·38 | 30·78 | $Y_2O_3$ 0·38, $Na_2O$ 0·79, $H_2O$ 0·43 = 98·63 |
| 27. Oberbergen | | 35·82 | 4·95 | 5·41 | 20·14[b] | 2·55[b] | — | 1·71 | 29·50 | = 100·08 |
| 28. Oberschaffhausen | | 36·59 | 7·10 | 5·42 | 19·65 | 2·26 | 0·27 | 1·61 | 26·93 | = 99·83 |
| 29. Oberbergen | | 36·33 | 7·05 | 5·43 | 17·08 | 2·84 | 0·25 | 2·70 | 27·47 | = 99·15 |
| 30. Colorado | 3·689 | 30·71 | 8·11 | 2·26 | 22·67 | — | *tr.* | 0·30 | 34·29 | $CO_2$ 1·48 = 99·82 |
| 31. Henderson Co., N. C. | 3·738 | 35·56 | 4·58 | 4·43 | 20·51 | 1·88 | — | 0·17 | 31·90 | ign. 0·55 = 99·58 |
| 32. Oberwiesenthal | | 29·15 | 10·84 | 6·50 | 21·92 | — | — | 0·98 | 29·40 | = 98·79 |

[a] $Mn_2O_3$. [b] Estimated; 22·97 $Fe_2O_3$ + FeO, determined.

F. **Uvarovite.** Ouvarovite. Uwarowit. *Calcium-chromium Garnet.* Kalkchromgranat *Germ.* Formula $3CaO.Cr_2O_3.3SiO_2$ = Silica 35·9, chromium sesquioxide 30·6, lime 33·5 = 100. Aluminium takes the place of the chromium in part (Cr : Al = 5 : 2 in anal. 1). H. = 7·5. G. = 3·41–3·52. Color emerald-green.

**Anal.**—1, Dmr., Ann. Mines, **4**, 115, 1843; also Komonen, Erdmann, 5th Ed., p. 270. 2, Id., Bull. Soc. Min., **2**, 165, 1879. 3, Hunt, Rep. G. Canada, 497, 1863. 4, Harrington, Can. Nat., **9**, 305, 1880.

| *Uvarovite.* | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Cr_2O_3$ | FeO | MnO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Bisersk | 3·514 | 35·57 | 6·25[a] | — | 23·45 | — | — | — | 33·22 | = 98·49 |
| 2. Pic Posets | 3·43 | 36·20 | 10·20 | 9·60 | 6·50 | 8·16 | 0·50 | — | 27·50 | = 98·66 |
| 3. Orford | | 36·65 | 17·50 | — | 6·20 | 4·97 | — | 0·81 | 33·20 | ign. 0·30 = 99·63 |
| 4. Wakefield, Quebec | 3·342 | 37·50 | 18·65 | 1·07 | 4·95 | — | — | 0·52 | 36·13 | ign. 0·48 = 99·30 |

[a] Includes some $Fe_2O_3$.

**Pyr., etc.**—Most varieties fuse easily to a light brown or black glass; F. = 3 in almandite, spessartite, grossularite, and allochroite; 3·5 in pyrope; but uvarovite, the chrome-garnet, is almost infusible, F. = 6. Allochroite and almandite fuse to a magnetic globule. Reactions with the fluxes vary with the bases. Almost all kinds react for iron; strong manganese reaction in spessartite, and less marked in other varieties; a chromium reaction in uvarovite, and in most pyrope. Some varieties are partially decomposed by acids; all except uvarovite are after ignition decomposed by hydrochloric acid, and generally with separation of gelatinous silica on evaporation. Decomposed on fusion with alkaline carbonates.

As shown by Magnus, the density of garnets is largely diminished by fusion. Thus a Greenland garnet fell from 3·90 to 3·05 on fusion, and a Vilui grossularite from 3·63 to 2·95. Further a brownish red Arendal garnet, having G. = 4·058, was reduced by heating to G. = 4·046, and by fusion to 3·596–3·204, Church; and a Ceylon hessonite, having G. = 3·666, had G. = 3·682 after heating to incipient fusion, Church. Cf. Magnus, Pogg., **22**, 391, 1831; Kbl., Schw. J., **64**, 283, 1832; Church, J. Ch. Soc., **17**, 386, 1864.

**Obs.**—Garnet in crystals or rounded grains is very common in mica schist, gneiss, syenitic gneiss and hornblende and chlorite schist; occurs often, also, in granite, syenite, crystalline limestone, sometimes in serpentine, and occasionally in volcanic rocks, lava and tufas; further, occasionally observed in lithophyses of rhyolite and as a product of contact metamorphism.

Garnet is sometimes found in the massive form as a prominent constituent of a rock. A white variety (lime-alumina garnet) occurs, forming, with a little serpentine, a whitish garnet rock at Orford in Canada, having G. = 3·52–3·53. A similar *garnet-felsyte* exists in Bayreuth in Bavaria. At St. François in Canada there is a yellowish white and greenish white garnet rock, consisting of the same garnet along with pyroxene, in the proportion, according to T. S. Hunt, of 57·7 of the former to 40·7 of the latter, having G. = 3·33 (Rep. G. Can., 496, 1863). *Eclogyte* is a *garnet-euphotide*, consisting of a massive reddish garnet and grass-green smaragdite or omphacite. These garnet rocks are all very tough as well as heavy rocks.

Garnet crystals often contain inclusions of foreign matter, but only in part due to alteration; as, vesuvianite, calcite, epidote, quartz (f. 8); at times the garnet is a mere shell, or perimorph, surrounding a nucleus of another species. A black garnet from Arendal, Norway, contains both calcite and epidote; crystals from Tvedestrand are wholly calcite within, there being but a thin crust of garnet. Crystals from East Woodstock, Maine, are dodecahedrons with a thin shell of cinnamon-stone enclosing calcite; others from Raymond, Me., show successive layers of garnet and calcite. Many such cases have been noted.

Crystals of garnet in the form of thin flat disks are not infrequently observed embedded between plates of mica.

The garnet of granite, gneiss, granulyte, mica schists, and similar rocks is chiefly the iron-aluminium variety, *almandite*, but includes also andradite and the isomorphous varieties intermediate between them. *Grossularite* is especially common in crystalline limestone, where it is associated with vesuvianite, wollastonite, diopside, etc.; it occurs also in crystalline schists. *Pyrope* belongs peculiarly to peridotytes and the serpentines formed from them; occurs also in basalt. *Spessartite* occurs in granitic rocks, in quartzyte, in whetstone schists (Belgium); it has been noted with topaz in lithophyses in rhyolyte (Colorado). The black variety of andradite, *melanite*, is common in eruptive rocks, especially with nephelite, leucite, thus in phonolytes, leucitophyres, nephelinytes; it also occurs as a product of contact metamorphism. *Demantoid* occurs in serpentine. *Uvarovite* belongs particularly with chromite in serpentine; it occurs also in granular limestone.

8.

Garnet enclosing quartz, Heddle.

Many foreign localities of garnet have been mentioned in the preceding pages, under the head of *composition* and *varieties*. The best *cinnamon-stone* comes from Ceylon, in gneiss; also from Malsjö in Wermland, in crystalline limestone; on the Mussa-Alp in the Ala valley in Piedmont, with clinochlore and diopside; at Mittagshorn, Saasthal, Switzerland, with the same minerals, reddish brown in color, also from Zermatt; pale isabella-yellow at Auerbach; nearly colorless dodecahedral crystals at Gleinitz near Jordansmühl, Silesia; a brownish variety (*romanzovite*) at Kimito in Finland. A honey-yellow garnet in *octahedrons* occurs in Elba. Grossularite of pale greenish color comes from the banks of the Vilui in Siberia; in serpentine with vesuvianite, also from Cziklowa and Orawitza in the Banat; honey-yellow to green or brown crystals at Rezbánya; with vesuvianite and wollastonite in ejected masses at Vesuvius; in white or colorless crystals in Tellemark, in Norway, and the Shishimsk Mts., in the Ural; also whitish in a resinopal pseudomorph after coral in Tasmania; in groups of dark brown dodecahedrons at Mudgee, New South Wales; dark honey-yellow dodecahedrons with pyrite at Guadalcazar, and clear pink dodecahedrons (G.=3·46 Pirsson) at Morelos, Mexico (see p. 1035).

*Pyrope* occurs in serpentine (from peridotyte), a serpentine conglomerate, and in the sands of the region, near Meronitz, Třziblitz, and Podsedlitz, in Bohemia, where the variety used as a gem is obtained; also at Zöblitz and Greifendorf in Saxony; the valley of Krems (Křemže) near Budweis in Bohemia, in a serpentine rock; in the Vosges; Elie in Fife, Scotland, the "Elie rubies;" in the diamond diggings of South Africa, as at Kimberley, see p. 5 ("Cape rubies"); reported from Burma. *Almandite* is common in granite, gneiss, eclogyte, etc., in many localities in Saxony, Silesia, etc.; at Eppenreuth near Hof, Bavaria (in eclogyte); in dodecahedrons 3 to 4 inches through at Falun in Sweden, in hyacinth-red or brown crystals in the Zillerthal and Oetzthal, Tyrol. Precious garnet comes in fine crystals from Ceylon, Pegu, Brazil, and Greenland; also from the Sarwar mines in Rajputana and at Kakoria in Jaipur in British India. *Spessartite* is from Aschaffenburg in the Spessart, Bavaria; in the white feldspar of the granite of Elba; at St. Marcel, Piedmont; in pegmatyte at Vilate near Chanteloube, Haute-Vienne; at Broddbo, near Falun, in Sweden; Ilefeld in the Harz; in the whetstone slates of the Ardennes at Viel Salm, Ottrez, Salm-Chateau, Belgium; in Ross-shire and other points in Scotland. (Cf. Heddle, l.c.)

Among the varieties of the calcium-iron garnet, *andradite*, the beautiful green *demantoid* or "Uralian emerald" occurs in transparent greenish rolled pebbles, also in crystals, in the gold washings of Nizhni-Tagilsk in the Ural: also in the stream Bobrovka, 10 versts S.W. from Poldnevaya in the Sisersk on the west slope of the Ural; first found in loose pieces, later in a serpentine rock, embedded in fibrous serpentine; green crystals occur at Schwarzenberg, Saxony; brown to green crystals at Morawitza and Dognacska; emerald-green at Dobschau; in the Ala valley, Piedmont, the yellow to greenish *topazolite*, with its characteristic vicinal hexoctahedron (ζ). *Allochroite*, an apple-green and yellowish variety, of different shades, occurs at Zermatt, in geodes of crystals in chlorite schist; brilliant black crystals (*melanite*) and also brown, at Vesuvius on Mte. Somma; and in a volcanic tufa at Frascati near Rome; in Baden at the Kaiserstuhl; Pic d'Espada and that of Ereslids near Barèges in the Hautes-Pyrénées (*Pyreneite*). *Aplome* occurs in yellowish and brownish green crystals at Schwarzenberg in Saxony, and on the borders of the Lena in Siberia; brown to black crystals, highly modified, in the Pfitschthal, Tyrol; other localities are Långban in Sweden, Pitkäranta in Finland, Arendal in Norway, whence very large dodecahedral crystals are obtained. *Uvarovite* is found at Saranovskaya near Bisersk, also in the vicinity of Kyshtymsk, Ural, lining cavities or fissures in chromic iron; at Hanle, in Rupshu in the western Himalayas; at Jordansmühl, Silesia; Pic Posets near Vénasque in the Pyrenees on chromite. It is named after the Russian Count Uvarov.

Near Cauterets, in the Hautes-Pyrénées, large crystals of brown garnet have a nucleus, easily separable, of dull green crystallized vesuvianite; the containing rock is a compact gray limestone.

In N. America, in *Maine*, beautiful yellow crystals or cinnamon-stone (with vesuvianite) at Parsonsfield, Phippsburg, and Rumford; manganesian garnet at Phippsburg, as well as fine yellow garnet; in mica slate near the bridge at Windham, with staurolite; in granite veins at Streaked Mountain, along with beryl; in large reddish brown crystals at Buckfield, on the estates of Mr. Waterman and Mr. Lowe; handsome red garnets at Brunswick. In *N. Hamp.*, at Hanover, small clear crystals in syenitic gneiss; blood-red dodecahedrons at Franconia, in geodes in massive garnet, with calcite and magnetic iron; at Haverhill, in chlorite, some 1½ in.; at Warren, beautiful cinnamon garnets with green pyroxene; at Unity, on the estate of J. Neal, with actinolite and magnetite, and at Lisbon, near Mink Pond, in mica slate with staurolite; at Grafton, ¼ to 1 in. in diameter. In *Vermont*, at New Fane, large crystals in chlorite slate; also at Cabot and Cavendish. In *Mass.*, at Carlisle, geodes of transparent cinnamon-brown crystals similar to figure 4, with scapolite in limestone; also in gneiss at Brookfield and Brimfield; in crystals at Bedford, Chesterfield, with the Cummington cyanite, and at the beryl locality of Barre; fine dark red or nearly black trapezohedral crystals at Russell, sometimes very large; red garnets at Chester. In *Conn.*, trapezohedrons, ¼ to 1 in., in mica slate, at Reading and Monroe; dodecahedrons at Southbury; at Haddam, crystals of manganesian garnet, often 2 in. through, with chrysoberyl; at Lyme, large blackish brown crystals in limestone; near New Haven, at Mill Rock in trap at junction with sandstone in pale yellow brown crystals (f. 6) resembling topazolite, also melanite (anal. 10) at East Rock on faces of trap in rosettes of dodecahedrons with magnetite, etc; manganesian garnet at Branchville.

In *N. York*, in mica slate, in Dover, Dutchess Co., small; at Roger's Rock, crystallized and massive, and colophonite of yellow, brown, and red colors, abundant; brown crystals at Crown Point, Essex Co.; colophonite as a large vein in gneiss at Willsboro, Essex Co., with wollastonite and green coccolite, and also at Lewis, 10 m. south of Keeseville; in Middletown, Delaware Co., large brown cryst.; a cinnamon variety, crystallized and massive, at Amity; on the Croton aqueduct, near Yonkers, in small rounded crystals, and a beautiful massive variety—the latter, when polished, forms a beautiful gem; oil-green dodecahedrons at the magnetite iron mine, Brewster, Putnam Co.; a large garnet weighing nearly 10 lbs. and with a maximum diameter of 6 inches was found in an excavation in New York City, in West 35th Street, in 1885. In *N. Jersey*, at Franklin, black, brown, yellow, red, and green dodecahedral garnets; also near the Franklin furnace polyadelphite. In *Penn.*, in Chester Co., at Pennsbury, fine dark brown crystals with polished faces, in granite; near Knauertown, at Keims' mine, in handsome lustrous crystals; at Chester, brown; in Concord, on Green's Creek, resembling pyrope; in Leiperville, red; at Mineral Hill, fine brown; at Warren, black; at Avondale quarry, fine hessonite; uvarovite at Woods' chrome mine, Lancaster Co. In *Delaware*, cinnamon-stone in trapezohedrons, at Dickson's quarry, 7 m. from Wilmington. In *Virginia*, beautiful transparent spessartite, used as a gem, at the mica mines at Amelia Court House. In *N. Carolina*, fine cinnamon-stone at Bakersville; red garnets in the gold washings of Burke, McDowell, and Alexander counties; also mined near Morgantown and Warlich, Burke Co., to be used as "emery," and as "garnet-paper;" a garnet-rock at Burnsville, Yancey Co. In *Kentucky*, fine pyrope in the peridotyte of Ellis Co. In *Arkansas*, at Magnet Cove, a titaniferous melanite with schorlomite. Large dodecahedral crystals entirely altered to chlorite occur at the Spurr Mt. iron mine, Lake Superior (Pumpelly).

In *Colorado*, at Nathrop, fine spessartite crystals in lithophyses in rhyolyte with quartz and topaz. In large dodecahedral crystals up to 14½ lbs. in weight at Ruby Mt., Salida, Chaffee Co., the exterior is usually green from a layer of a chlorite (see p. 660) due to alteration. In *Nevada*, small but fine red garnets in Ruby Valley, Elko Co.; at Black Cañon, Colorado R.; almandite in White Pine Co. In *Arizona*, yellow-green crystals in the Gila cañon; pyrope on the Colorado River in the western part of the territory. *New Mexico*. fine pyrope on the Navajo reservation associated with chrysolite and a chrome-pyroxene. In *California*, green with copper ore, Hope Valley, El Dorado Co., on Rogers' claim; also with copper ore in Los Angeles Co., in Mt. Meadows; uvarovite, in crystals on chromite, at New Idria; uvarovite in serpentine with chromite on the American river below Towle's station on the Central Pacific R.R. Common garnets at many points. Fine crystals (f. 4) of ideal symmetry of a rich red color and an inch or more in diameter occur in the mica schists at Fort Wrangell, mouth of the Stickeen R., in *Alaska*.

In *Canada*, at Marmora, dark red; at Grenville, a cinnamon-stone; an emerald-green chrome-garnet at Orford, Quebec, in granular masses and druses of minute transparent dodecahedral crystals, with millerite and calcite; and in the same vicinity large cinnamon-red and yellowish crystals of garnet along with pyroxene; fine colorless to pale olive-green, or brownish crystals, at Wakefield, Ottawa Co., Quebec, with white pyroxene, honey-yellow vesuvianite, etc., also others bright green carrying chromium; dark red garnet in the townships of Villeneuve (spessartite) and Templeton; pale yellow at N. Elmsby.

In jewelry, the lighter clear garnets are often called hyacinth. The yellowish is the *Jacinta la bella;* a yellowish crimson, the *Guarnaccino;* and another very similar, *Vermeille*, or *Hyacinth-Garnet;* the red, with a violet tinge, *Rubino-di-rocca*, and also *Grenat Syrian* (from Syriam in Pegu), and probably the *Amethystizontes* of Pliny. The deep and clear red, like Burgundy wine in shade, is the true *precious garnet*, which is either pyrope or almandite. The ancient name ἄνθραξ, meaning *a burning coal*, alludes to the internal fire-like color and reflection, and was applied also to some ruby. The Latin name *carbunculus*, from *carbo, coal*, has the same signification.

**Alt.**—Garnets containing ferrous iron often become rusty and disintegrated through the oxidation of the iron, and sometimes are altered, more or less completely, to *limonite, magnetite*, or *hematite*. The action of waters containing traces of carbon dioxide and carbonates and silicates in solution results in the same changes nearly as with pyroxene, producing at different times a loss, or alteration, of bases, or by a further change and the addition of water, *steatite*, *serpentine, chlorite.* The lime in the lime garnets may be taken up by the carbonic acid of the waters; and if magnesia is combined with the carbonic acid, it may take the place of the lime, and thus give rise to a *serpentine* or *steatite* pseudomorph, or to a *chlorite,* if the iron partly remains. Alkaline carbonates seldom produce the changes, for alkaline pseudomorphs are rare. An excess of silica is to be expected in analyses, according to Bischof, since part of the bases is often lost through incipient change. Quartz also occurs with the form of garnet.

The common iron-aluminium garnet is especially liable to alteration, and besides the changes noted above, pseudomorphs of scapolite, mica, oligoclase, epidote, amphibole have been noted (cf. Cathrein, below). The calcium-iron garnet yields pseudomorphs of epidote, chlorite, serpentine, orthoclase.

The magnesium-aluminium garnet, pyrope, is also frequently altered, forming chlorite, serpentine, and various more or less definite substances. Schrauf's *kelyphite* (Vh. G. Reichs., 244, 1879, Zs. Kr., **6**, 359, 1882) forms a zone about a nucleus of pyrope (hence from *κέλυφος, a nut shell*) at Krems, Bohemia. Its composition is given by the analysis below, but Lasaulx (l. c.) has shown that it is not a homogeneous substance.

| | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | |
|---|---|---|---|---|---|---|---|---|---|
| *Kelyphite* | G.=3·064 | 40·41 | 13·35 | 2·47 | 7·02 | 0·31 | 27·40 | 5·05 | ign. 2·21, $Cr_2O_3$ 1·75=99·97 |

On the alteration of garnet, see Blum, Pseudomorphosen, Roth, Ch. Geologie, **1**; also the following: Helland, Pogg., **145**, 480, 1872; Saualpe, Niedzwiedski, Min. Mitth., 162, 1872; Lsx., Ber. nied. Ges., July 3, 1882; serpentine region near Budweis, Bohemia, Schrauf, Zs. Kr., **6**, 321, 1882, and Lsx., **8**, 303, 1883; altered garnets in amphibolyte, Tyrol, Cathrein, Zs. Kr., **10**, 433, 1885; Lake Superior, crystals altered to chlorite, Pumpelly, Am. J. Sc., **10**, 17, 1875; L. Superior and Colorado, Penfield and F. L. Sperry, Am. J. Sc., **32**, 307, 1886.

For the analyses of the various kinds of "chlorite" produced by the alteration of garnet, *e.g.* that of L. Superior, Salida, Col., see under the CHLORITE GROUP, p. 660.

**Artif.**—Obtained artificially with difficulty, except the manganesian variety, spessartite, which has been formed by Gorgeu from fusion of the constituents in magnesium chloride; also by Bourgeois with arborescent crystallites of hausmannite. The fusion of garnet ordinarily results in the separation into such compounds as pyroxene, melilite, monticellite, scapolite, anorthite. Melanite with nephelite has been formed, however, from fusion by Fouqué and Lévy. Also early reported that melanite garnets have been obtained in a glass proceeding from the fusion of vesuvianite (Klaproth) and of a melanite from Frascati (by Kobell). Miller mentions the occurrence of garnet in crystals as a furnace product. Cf. Bourgeois, Ann. Ch. Phys., **29**, 458, 1883, and Reprod. Min., 121, 1884; Doelter, Jb. Min., **1**, 158, 1884; Fouqué & Lévy, Bull. Soc. Min., **2**, 105, 1879, also Synth. Min., 121, 1882; Gorgeu, Bull. Soc. Min., **6**, 283, 1883.

**Ref.**—[1] See Bauer, Zs. G. Ges., **26**, 119, 1874, for list, early authorities, localities, etc. [2] Websky, Jordansmühl, Zs. G. Ges., **21**, 753, 1869. [3] Bauer, l. c. [4] E. S. D., New Haven, Am. J. Sc., **14**, 218, 1877. [5] Rath, Pfitschthal, other planes with anomalous indices are noted, Zs. Kr., **2**, 173, 1878. [6] Schumacher, Zs. G. Ges., **30**, 493, 1878. [7] Rath, Piz Alpetta, Zs. Kr., **5**, 495, 1881. [8] E. Scc., Tiriolo, Rend. Acc. Linc., **2**, 182, 1886. [9] Cathrein, Rothenkopf, Tyrol, Min. Mitth., **10**, 55, 1888. [10] Wiik, Min.-Saml. Helsingfors, p. 33, 1887. [11] Cathrein, grossularite, Le Selle, Tyrol, Min. Mitth., **10**, 397, 1888.

[12] *Twins,* Arzruni, Pitkäranta, he shows also that the supposed twins of Kobell with tw. pl. *o* are only accidental associations, Vh. Min. Ges., **23**, 126, 1887. [13] *Parting* ‖ *d,* Mügge, Jb. Min., **1**, 239, 1889.

[14] *Optical anomalies,* Wichmann, Zs. G. Ges., **27**, 749, 1875; Hirschwald, Min. Mitth., 240, 1875; Lsx., Jb. Min., 630, 1876; Mld., Ann. Mines, **10**, 100, 1876; Btd., Bull. Soc. Min., **4**, 12, 1881; Klein, Jb. Min., **1**, 87, 1883, **1**, 200, 1887; G. Nordenskiöld, G. För. Förh., **12**, 350, 1890; Bgr., Zs. Kr., **16**, 170, 1890. [15] *Refractive indices,* quoted by Rosenbusch, Mikr. Phys., 260, 1885; cf. also Dx., N. R., 8, 1867. *Absorption spectra,* Vogel, Ber. Ch. Ges., **10**, 373, 1877. *Specific heat,* Öberg, Öfv. Ak. Stockh., **42**, No. 8, 43, 1885.

TRAUTWINITE *E. Goldsmith,* Proc. Ac. Philad., pp. 9, 348, 365, 1873. An impure uvarovite (Genth) occurring with chromite from Monterey Co., Cal.

**371. SCHORLOMITE.** *Shepard,* Am. J. Sc., **2**, 251, 1846. Ferrotitanite *Whitney,* J. Nat. Hist. Boston, **6**, 45, 1849. Schorlamit *Rg.*

Iwaarit *Kutorga,* 1851. *N. Nd.*, Verz. Finl. Min., 1852. Ivaarite.

Isometric, in trapezohedrons and dodecahedrons (?). Usually massive, without cleavage.

Fracture conchoidal. H. = 7–7·5. G. = 3·81–3·88. Luster vitreous. Color black, sometimes tarnished blue, and with pavonine tints. Streak grayish black. Optically isotropic like garnet, Dx.

**Comp.**—Probably analogous to garnet, $3CaO.(Fe,Ti)_2O_3.3(Si,Ti)O_2$.

Cf. Rg., Min. Ch., Erg., 201, 1886, Koenig, Proc. Acad. Philad., 355, 1886.

**Anal.**—1, Whitney, l. c. 2, Rg., Min. Ch., 672, 1875. 3, Knop, Zs. Kr., **1**, 58, 1877. 4, Koenig, l. c. Also 5th Ed., p. 390.

| | | G. | $SiO_2$ | $TiO_2$ | $Fe_2O_3$ | FeO | CaO | MgO | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | Magnet Cove | 3·807 | 25·66 | 22·10 | 21·58 | — | 29·78 | — | = 99·12 |
| 2. | " " | 3·783 | 26·09 | 21·34 | 20·11 | 1·57 | 29·38 | 1·36 | = 99·85 |
| 3. | " " | | 26·10 | 20·52 | 21·95 | | 29·35 | 1·47 | = 99·39 |
| 4. | " " | 3·876 | 25·80 | 12·46 | 23·20 | 0·46[a] | 31·40 | 1·22 | $Ti_2O_3$ 4·44, $Al_2O_3$ 1·00 = 99·98 |

[a] MnO.

The mineral was first correctly described and analyzed by Whitney, l. c. Shepard made it a hydrous silicate of iron sesquioxide, yttria, and perhaps thoria. Koenig showed that it could be referred to the Garnet Group, an idea earlier suggested by Rg. and others.

**Pyr., etc.**—B.B. fuses quietly at 3 to a black glass. Reactions for iron with the fluxes. Fused with salt of phosphorus on charcoal, with tin, in the inner flame, gives a violet bead. Gelatinizes with hydrochloric acid, the solution becoming violet when boiled with metallic tin (titanium).

**Obs.**—In small masses with elæolite and brookite in the Ozark Mts., Magnet Cove, Arkansas. It occurs intimately associated with black garnet forming parts of garnet crystals and probably has itself the same form. A titaniferous garnet resembling it occurs in the Kaiserstuhl, near Oberschaffhausen, in phonolyte. Cf. Knop, l. c. and analyses, p. 444. Named from a resemblance to schorl (black tourmaline).

IVAARITE *N. Nordenskiöld*, Beskr. Finl. Min., 101, 1855. Has the characters of schorlomite, and like it is found with elæolite. It occurs both massive and in garnet-like crystals, is lustrous black and opaque, with adamantine luster. H. = 6·0, and G. = 3·67–3·69. The mineral is stated on the basis of an unpublished analysis of Thoreld to have the percentage composition (calculated): $SiO_2$ 29·15, $TiO_2$ 18·98, $Fe_2O_3$ 25·26, CaO 26·61 = 100, which corresponds very closely to schorlomite. B.B. fuses to a black glass. From Ivaara in Kuusamo, Finland.

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## MONOCLINIC SPECIES RELATED TO THE FOREGOING.

Partschinite and Agricolite have respectively the composition of spessartite and eulytite. Both species need further examination.

**372. PARTSCHINITE.** Partschin *Haid.*, Ber., **3**, 440, 1847, Ber. Ak. Wien, **12**, 480, 1854.

Monoclinic. In small dull crystals somewhat resembling augite.

**Forms:** *a* (100, *i-ī*), *c* (001, *O*), *m* (110, *I*), *e* (011, 1-ì), *p* ($\bar{1}12$, ½). Angles (meas. Foetterle) *mm'''* = 88° 8', *ac* = 52° 16', *ee'* = 64°, also (calc.) *cp* = 53° 8', *pp'* = 76° 34'.

Fracture subconchoidal. H. = 6·5–7. G. = 4·006 Hauer. Luster a little greasy, feeble. Color yellowish, reddish. Subtranslucent.

**Comp.**—$(Mn,Fe)_3Al_2Si_3O_{12}$ like spessartite.

**Anal.**—1, 2, Hauer. Another incomplete analysis gave 46·72 p. c. $SiO_2$.

| $SiO_2$ | $Al_2O_3$ | FeO | MnO | CaO | $H_2O$ |
|---|---|---|---|---|---|
| 35·28 | 19·03 | 14·38 | 29·11 | [1·82] | 0·38 = 100 |
| 34·89 | 18·95 | 13·86 | 29·34 | 2·77 | |

**Obs.**—In very small dull crystals and rounded fragments, in the auriferous sands of Oláhpian, Transylvania; attention was early called to them by Breithaupt.

**373. AGRICOLITE.** *Frenzel*, Jb. Min., 791, 947, 1873; 686, 1874.

Monoclinic, Groth. $\beta = 70°$. In globular or semi-globular forms, with radiated or fibrous structure. Also in indistinct groups of crystals. Soft, brittle, heavy. Luster adamantine, greasy. Colorless to wine-yellow, hair-brown.

**Comp.**—As for eulytite, $Bi_4Si_3O_{12}$.

**Anal.**—Frenzel, l. c.

$SiO_2$ 16·67 $Bi_2O_3$ 81·82 $Fe_2O_3$ 0·90 = 99·39

**Obs.**—Occurs at Johanngeorgenstadt on quartz, associated with native bismuth, cloanthite, bismite; also at the mine Neuglück, Schneeberg.

Includes, according to Frenzel, the *arsenwismuth* of Breithaupt. Arsenik-Wismuth *Wern.* Breith. Letzt. Min. Syst., 23, 62, Hoffm., **4**, 65, 1817. Formerly included with eulytite.

Named for the Saxon mineralogist, Georg Agricola (1490–1555).

## 5. Chrysolite Group. $R_2SiO_4$. Orthorhombic.

| | | | |
|---|---|---|---|
| 374. | Monticellite | $CaMgSiO_4$ | $\breve{a} : \bar{b} : \dot{c} = 0·4337 : 1 : 0·5758$ |
| 375. | Forsterite | $Mg_2SiO_4$ | $0·4656 : 1 : 0·5865$ |
| | Boltonite | | |
| 376. | Chrysolite | $(Mg,Fe)_2SiO_4$ | |
| | Hyalosiderite | | |
| 376A. | Hortonolite | $(Fe,Mg,Mn)_2SiO_4$ | |
| 376B. | Titan-Olivine | | |
| 377. | Fayalite | $Fe_2SiO_4$ | $0·4584 : 1 : 0·5793$ |
| 378. | Knebelite | $(Fe,Mn)_2SiO_4$ | |
| 379. | Tephroite | $Mn_2SiO_4$ | $0·4600 : 1 : 0·5939$ |
| 379A. | Roepperite | $(Fe,Mn,Zn)_2SiO_4$ | |

In form the species of the Chrysolite Group, $R_2SiO_4$, are closely related in angle to Chrysoberyl, $BeAl_2O_4$; also somewhat less closely to the species of the Diaspore Group, $H_2Al_2O_4$, etc. Cf. Brögger, Zs. Kr., **18**, 377, 1890.

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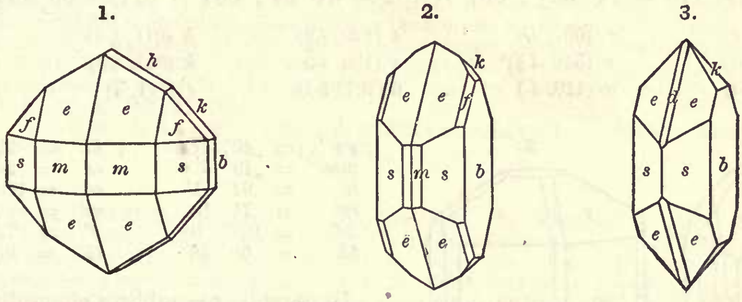
**374. MONTICELLITE.** *Brooke*, Phil. Mag., **10**, 265, 1831. Batrachit *Breith.*, Char., **307**, 1832. Sacchit [misprint for Scacchit?] *N. Nordenskiöld,* Atom. Ch. Min. Syst., 94, 1848.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·43375 : 1 : 0·57576$ Rath[1].
$100 \wedge 110 = 23° 27'$, $001 \wedge 101 = 53° 0\frac{1}{2}'$, $001 \wedge 011 = 29° 55\frac{5}{6}'$.

**Forms**[1]: *m* (110, *I*) *d* (101, 1-ĭ) *k* (021, 2-ĭ) *f* (121, 2-2̆)
*b* (010, *i*-ĭ) *s* (120, *i*-2̆) *h* (011, 1-ĭ) *e* (111, 1)

| | | | |
|---|---|---|---|
| *mm'''* = 46° 54' | *hh'* = 59° 52' | *ff'* = 82° 4' | *ee'''* = *38° 13' |
| *ss'* = 98° 7' | *kk'* = 98° 3' | *ee''* = 110° 42' | *me* = *34° 39' |
| *dd'* = 106° 1' | *ee'* = 98° 0' | *ff''* = 120° 43' | *ff'''* = 69° 26' |



1, Vesuvius, Rath. 2, Monzoni, Id. 3, Magnet Cove, Pirsson.

Crystals like chrysolite in habit (f. 1–3). Also in embedded crystalline grains and cleavable massive.

Cleavage: *b* distinct. Fracture subconchoidal to uneven. Brittle. H=5–5·5. G. = 3·03–3·25. Luster vitreous, slightly resinous in the massive variety. Colorless, yellowish gray, pale greenish gray, and whitish. Streak uncolored. Transparent to translucent.

**Var.**—(1) *Monticellite,* in colorless to yellowish gray crystals; the original from Vesuvius; G. = 3·119–3·245.

(2) *Batrachite,* cleavable massive, of a pale greenish gray color, or whitish; G. = 3·033, Breith.

**Comp., Var.**—$CaMgSiO_4$ or $CaO.MgO.SiO_2$ = Silica 38·5, magnesia 25·6, lime 35·9 = 100. Iron replaces part of the magnesium.

**Anal.**—1, Rg., Pogg., **109**, 569, 1860. 2, Id., ib., **51**, 446, 1840. 3, Ratn, ib., **155**, 32, 1875. 4, Genth, after deducting 4·7 p. c. apatite, Am. J. Sc., **41**, ——, 1891.

| | | | $SiO_2$ | FeO | MnO | MgO | CaO | ign. | |
|---|---|---|---|---|---|---|---|---|---|
| 1. *Monticellite* | G. = 3·119 | | 37·89 | 5·61 | — | 22·04 | 34·92 | — | = 100·46 |
| 2. *Batrachite* | | | 37·69 | 2·99 | — | 21·79 | 35·45 | 1·27 | = 99·19 |
| 3. " | G. = 3·054 | $\frac{2}{2}$ | 38·25 | 4·30 | — | 23·05 | 34·75 | — | = 100·35 (ign. 1·31) |
| 4. Magnet Cove | G. = 3·108 | $\frac{2}{2}$ | 35·14 | 5·25 | 1·17 | 21·65 | 34·20 | 2·40 | $Al_2O_3$ 0·19 = 100 |

A chrysolite from the paleopicryte of Dillenburg, Nassau, gave Öbbeke: $SiO_2$ 42·53, MnO 6·48, MgO 35·68, CaO 14·09 = 98·78, Jb. Min., 845, 1877.

**Pyr., etc.**—B.B. rounded only on the edges. Soluble in dilute hydrochloric acid to a clear solution, which on evaporation gelatinizes.

**Obs.**—Occurs in crystals embedded in granular limestone with mica and augite, on Mte. Somma; very rare, most so-called monticellite being simply chrysolite. In small masses (*batrachite*) containing calcite and black spinel at the Toal dei Rizzoni, on the south side of Mte. Monzoni in the Tyrol. Also on the Pesmeda Alp in the same region.

Monticellite also occurs in crystals (f. 3 and anal. 4), and in grains embedded in calcite, at Magnet Cove, Arkansas; the crystals have a pale yellowish gray color and are of considerable size, up to 1 inch in length.

*Monticellite* was named after the Italian mineralogist, T. Monticelli (1759–1846); *Batrachite* from *βάτραχος*, *frog*, in allusion to the color.

**Alt.**—The crystals from Tyrol are often altered to serpentine (anal. 1), also in part consisting of an aggregate of minute fassaite crystals (anal. 2). There is a remarkable similarity in form, as noted by Rath, between the form of the original fassaite of the locality and the altered monticellite. Cf. Rath, l. c.

| | | $SiO_2$ | $Al_2O_3$ | FeO | CaO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. *Serpentine* | G. = 2·617 | 41·31 | 1·34 | 5·73 | 6·47 | 33·08 | 12·35 | = 100·28 |
| 2. *Fassaite* | G. = 2·960 | 47·69 | 7·01 | 3·62 | 24·57 | 16·10 | 1·05 | = 100·04 |

**Ref.**—[1] Rath, Pogg., Erg.-Bd., **5**, 434, 1870; **155**, 24, 1875.

### 375. FORSTERITE.

*Lévy*, Ann. Phil., **7**, 59, 1824. Peridoto bianco *Scacchi*, Distrib. Sist. Min., 63, Napoli, 1842. Péridot blanc *Fr.* White Olivine. Boltonite *Shep.*, Min., **1**, 78, 1835.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·46476 : 1 : 0·58569$ Bauer[1].

$100 \wedge 110 = 24° 55\frac{2}{3}'$, $001 \wedge 101 = 51° 34'$, $001 \wedge 011 = 30° 21\frac{1}{2}'$.

**Forms**[2]:

*a* (100, *i*-$\bar{i}$)

*b* (010, *i*-$\breve{i}$)

*c* (001, *O*)

*v* (540, *i*-$\bar{\frac{5}{4}}$)[3]

*m* (110, *I*)

*s* (120, *i*-$\breve{2}$)

*r* (130, *i*-$\breve{3}$)

*d* (101, 1-$\bar{i}$)

*h* (011, 1-$\breve{i}$)

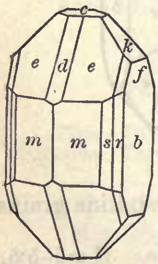
*k* (021, 2-$\breve{i}$)

*e* (111, 1)

*f* (121, 2-$\breve{2}$)

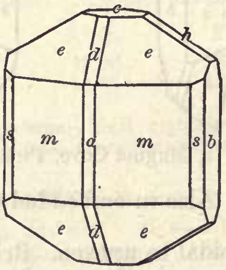
*l* (131, 3-$\breve{3}$)

1.



1, Baccano, Strüver.

2.



2, Ural (anal. 7), Kk.

$vv''' = 40° 47\frac{1}{2}'$

$mm''' = 49° 51'$

$ss' = 94° 11'$

$rr' = 71° 18'$

$dd' = 103° 8'$

$hh' = 60° 43'$

$kk' = 99° 1\frac{1}{2}'$

$ee' = 94° 48'$

$ee'' = 108° 31'$

$ee''' = 40° 0\frac{1}{2}'$

$ff''' = 72° 7'$

$ll''' = 95° 3'$

In crystals resembling chrysolite; often with *b* prominent; sometimes in twins. Also in embedded imperfect crystals, grains, or masses.

Cleavage: *b* distinct, *c* less so. Fracture subconchoidal to uneven. H. = 6–7. G. = 3·21–3·33. Luster vitreous. Transparent to translucent. Color white, yellowish white, wax-yellow, grayish, bluish gray, greenish; sometimes becoming yellowish on exposure when not in distinct crystals. Streak uncolored. Optically +. Ax. pl. ∥ *c*. Bx ⊥ *a*. Axial angles, Dx.[4]

$2H_{a.r} = 100° 52'$ $2H_{o.r} = 111° 28'$ $\therefore \beta_r = 1·657$ $2V_r = 86° 1'$

$2H^{a.y}_{o.y} = 101° 2'$, $111° 13'$ $\beta_y = 1·659$ $2V_y = 86° 10'$

$2H_{a.bl} = 101° 30'$ $2H_{o.bl} = 110° 43'$ $\beta_{bl} = 1·670$ $2V_{bl} = 86° 32'$

**Var.**—1. *Forsterite,* white crystals from Vesuvius, etc.; also in colorless grains; H. = 7; G. = 3·243 Rg.

2. *Boltonite,* in embedded grains or imperfect crystals of a pale greenish or yellowish color, showing distinct cleavage, from Bolton, etc., Mass.; H. = 6-6·5; G. = 3·208-3·328 Smith.

**Comp.**—Magnesium orthosilicate, $Mg_2SiO_4$ or $2MgO.SiO_2$ = Silica 42·9, magnesia 57·1=100. Iron is present in small amount, and thus it passes into ordinary chrysolite, for no sharp line can be drawn between the two species; see further pp. 452, 453.

**Anal.**—1, Rg., Pogg., **109**, 568, 1860. 2, Rath, ib., **155**, 34, 1875. 3, 4, Mierisch, Min. Mitth., **8**, 119, 1886. 5, Knop, Zs. Kr., **13**, 240, 1887. 6, Helland, Pogg., **148**, 329, 1873. 7, Nikolayev, Vh. Min. Ges., **17**, 309, 1882. 8, J. L. Smith, Am. J. Sc., **18**, 372, 1854. 9, Brush, ib., **27**, 395, 1859.

| | | $SiO_2$ | MgO | FeO | CaO | ign. |
|---|---|---|---|---|---|---|
| 1. Mte. Somma | G. = 3·243 | 42·41 | 53·30 | 2·33 | — | — = 98·04 |
| 2. " " | G. = 3·191 | 42·33 | 54·90 | 1·57 | *tr.* | — = 98·80 |
| 3. " " | | 41·09 | 52·51 | 3·80 | — | 0·24 $Na_2O$ 0·30, $K_2O$ 0·18 = 98·12 |
| 4. " " | | 41·85 | 56·17 | 1·07 | — | 0·19 $Na_2O$ 0·12, $K_2O$ 0·40 = 99·80 |
| 5. Kaiserstuhl | | 41·88 | 49·83 | 4·56 | — | — MnO 1·73, $Al_2O_3$ & loss 2·00=100 |
| 6. Snarum | G. = 3·22 | 41·32 | 54·69 | 2·39 | — | 0·20 $Al_2O_3$ 0·28, CrO 0·05 = 98·93 |
| 7. Ural | G. = 3·191 | 40·11 | 57·73 | 0·22 | — | 0·16 $Fe_2O_3$ 1·18 = 99·40 |
| 8. *Boltonite* | G. = 3·328 | 42·75 | 51·70 | 2·28 | — | 1·90 $Al_2O_3$ 0·18 = 98·81 |
| 9. " | G. = 3·21 | 42·82 | 54·44 | 1·47 | 0·85 | 0·76 = 100·34 |

**Pyr., etc.**—B.B. unaltered and infusible. Boltonite gives traces of moisture in the closed tube and becomes colorless. Decomposed by hydrochloric acid with separation of gelatinous silica.

**Obs.**—*Forsterite* occurs in implanted crystals, with spinel and augite in ejected masses on Mte. Somma, Vesuvius; also in the Albani Mts. at the crater of Baccano, with wollastonite, garnet, spinel, etc.; with serpentine at Snarum, at Norway; in a bluish calcite at the Nikolaye-Maximilian mine, Zlatoust, Ural; in the limestone of the Schelinge Matte, Kaiserstuhl, in grains of a dull yellow color.

*Boltonite* is disseminated through a whitish crystalline limestone, at Bolton, Mass.; also at Roxbury and Littleton, Mass.; its embedded masses or crystals are often over an inch through, and rectangular in section. Part of the boltonite is altered, and then softer and hydrous, with the composition of villarsite, see under chrysolite, beyond.

*Forsterite* was named by Lévy after Mr. J. Forster, founder of the Heuland cabinet.

**Artif.**—Artificial magnesium chrysolite has been made by Ebelmen, by fusing together in a porcelain furnace a mixture of silica and magnesia, with potassium carbonate, or boric acid. Ann. Ch. Phys., **33**, 56, 1851. Also later by Hautefeuille by fusing a mixture of silica, magnesia, and magnesium chloride, ibid., **4**, 129, 1869; again by Lechartier similarly, but using calcium chloride, C. R., **67**, 44, 1868.

**Ref.**—[1] Jb. Min., **1**, 23, 1887. [2] Mlr., 318, 1852; also Lévy, l. c. [3] Hbg., Min. Not., **1**, 21, 1856. [4] Dx., N. R., 81, 1867, Min., **2**, ix, 1874.

**376. CHRYSOLITE.** Smaragdus?, Beryllus?, pt. *Vet.* Topazos? pt. *Plin.* Not Chrysolithus [= Topaz] *Plin.*, **37**, 42. Chrysolit, Gemma pellucidissima colore viridi subflavo in igne fugaci (description also says quadrangular, infusible, etc.), *Wall.*, Min., 118, 1747. Peridot ordinaire [not the Oriental] *d'Argenville,* Orykt., 161, 1755. Gulgrön Topas = Chrysolit *Cronst.*, Min., 43, 1758. Chrysolite ordinaire *de Lisle,* Crist., 230, 1772, 2, 271, 1783 [not Peridot de Ceylan = Tourmaline ib., 2, 346]. Krisolith *Wern.*, Bergm. J., 373, 1789 + Olivine (fr. basalt) [= Chrysolite des Volcans *Faujas.* Vivarais, 1778.] *Wern.*, ib., 55, 1790. Peridot *H.*, Tr., **3**, 1801. Hyalosiderit *Walchner,* Schw. J., **39**, 65, 1823. Glinkit *Romanovski,* Bergjournal Russ., Oct. 1847; ident. with Chrysolite, *Beck,* Vh. Min. Ges., 244, 1847.

Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c}$ = 0·46575 : 1 : 0·58651 Koksharov[1].

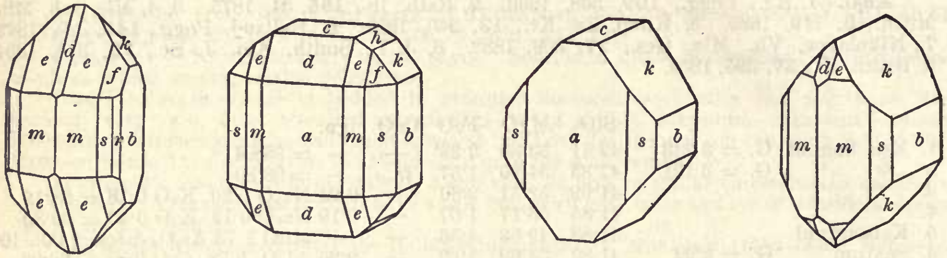
100 ∧ 110 = 24° 58′ 26″, 001 ∧ 101 = 51° 32′ 48″, 001 ∧ 011 = 30° 23′ 31″.

**Forms**[2]:
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)
*c* (001, *O*)
*m* (110, *I*)
*s* (120, *i*-2̆)
*r* (130, *i*-3̆)
*z* (140, *i*-4̆)
*β* (106, ⅙-ī)[4]
*v* (102, ½-ī)[4]
*d* (101, 1-ī)
*w* (012, ½-ĭ)[3]
*h* (011, 1-ĭ)
*k* (021, 2-ĭ)
*i* (041, 4-ĭ)
*q* (116, ⅙)[4]
*o* (112, ½)[4]
*e* (111, 1)
*g* (212, 1-2̄)
*f* (121, 2-2̆)
*l* (131, 3-3̆)

Also, on crystals from the Pallas Iron (Koksharov[4]) macrodome *γ* on edge *d/v*, and macropyramid *α* on edge *d/o*.

| | | | |
|---|---|---|---|
| $mm'$ = 49° 57′ | $dd'$ = 103° 6′ | $co$ = 34° 47′ | $ff'$ = 78° 30′ |
| $ss'$ = 94° 4′ | $ww'$ = 32° 41′ | $ce$ = 54° 15′ | $ll'$ = 63° 47′ |
| $rr'$ = 71° 11′ | $hh'$ = 60° 47′ | $cf$ = 59° 50½′ | $oo'''$ = 27° 52½′ |
| $zz'$ = 56° 27′ | $kk'$ = 99° 6′ | $cl$ = 65° 12′ | $ee'''$ = 40° 5′ |
| $\beta\beta'$ = 23° 42′ | $ii'$ = 133° 50′ | $oo'$ = 62° 17′ | $ff'''$ = 72° 13′ |
| $vv'$ = 64° 23′ | $cq$ = 13° 2′ | $ee'$ = 94° 44′ | $ll'''$ = 95° 9′ |

1. 2. 3. 4.

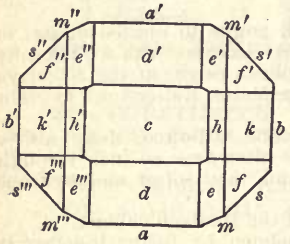


Figs. 1, Vesuvius, Rath. 2, *Oriental chrysolite,* Rose. 4, *Hyalosiderite,* Bauer.

Twins rare: (1) tw. pl. *h* (011)[5] with $c\underline{c}$ = 60° 47′, penetration-twins, sometimes repeated forming stellate trillings, similar to those of chrysoberyl; (2) tw. pl. *w* (012)[6] the vertical axes crossing at an angle of about 30° since $c\underline{c}$ = 32° 41′. Crystals often flattened ∥ *a* or *b*, less commonly elongated ∥ $\dot{c}$. Massive and compact, or granular; usually in embedded grains.

Cleavage; *b* rather distinct; *a* less so. Fracture conchoidal. Brittle. H. = 6·5–7. G. = 3·27–3·37, increasing with the amount of iron; up to 3·57 for hyalosiderite. Luster vitreous. Color green—commonly olive-green, sometimes brownish, grayish red, grayish green, becoming yellowish brown or red by oxidation of the iron. Streak usually uncolored, rarely yellowish. Transparent to translucent.

5.



Optically +. Double refraction strong. Ax. pl. ∥ *c*. Bx ⊥ *a*. Dispersion $\rho < v$, weak. Axial angles, Dx.[7]

$\alpha = 1{\cdot}661$ $\beta = 1{\cdot}678$ $\gamma = 1{\cdot}697$ for yellow (Na) ∴ $2V_y = 87° 46'$

$2H_{a.r} = 105° 58'$, $2H_{a.y} = 106° 21'$, $2H_{a.bl} = 107° 14'$, ∴ $2V_y = 88° 54'$, $2V_{bl} = 90°$ approx.
$2H_{o.r} = 108° 30'$, $2H_{o.y} = 108° 20'$, $2H_{o.bl} = 107° 57'$

**Var.**—1. *Precious.* Of a pale yellowish green color, and transparent. G. = 3·441, 3·351. Occasionally seen in masses as large as "a turkey's egg," but usually much smaller. It has long been brought from the Levant for jewelry, but the exact locality is not known.

2. *Common; Olivine* of Werner. Dark yellowish green to olive- or bottle-green. G. = 3·26–3·40; fr. Etna. Commonly disseminated in crystals or grains in basic igneous rocks, basalt and basaltic lavas, etc.

*Glinkite* is pale-green chrysolite from talcose schist; G. = 3·39–3·43 Herm.

3. *Hyalosiderite.* A highly ferruginous variety, anal. 32. It has $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}46815 : 1 : 0{\cdot}58996$, and $mm''' = 50° 10'$, $kk' = 99° 26'$, Bauer[8].

**Comp.**—$(Mg,Fe)_2SiO_4$ or $2(Mg,Fe)O.SiO_2$. The ratio of Mg : Fe varies widely, from 16 : 1, 12 : 1, etc., to 2 : 1 in hyalosiderite, and hence passing from fosterite on the one side to fayalite on the other. No sharp line can be drawn on either side. Titanium dioxide is sometimes present replacing silica; also tin and nickel in small quantities. Percentage composition, as follows:

| | $SiO_2$ | MgO | FeO | |
|---|---|---|---|---|
| Mg : Fe = 9 . 1 | 41·0 | 49·2 | 9·8 | = 100 |
| " = 5 : 1 | 39·8 | 44·3 | 15·9 | = 100 |
| " = 3 : 1 | 38·5 | 38·5 | 23·0 | = 100 |
| " = 2 : 1 | 37·2 | 33·1 | 29·7 | = 100 |

An olivine from the paleopicryte of the Schwarze Stein, Nassau, contains 14 p. c. CaO as analyzed by Oebbeke, see p. 450.

**Anal.**—1, Dingestedt, Min. Mitth., 130, 1873. 2, Velain, Bull. Soc. Min., **7**, 172, 1884. 3, F. W. Clarke, Am. J. Sc., **35**, 485, 1888. 4, Genth, Am. J. Sc., **33**, 199, 1862. 5, Clar, Min. Mitth., **5**, 85, 1883. 6, Rath, Pogg., **155**, 35, 1875. 7, Knop, Jb. Min., 698, 1877. 8, Stromeyer, Gel. Anz. Gött., 2078, 1824. 9, T. M. Chatard, Am. J. Sc., **32**, 125, 1886. 10, Phillip, Pogg., **141**, 512, 1870. 11, Ricciardi [Gazz. Ch. Ital., **11**, 144, 1881], Zs. Kr., **8**, 309. 12, L. V. Pirsson, priv. contr. 13, L. G. Eakins, Am. J. Sc., **40**, 315, 1890. 14, E. O. Hovey, priv. contr. 15, F. W. Mar, priv. contr. 16, Scharizer, Jb. G. Reichs., **34**, 707, 1884. 17, Leuchtenberg, Min. Russl., **6**, 58, 1870. 18, Inostranzev, Vh. Min. Ges., **4**, 310, 1869. 19, Kalle, Rg., Min. Ch., 427, 1875. 20, Müller, Min. Mitth., 36, 1877. 21, Harrington, Rep. G. Canada, 390, 1878. 22, Kinnicutt, Rep. Peabody Mus. Archæol., 3, 382, 1884. 23, Rg., Min. Ch., 427, 1875. 24, Kertscher, Doelter, Vulk. Gest. Capverd. Inseln, 73, 1882. 25, E. E. Schmid, Pogg., **84**, 501, 1851. 26, Beck, Vh. Min. Ges., 244, 1847. 27, Hunt, Am. J. Sc., **29**, 283, 1860. 28, Hjortdahl, Nyt Mag., **23**, 227, 1877. 29, Ziegenspeck, Inaug. Diss., p. 28, Jena, 1883. 30, E. S. D., Am. J. Sc., **3**, 49, 1872. 31, Meyer, Jb. Min., Beil.-Bd., **2**, 389, 1883. 32, Rosenbusch, Jb. Min., 50, 1872.

| | | G. | $SiO_2$ | MgO | FeO | |
|---|---|---|---|---|---|---|
| 1. | Vesuvius | 3·261 | 42·30 | 51·64 | 5·01 | $Al_2O_3$ 0·42, CaO 1·08 = 100·45 |
| 2. | Ile Bourbon | 3·364 | 39·96 | 49·18 | 6·28 | $Al_2O_3$ 2·33 CaO 2·05, = 99·80 |
| 3 | Douglas Co., Oregon | | 42·81 | 45·12 | 7·20 | NiO 0·26, $Fe_2O_3$ 2·61, $Cr_2O_3$ 0·79, [ign. 0·57 = 99·36 |
| 4. | Webster, N. C. | 3·266 | $\frac{3}{3}$ 41·17 | 49·16 | 7·35 | CaO 0·04, NiO 0·41, ign. 0·69, insol. [1·23 = 100·05 |
| 5. | Fehring. Styria | 3·359 | 42·45 | 49·17 | 8·48 | $Al_2O_3$ 0·30, ign. 0·85 = 101·25 |
| 6. | Vesuvius | 3·183 | 39·93 | 48·70 | 8·43 | MnO 1·03, $Al_2O_3$ 0·10 = 98·19 |
| 7. | Lützelberg | | 41·19 | 50·27 | 8·54 | = 100 |
| 8. | Oriental | 3·351 | 39·73 | 50·13 | 9·19 | $Mn_2O_3$ 0·09, NiO 0·32, $Al_2O_3$ 0·22 [= 99·68 |
| 9. | Elliot Co., Ky. | 3·377 | 40·05 | 48·68 | 7·14 | $TiO_2$ 0·07. $P_2O_5$ 0·04, $Fe_2O_3$ 2·99[a], [MnO 0·20, CaO 1·16, alk. 0·29, ign. 0·80 = 99·42 |
| 10. | Dreiser Weiher | 3·36 | 41·25 | 48·85 | 9·90 | = 100 |
| 11. | Etna | | 41·06 | 46·83 | 10·13 | $Al_2O_3$ 0·68, $H_2O$ 1·33 = 100·03 |
| 12. | Vesuvius | | 39·85 | 49·19 | 10·54 | = 99·58 |
| 13. | Kiowa, Kansas, *Meteor.* | 3·376 | 40·70 | 48·02 | 10·79 | $Fe_2O_3$ 0·18, NiO 0·02, MnO 0·14 [= 99 85 |
| 14. | Sandwich Is. | | 39·90 | 47·15 | 11·21 | = 98·26 |
| 15. | " " | | 40·01 | 48·09 | 11·12 | $TiO_2$ 0·12, NiO 0·22[b], $Al_2O_3$ 0·49[c] [= 100·05 |
| 16. | Jan Mayen | 3·294 | 40·39 | 48·12 | 11·18 | CaO 0·12 = 99·81 |
| 17. | Pallas Iron, *Meteor.* | 3·339 | $\frac{3}{3}$ 40·24 | 47·41 | 11·80 | MnO 0·29, $Al_2O_3$ 0·06, $SnO_2$ 0·08 [= 99·88 |
| 18. | Brahin, *Meteor.* | 3·37 | 39·61 | 48 29 | 11·88 | MnO 0·19, $Al_2O_3$ 0·21 = 100·18 |
| 19. | Vesuvius | | 40·35 | 46·70 | 12·34 | = 99·39 |
| 20. | Ultenthal | | 40 60 | 45·81 | 12·35 | $Al_2O_3$ 0·86, CaO, CuO *tr.* = 99·62 |
| 21. | Ste. Anne | | 38·56 | 44·37 | 12·65 | $Fe_2O_3$ 1·36, MnO(CoO) 0·11, ign. [2·91 = 99·96 |
| 22. | Turner Mound, *Meteor.* | 3·336 | 40·02 | 45·60 | 14·06 | MnO 0·10 = 99·78 |
| 23. | Engelhaus | | 39·34 | 45·81 | 14·85 | = 100 |
| 24. | Cape Verde Is. | 3·38 | 39·33 | 43·88 | 15·63 | $Al_2O_3$ 1 24 = 100·08 |
| 25. | Atacama, *Meteor.* | | 36·92 | 43·16 | 17·21 | MnO 1·81 = 99·10 |
| 26. | *Glinkite* | 3·479 | $\frac{2}{2}$ 39·21 | 44·06 | 17·45 | = 100·72 |
| 27. | Montarville | | 37·17 | 39 68 | 22·54 | = 99·39 |
| 28. | Skurruvaselv | | 38·30 | 38 29 | 24·02 | = 100·61 |
| 29. | Volcano Yate | 3·42–3·5 | 38·47 | 37·62 | 24·83 | = 100·92 |
| 30. | Waterville, N. H. | | 38·85 | 30·62 | 28·07 | MnO 1·24, CaO 1·43 = 100·21 |
| 31. | Hochbohl | 3·20 | 41·90 | 28·48 | 29·16 | = 99·54 |
| 32. | Kaiserstuhl, *Hyalosiderite* | 3·566 | 36·72 | 31·99 | 29·96 | = 98·67 |

[a] Incl. 0·24 $Cr_2O_3$, 0·39 $Al_2O_3$. [b] Incl. 0·06 CoO. [c] Incl. 0·11 $Fe_2O_3$

**Pyr., etc.**—B.B. whitens, but is infusible in most cases; hyalosiderite and other varieties rich in iron fuse to a black magnetic globule; some kinds turn red upon heating. With the fluxes gives reactions for iron. Some varieties give reactions for titanium and manganese. Decomposed by hydrochloric and sulphuric acids with separation of gelatinous silica.

**Obs.**—A common constituent of some eruptive rocks, especially those of a basic character where it is associated with augite, bronzite, hypersthene, also a triclinic feldspar (as labradorite), magnetite, etc. Usually in embedded grains or less commonly distinct crystals. Distinct crystals and varieties rich in iron are more common in basalt, basaltic lavas, and the immediately related rocks; also in peridotyte, dunyte, picryte; commonly in grains in olivine-diabase, olivine-gabbro, olivine-noryte. Further, not uncommon in granular limestone and dolomite, but usually varieties low in iron; sometimes an accessory constituent in hornblendic or pyroxenic crystalline schists; occasionally in ore deposits.

6.

Chrysolite chondrule from the Knyahinya meteorite (×10 diam.).

In grains, rarely crystals, embedded in some meteoric irons, especially in the siderolites or "Pallasites." In the Pallas Iron, the chrysolite is abundant and in large yellow grains, which when carefully extracted show large numbers of crystalline facets over the rounded surface (cf. Kk., l. c.); through the interior there are numerous hollow canals ∥ $\dot{c}$. The Estherville, Iowa, the Kiowa, Kansas, and the Atacama meteorites are others in which chrysolite is similarly prominent. Also present in meteoric stones, frequently in spherical forms, or chondrules, sometimes made up of a multitude of grains with like (or unlike) optical orientation inclosing glass between (f. 6).

Among the more prominent localities are: Vesuvius in lava and on Monte Somma in ejected masses, with augite, mica, etc., where fosterite also occurs, and more commonly; the crystals are sometimes associated in parallel position with clinohumite. Observed in the so-called sanidine bombs at the Laacher See, but not common; at Forstberg near Mayen in the Eifel and forming the mass of "olivine bombs" in the Dreiser Weiher near Daun in the same region; at Expailly in Haute-Loire; at Unkel, on the Rhine, crystals several inches long; at Kapfenstein in Lower Styria, in spheroidal masses; at Sasbach and Ihringen in the Kaiserstuhl, near Freiburg, Baden, in basalt, a variety containing much iron (*hyalosiderite*). In Sweden, with ore-deposits, as at Långban, Pajsberg, Persberg, etc. In serpentine at Snarum, Norway, in large crystals, themselves altered to the same mineral. In talcose schist, found near Kyshtymsk, N. of Miask, and near Sysersk in the Ural, in greenish embedded nodules (*glinkite*, anal. 26). Common in the volcanic rocks of Sicily, Hecla, the Sandwich Islands, the Azores, the Canaries, and Cape Verde Islands.

In the U. S., in Thetford and Norwich, Vermont, in boulders of coarsely cryst. basalt, the crystals or masses several inches through. In olivine-gabbro of Waterville, in the White Mts., (anal. 30), New Hampshire; at Webster, in Jackson Co., N. C., along with serpentine, pyrosclerite, and chromite; with chromite in Loudon Co., Va.; in Lancaster Co., Pa., at Wood's mine, with serpentine and chromite (Genth); near Media, Delaware Co., Pa., with bronzite and chromite. In small clear olive-green grains with garnet at some points in Arizona and New Mexico, locally called Job's tears because of their pitted surface.

In basalt in Canada, near Montreal, at Rougemont and Mounts Royal and Montarville, and in eruptive rocks at other points.

Chrysolite is named from χρυσός, *gold*, and λίθος. The hyalosiderite, from ὕαλος, *glass*, and σίδηρος, *iron*.

The *chrysolithus* of Pliny was probably our topaz; and his *topaz* our *chrysolite*. But Pliny's statement that "topazos" is the largest of all the precious stones, and that a statue 4 cubits high was made of it, shows that he confounded together different stones, since solid chrysolite crystals are never as large as some topaz crystals, and two inches is an extraordinary magnitude. The hardness mentioned, that it yields to the action of the file and wears with use, is right, and seems to prove that true chrysolite was included under the name of *topazion*. It came from an island in the Red Sea, and was very highly valued. It is stated by Diodorus Siculus to have resembled glass, but to have had a remarkable golden appearance, especially conspicuous at night (King).

**Alt.**—Alteration of chrysolite often takes place through the oxidation of the iron; the mineral becomes brownish or reddish brown and iridescent. The process may end in leaving the cavity of the crystal filled with limonite or red oxide of iron.

A very common kind of alteration is to the hydrous magnesium silicate, serpentine, with the partial removal of the iron or its separation in the form of grains of magnetite, also as iron sesquioxide; this change has often taken place on a large scale. See further under serpentine, p. 671. A change to anthophyllite and to actinolite has been noted (Becke). Deposits of a hydrous nickel silicate, near genthite, in Douglas Co., Oregon, are shown by Clarke to be probably derived from a nickeliferous chrysolite (anal. 3); a similar occurrence has been noted in North Carolina. See genthite. Chrysolite also occurs altered to amphibole, under certain conditions, in the older crystalline rocks, a zone of which with fibers normal to the outline surrounds a nucleus of the original mineral. Becke has given the name *pilite* to needles of colorless amphibole formed from chrysolite and enclosing also some serpentine, chlorite, magnetite, etc., Min. Mitth., **5**, 164, 1882.

*Limbilite*, *chusite*, and *sideroclepte* of Saussure (J. Phys., 341, 1794), all from Limburg in the Kaiserstuhl, Breisgau, have been regarded as chrysolite more or less altered, but this is doubtful. Cf. Rosenbusch, Jb. Min., 169, 1872.

**Artif.**—Chrysolite and the related minerals of the group have often been observed in slags, cf. Mlr., Min., 319, 1852, also Lasp., Zs. Kr., **7**, 494, 1883 (literature given); Meunier, C. R., **93**, 737, 1881, and especially Vogt, Ak. H. Stockh., Bih., **9** (1), 45, 1884, Arch. Math. Nat., **30**, 8, 1889.

**Ref.**—[1] Deduced from a series of measurements, Min. Russl., **6**, 16, 1870; cf. ib., **5**, 12, 1866; also Bauer, Jb. Min., **1**, 1, 1887, who compares the axial ratios of different members of the group.

[2] Haid., Min. Mohs, **2**, 345, 1825; Rose (Pallas Iron), Pogg., **4**, 186, 1825, and Beschr. Met., p. 73, 1863; Lévy, Min. Heul., **2**, 57, 1837; Scc., della Humite e del Peridoto, etc., 1852, or Pogg., Erg., **3**, 184, 1853; Mlr., Min., 316, 1852; Dx., Min., **1**, 30, 1862; Kk., l. c.

[3] Rath, Laacher See, Pogg., **135**, 580, 1868. [4] Kk., Pallas Iron, l. c., **6**, 1. [5] Twins, Rath, l. c., p. 581; Kalkowsky, Zs. Kr., **10**, 17, 1885. Cf. Hyland, Min. Mitth., **10**, 225, 1888. [6] Rinne, Ber. Ak. Berlin, 1109, 1889. [7] Min., **1**, 31, 1862, N. R., 83, 1867, cf. also Rinne, l. c. [8] Jb. Min., **1**, 19, 1887.

VILLARSITE *Dufrenoy*, C. R., **14**, 697, 1842, Ann. Mines, **1**, 387, 1842. Serpentin aus d. Malenkerthal *Fellenberg*, J. pr. Ch., **101**, 38, 1867.

An altered chrysolite, occurring in pseudomorphous crystals, often trillings, also in rounded grains. Analyses.—1, 2, Dufrenoy, l. c., and Min., **4**, 343, 1859. 3, Fellenberg, l. c.

| | | $SiO_2$ | FeO | MnO | MgO | CaO | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Traversella | G. = 2·975 | 39·61 | 3·59 | 2·42 | 47·37 | 0·53 | 0·46 | 5·80 | = 99·78 |
| 2. Forez | | 40·52 | 6·25 | — | 43·75 | 1·70 | 0·72 | 6·21 | = 99·15 |
| 3. Malenkerthal | G. = 2·99 | $\frac{2}{2}$ 41·72 | 7·96 | — | 42·15 | — | — | 5·55 | CrO NiO 0·75, [$Al_2O_3$ 3·19 = 101·30 |

Anal. 1 is of the original villarsite from Traversella, where it is associated with mica, quartz, and dodecahedral magnetite; 2, of grains from the granite of Forez and Morvan, France. Grains in the interior of the serpentine pseudomorphs of Snarum have sometimes a similar composition. The mineral from Pirlo in the Malenkerthal, of the Grisons, constitutes the base of a serpentine-like rock, which is slightly crystalline in texture, somewhat slaty, feeble luster, and between blackish gray and dark green in color.

On the optical properties of villarsite see Dx., Min., **1**, 95, 1862, and Lcx., Bull. Soc. Min., **10**, 144, 1887. Named after the mineralogist, Villars, who published a Natural History of Dauphiny.

MATRICITE *N. O. Holst*, G. För. Förh., **2**, 528, 1875. In crystalline masses with concentric, fine fibrous structure. Fracture splintery to uneven. Feel greasy. H. = 3–4. G. = 2·53. Luster pearly. Color gray, often with a greenish tinge. Streak white. Subtranslucent to opaque. Analysis (after the deduction of 28·36 p. c. $CaCO_3$ mechanically mixed):

| $SiO_2$ | MgO | CaO | $Al_2O_3$ | FeO | MnO | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 33·99 | 37·96 | 5·64 | 1·33 | 1·82 | 0·47 | 0·98 | 17·81 | = 100 |

B.B. infusible. Yields water in the closed tube. Decomposed by acids with separation of silica, but does not gelatinize. Occurs intimately mixed with calcite and associated with spodiosite, at the Krangrufva in Wermland, Sweden.

FERRITE *Wallace Young*, quoted by Heddle, Min. Mag., **5**, 28, 1882. *Heddle*, ibid., and **7**, 134, 1887. An alteration product of chrysolite in the doleryte between Gleniffar and Boyleston near Glasgow, Scotland. It retains the form in some cases, is soft, deep red to chocolate-brown in color, with cleavage prominent ‖ *a* and *b*. Analysis, Heddle, of the air-dried mineral (loss at 100°, 3·83 p. c.): $SiO_2$ 13·02, $Al_2O_3$ 13·16, $Fe_2O_3$ 53·47, FeO 4·51, MnO 0·15, MgO 6·63, CaO 0·75, $H_2O$ 8·39 = 100·08.

376A. **Hortonolite** *G. J. Brush*, Am. J. Sc., **48**, 17, 1869, *John M. Blake*, ibid., p. 20. In crystals and crystalline masses. Forms: *b* (010, *i*-ĭ), *c* (001, *O*), *m* (110, *I*); *d* (101, 1-ĭ): *k* (021, 2-ĭ); *e* (111, 1), *g* (212, 1-$\bar{2}$). Crystals flattened ‖ *b*, with *d* prominent. Measured angles; *bm* = 65°, ∴ *mm‴* = 50°; *bk* = 40° 45′, ∴ *kk′* = 98° 30′ Blake.

Cleavage: *a* (100), *c* (001). Fracture uneven. H. = 6·5. G. = 3·91. Luster vitreous to resinous. Color yellow to dark yellowish green on the fresh fracture, but black and dull on the surface. Translucent.

Composition, $(Fe,Mg)_2SiO_4$, or intermediate between chrysolite and fayalite, but containing also manganese and hence near some knebelite, p. 457. Anal.—G. J. Brush, l. c., on material purified by an electro-magnet.

$SiO_2$ 33·59, FeO 44·37, MnO 4·35, MgO 16·68, CaO *tr.*, $K_2O$ 0·39, ign. 0·26 = 99·64

B.B. fuses at 4. Reacts for iron and manganese with the fluxes. Decomposed by hydrochloric acid with gelatinization.

Occurs intimately associated with magnetite, also embedded in calcite at an iron mine at Monroe, Orange Co., N. Y. It is named after Mr. Silas R. Horton.

NEOCHRYSOLITE *A. Scacchi*, Rend. Accad. Napoli, Oct. 14, 1876. In small, black, crystalline plates ‖ *b*, also thick tabular ‖ *a*, crystallographically identical with chrysolite. Cf. E. Scc., Zs. Kr., **15**, 293, 1889. Peculiar in containing a considerable amount of manganese, but not yet analyzed. Found in the cavities of the lava of 1631, with sodalite and orthoclase, at the Cupa di Sabataniello, Vesuvius.

376B. **Titan-Olivine** *Damour*, Bull. Soc. Min., **2**, 15, 1879. Péridot titanifère *Id.*, Ann. Mines, **8**, 90, 1855. A variety of chrysolite characterized chemically by the presence of titanium, and physically by its deep yellow or red color and strong pleochroism. Occurs in imperfect crystals or grains, having the angles of ordinary chrysolite, but showing some unusual and uncertain forms, Dx. (Min., **1**, 35, 1862). Sections ⊥ Bx (= 𝔞) show twinning, sometimes polysynthetic with 𝔟 inclined 20° to the trace of the twinning plane symmetrically in each half. Indices: $\alpha = 1{\cdot}669$, $\beta = 1{\cdot}678$, $\gamma = 1{\cdot}702$, $2H_{a.y} = 72° 20'$. $\therefore$ $2V_y = 62° 18'$. Color brownish red. Pleochroism strong: 𝔠 (= 𝔟) bright yellow, 𝔞 deep reddish yellow. Absorption 𝔞 > 𝔟 = 𝔠. It is suggested that the form may be monoclinic similar to clinohumite, to which it bears a certain resemblance, but it is more probably like ordinary chrysolite. Cf. Lcx., who gives the above optical determinations, Bull. Soc. Min., **13**, 15, 1890.

Analyses.—1, 2, Dmr., Ann. Mines, **8**, 90, 1855. 3, Id., Bull. Soc. Min., **2**, 15 1879.

| | G. | $SiO_2$ | $TiO_2$ | MgO | FeO | MnO | ign. | |
|---|---|---|---|---|---|---|---|---|
| 1. Pfunders | 3·25 | 36·30 | 5·30 | 49·65 | 6·00 | 0·60 | 1·75 | = 99·60 |
| 2. " | | 36·87 | 3·51 | 50·14 | 6·21 | 0·60 | 1·71 | = 99·04 |
| 3. Zermatt, *Titan-olivine* | 3·27 | 36·14 | 6·10 | 48·31 | 6·89 | 0·19 | 2·23 | = 99·86 |

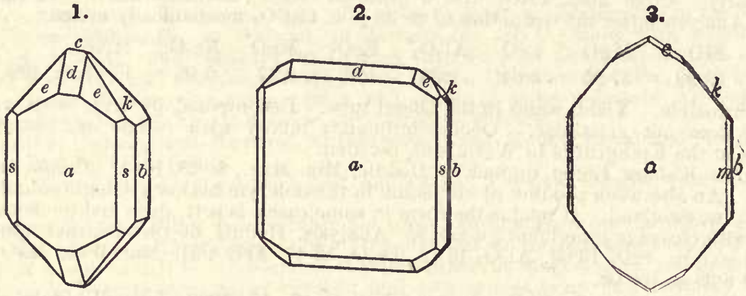
From Pfunders in Tyrol in talcose schist; also embedded in a similar rock found in masses in the moraine of the Findelen glacier at Zermatt, Switzerland.

**377. FAYALITE.** *C. G. Gmelin*, Pogg., **51**, 160, 1840. Eisenperidot, Eisenglas, *Germ.* Iron Chrysolite.

Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c} = 0{\cdot}4584 : 1 : 0{\cdot}5793$ Penfield[1].
$100 \wedge 110 = 24° 37\frac{2}{3}'$, $001 \wedge 101 = 51° 38\frac{2}{3}'$, $001 \wedge 011 = 30° 5'$.

**Forms:**
*a* (100, *i*-$\bar{i}$)
*b* (010, *i*-$\breve{i}$)
*c* (001, *O*)
*m* (110, *I*)
*s* (120, *i*-$\breve{2}$)
*d* (101, 1-$\bar{i}$)
*k* (021, 2-$\breve{i}$)
*e* (111, 1)
*f* (121, 2-$\breve{2}$)[2]

*mm'''* = 49° 15'
*as* = *42° 31'
*ss'* = 94° 58'
*dd'* = *103° 17'
*kk'* = 98° 24'
*ee'* = 95° 7'
*ee''* = 108° 32'
*ee'''* = 39° 33'
*ff'''* = 71° 26'



1, Obsidian Cliff; 2, Lake of the Woods, Yellowstone Park, Pfd. 3, Lipari, Id.

In minute crystals, tabular ∥ *a*. Also massive.

Cleavage: *b* distinct, *a* less so. Fracture imperfectly conchoidal. Brittle. H. = 6·5. G. = 4–4·14; 4·138 Fayal; 4·006 Ireland, Delesse. Luster metalloidal, somewhat resinous on the fracture. Color of crystals light yellow, transparent; becoming opaque and dark brown to black and often iridescent on the surface by oxidation. Ax. pl. ∥ *c*. Bx ⊥ *a*.

**Comp.**—Ferrous orthosilicate, $Fe_2SiO_4$ or $2FeO.SiO_2$ = Silica 29·4, iron protoxide 70·6 = 100.

**Anal.**—1, Rg., Min. Ch., 425, 1875. 2, Delesse, Bull. G. Fr., **10**, 571, 1853. 3, Gooch, Am. J. Sc., **30**, 58, 1885. Also 5th Ed., p. 259.

| | $SiO_2$ | FeO | MnO | MgO | CaO | |
|---|---|---|---|---|---|---|
| 1. Fayal | 29·25 | 66·01 | | — | 0·45 | CuO 1·33, $Al_2O_3$ 3·57 = 100·61 |
| 2. Slavcarrach G. = 3·885 | 29·50 | 63·54 | 5·07 | 0·30 | — | = 98·41 |
| 3. Yellowstone | 32·41 | 65·49 | 2·10 | — | — | = 100 |

The crystals analyzed by Gooch were coated with iron oxide; 14·92 $Fe_2O_3$, 7·02 quartz have been deducted and the analysis calculated to 100.

**Pyr., etc.**—Fuses readily to a black magnetic globule. Gelatinizes with acids

**Obs.**—From the Mourne Mts., Ireland, on Slavcarrach, near Bryansford, in pegmatyte; forms nodules in volcanic rocks at Fayal, one of the Azores.

In lithophyses in rhyolite at Obsidian Cliff and other localities in the Yellowstone Park with quartz and a glassy feldspar (anorthoclase, anal. 17, p. 325)[3]; similarly in the obsidian of Lipari (Iddings and Penfield, Am. J. Sc., **40**. 75, 1890). Probably also in similar association in the obsidian of the Cerro de las Navajas, Mexico (Rose, Pogg., **10**, 323, 1827; Iddings, l. c.). Also from Colorado at Cheyenne Mt. Probably with the hafnefiordite of Iceland.[2]

**Artif.**—Crystalline slags having the composition of fayalite are not uncommon. See references under chrysolite, p. 454, also ref. [1] below; further Bull. Soc. Min., **7**, 61, 1884.

Among the various artificial chrysolites is also one having the composition $(Ca,Fe)_2SiO_4$. Vogt (ref. on p. 454) describes crystals, and an analysis by Kruhs gave: $SiO_2$ 34·30, FeO 25·64, CaO 33·72, MnO 0·86, MgO 4·68, $Al_2O_3$ 0·78 = 99·98. Cf. Jackson, Am. J. Sc., **19**, 358, 1855.

**Ref.**—[1] Yellowstone Park, Am. J. Sc., **30**, 59, 1885. Cf. Bauer, Jb. Min., **1**, 1, 1887. [2] Iceland, Dx., Min., **2**, p. x, 1874. [3] Iddings, Obsidian Cliff, 7th Ann. Rep., U. S. G. Surv., p. 270, 1888.

**378 KNEBELITE.** Knebelit *Döbereiner*, Schw. J., **21**, 49, 1817. Igelströmit *Weibull*, G. För. Förh., **6**, 500, 1883; Eisenknebelit *Id.*, Min. Mitth., **7**. 120. 1885.

Orthorhombic. Usually crystalline massive.

Cleavage: *m* distinct; *a*, *c* indistinct. Fracture subconchoidal to uneven. Brittle. H. = 6·5. G. = 3·9–4·17; 4·122 Erdmann. Luster glistening, greasy. Color gray, spotted dirty-white, red, brown, yellow, and green; also grayish black to black. Translucent to opaque.

Optically −. Ax. pl. ∥ $c$. Bx ⊥ $a$. Dispersion $\rho > v$. Ax. angle = 63° 45′ (in glass) Dx. For igelströmite 59° 12′ Weibull.

**Comp.**—$(Fe,Mn,Mg)_2SiO_4$ or $2(Fe,Mn,Mg)O.SiO_2$. The relation between the iron, manganese and magnesium varies widely.

**Var.**—1. *Ordinary.* Ratio of Fe : Mn nearly = 1 : 1, which requires: Silica 29·6, iron protoxide 35·5, manganese protoxide 34·9 = 100. In crystalline masses, showing cleavage.

2. *Igelströmite. Eisenknebelit.* Contains about 10 p. c. more FeO and less MnO than ordinary knebelite. A variety (anal. 5) from the rock called eulysyte contains still more iron, and approximates toward hortonolite (p. 455) and hyalosiderite (p. 452).

**Anal.**—1, Pisani, Dx. Min., **2**, p. xi, 1874. 2. Weibull. Min. Mitth., **7**, 121, 1885. 3, Id., G. För. Förh., **6**, 500, 1883. 4, Id., ibid., **7**, 263, 1884. 5, Erdmann, Öfv. Ak. Stockh., **6**, 111, 1849.

| | | | $SiO_2$ | FeO | MnO | MgO |
|---|---|---|---|---|---|---|
| 1. Dannemora | G. = 3·93 | | 29·50 | 36·95 | 30·07 | 1·70 $Al_2O_3$ 1·72, CaO 0·18 = 100·12 |
| 2. " | | | 28·96 | 36·73 | 29·69 | 2·33 $Al_2O_3$ 1·07, CaO 1·00 = 99·78 |
| 3. Silfberg, *Igelströmite* | G. = 4·17 | $\frac{2}{2}$ | 29·57 | 47·06 | 18·84 | 3·01 $CaCO_3$ 1·14 = 99·62 |
| 4. Hillängs mine | | | 28·76 | 48·59 | 18·57 | 1·98 $CaCO_3$ 2·25 = 100 15 |
| 5. Tunaberg | | | 29·34 | 54·71 | 8·39 | 3·04 $Al_2O_3$ 1·20, CaO 3·07 = 99·75 |

**Pyr.**, **etc.**—According to Döbereiner, unaltered B.B., but Erdmann's mineral fused easily to a lusterless magnetic bead, and gave with the fluxes reactions for iron and manganese. Decomposed readily by hydrochloric acid with separation of gelatinous silica.

**Obs.**—The original mineral analyzed by Döbereiner was from an unknown locality, but G. Suckow (Kenng., Ueb. Min., 93, 1855) states, on the authority of Knebel, that it was found in granite near Ilmenau. The Dannemora mineral is grayish black to black in large masses, light gray on the thin edges, and is stated to cleave parallel to a prism of about 65°. Also from the Vester-Silfberg mine in the Norrbärke parish, Dalekarlia, and the Hillängs mine, 4 miles to the southwest.

Erdmann's mineral was from the chrysolitic rock called by him eulysyte from the region of Tunaberg, Södermanland, Sweden; it was dark yellow to reddish brown in color, and was intimately mingled with diallage and a brown garnet.

Named after Major von Knebel.

**379. TEPHROITE.** Tephroit *Breith*, Char., 278, 1823; 212, 329, 1832. Tefroit *Swed*. Picrotephroite.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c}$ = 0·46004 : 1 : 0·59389 Hj. Sjögren[1].

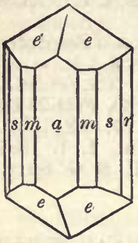
100 ∧ 110 = 24° 42¼′, 001 ∧ 101 = 52° 14¼′, 001 ∧ 011 = 30° 42⅓′.

**Forms**[2]: *a* (100, $i\text{-}\bar{i}$), *x* (10·9·0, $i\text{-}\frac{10}{9}$), *m* (110, $I$), *s* (120, $i\text{-}\breve{2}$), *h* (011, $1\text{-}\breve{i}$), *e* (111, 1), *f* (121, $2\text{-}\breve{2}$). *l* (131, $3\text{-}\breve{3}$).

*mm‴* = 49° 24′ *ae* = *42° 1′ *ee″* = 109° 44′ *ee‴* = 39° 58′
*ss′* = 94° 46′ *ee′* = 95° 58′ *ff″* = 120° 38′ *ff‴* = 72° 4′
*as* = *42° 37′ *ff′* = 79° 29′ *ll″* = 131° 7′ *ll‴* = 94° 59′
*hh′* = 61° 25′ *ll′* = 64° 35′

Crystals rare. Usually crystalline massive.

Cleavage distinct in two directions at right angles. Fracture subconchoidal. Brittle. H.=5·5–6. G.=4–4·12. Luster vitreous to greasy. Color grayish flesh-red, reddish brown, and rose-red, to ash-gray, smoky-gray. Streak pale gray. Darkens on exposure to brown and black. Translucent to subtranslucent.



Pajsberg, Flink.

Pleochroism distinct: $\mathfrak{c}$ (= $\breve{a}$) greenish blue, $\mathfrak{b}$ (= $\breve{c}$) reddish, $\mathfrak{a}$ (= $b$) brownish red. Absorption $\mathfrak{b} > \mathfrak{c} > \mathfrak{a}$. Optically −. Ax. pl. ∥ $c$. Bx ⊥ $b$. Axial angles, Dx. and Flink:

$$2H_{a.r} = 84^\circ\ 41' \quad 2H_{a.bl} = 82^\circ\ 59' \quad \therefore 2E_r = 161^\circ\ 48' \quad 2E_{bl} = 156^\circ\ 35'$$
$$2H_{a.y} = 81^\circ\ 4' \quad 2H_{o.y} = 112^\circ\ 16' \quad \therefore 2V_{a.y} = 76^\circ\ 6'$$

**Comp.**—Manganese orthosilicate, $Mn_2SiO_4$ or $2MnO.SiO_2$ = Silica 29·8, manganese protoxide 70·2 = 100. Magnesium is usually present, and in picrotephroite to considerable amount. Also in small quantity iron, and sometimes zinc, though the zinc may be in part due to zincite (Brush).

**Anal.**—1, G. J. Brush, Am. J. Sc., **37**, 66, 1864 (the original tephroite of Breithaupt). 2, Collier, ibid. 3, Hague, ibid. 4, Mixter, ib., **46**, 231. 1868. 5, G. C. Stone, Sch. Mines Q., **8**, 152. 1887. 6, Damour, Ann. Mines, **2**, 340, 1862. 7, 8, Igelström, Öfv. Ak. Stockh., **22**, 228, 1865. 9, Wiborgh, G. För. Förh., **6**, 539, 1883. 10, Pisani, C. R., **84**, 1511, 1877. 11, Paijkull, G. För. Förh., **3**, 351, 1877.

| | G. | $SiO_2$ | MnO | FeO | ZnO | MgO | CaO | ign. | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Sterling Hill | 4·10 | 30·19 | 65·59 | 1·09 | 0·27 | 1·38 | 1·04 | 0·37 | = 99·93 |
| 2. " " *brown* | 3·97 | 30·55 | 52·32 | 1·52 | 5·93 | 7·73 | 1·60 | 0·28 | = 99·93 |
| 3. " " *red* | 3·87 | 31·73 | 47·62 | 0·23 | 4·77 | 14·03 | 0·54 | 0·35 | = 99·27 |
| 4. Franklin Furnace, *ash-gray* | 4·0 | 29·44 | 57·31 | 0·87 | 7·36 | 2·50 | 2·51 | 0·27 | = 100·26 |
| 5. " " | 3·913 | 30·63 | 49·80 | 3·33 | 5·74 | 10·16 | — | — | = 99·66 |
| 6. " " | | 29·95 | 36·43 | 1·96 | 11·61 | 18·60 | — | 1·71 | = 100·26 |
| 7. Pajsberg, *rose* | | 30·82 | 56·83 | — | — | 2·79 | 5·37 | 2·20 | = 98·01 |
| 8. " *brown* | | 31·36 | 44·07 | 4·15 | — | 17·71 | *tr.* | 0·87 | = 98·16 |
| 9. Långban | 3·95–4·02 | 31·39 | 65·34 | — | — | 3·15 | — | — | = 99·88 |
| 10. " | | 31·70 | 47·70 | 0·80 | — | 9·48 | 9·80 | — | = 99·48 |
| 11. *Picrotephroite* | | 33·70 | 51·19 | — | — | 12·17 | 0·95 | 0·44 | = 98·45 |

**Pyr., etc.**—B.B. fuses at 3·5 to a black scoria. Gelatinizes in hydrochloric acid without evolving chlorine. With the fluxes gives reactions for manganese and iron. The magnesian variety fuses at 4 (anal. 2) to 6 (anal. 3).

**Obs.**—Found at Sterling Hill in the town of Sparta, Sussex Co., N. J., with zincite, willemite, and franklinite, in cleavable masses; at Franklin Furnace in the same region, similarly associated; also at Pajsberg in Wermland, Sweden. along with rhodonite and other manganesian minerals; at the Sjögrufva, with hausmannite; at Långban. Wermland (*picrotephroite*) with jacobsite, diopside, etc.

The name *tephroite* is from *τεφρός, ash-colored.* Breithaupt's original specimen was from the collection of H. Heyer at Dresden.

**Ref.**—[1] Långban, G. För. Förh., **6**, 539, 1883. Flink, Pajsberg, Ak. H. Stockh., Bihang, **13** (2), No. 7, 64, 1888. Flink calculates: $\breve{a} : \bar{b} : \breve{c} := 0{\cdot}4621 : 1 : 0{\cdot}5914$. [2] Dx., Ann. Mines, **2**, 339, 1862, N. R., 99, 1867. Also Flink, l. c.

HYDROTEPHROITE. Hydrotefroit. *L. J. Igelström*, Öfv. Ak. Stockh., **27**, 605, 1865. A hydrous tephroite from Pajsberg, which has a pale reddish color, a colorless streak, and H. = 4; gelatinizes with acids and yields water. Analysis: $SiO_2$ 28·46, $Mn_2O_3$ 0·49, MnO 53·44, MgO 11 89, CaO FeO *tr.*, $H_2O$ 5·85 = 100·13, and corresponding to $(Mn,Mg)_2SiO_4 + \frac{2}{3}H_2O$. It may be an altered tephroite.

EPIGENITE *L. J. Igelström*, G. För. Förh., **11**, 393, 1889. NEOTESITE *Id.*, Jb. Min., **1**, 257, 1890. Near hydrotephroite and apparently also derived from tephroite. Occurs in small bladed masses embedded in tephroite. Cleavage: distinct. H. = 5–5·5. Color brownish red, resembling orthoclase or some rhodonite. Streak pale red. Composition $(Mn,Mg)SiO_4.H_2O$. Analysis: Igelström, l. c.

$SiO_2$ 29·50 MnO 40·60 FeO *tr.* MgO 20·05 $H_2O$ 9·85 = 100

B.B. fuses rather easily to a black bead. Decomposed by acids without gelatinization.

Occurs at the manganese mine, the Sjögrufva, in the Grythytte parish, Örebro, Sweden, immediately associated with gray tephroite, calcite, etc., in an ore carrying hausmannite.

*A black silicate of manganese* from Klapperud, Dalekarlia, having a submetallic luster and yellowish brown streak, afforded Klaproth (Beitr., 4, 137): $SiO_2$ 25·0, MnO 55·8, $H_2O$ 13·0=93·8 = $Mn_2SiO_4 + 2H_2O$, agreeing with the tephroite, excepting the water. Klaproth obtained 60 p. c. of $MnO,Mn_2O_3$, whence the above is deduced by Berzelius.

**379A. Rœpperite.** Iron-manganese-zinc chrysolite *Rœpper*, Am. J. Sc., **50**, 35, 1870. *Rœpperite G. J. Brush*, Dana's Min., App. I, p. 13, 1872. Stirlingite *Kenngott*, Jb. Min., 188, 1872.

Orthorhombic. In large coarse crystals resembling chrysolite, with *a* (100), *b* (010), *c* (001), *m* (110), *d* (101), *k* (021), *e* (111), *ω* (211)?. Angles: *mm‴* = 50°, *dd′* = 103°.

Cleavage: *b*, *c* distinct; *a* splintery. H. = 5·5–6. G. = 3·95–4·08. Luster vitreous to greasy. Color when fresh pale yellow, as weathered dark green to black, mottled. Translucent in thin splinters. Streak yellow to reddish gray. Slightly magnetic.

Composition: $(Fe,Mn,Zn,Mg)_2SiO_4$, and hence near some kinds of tephroite, p. 458. Anal.—1–3, W. T. Rœpper, l. c.

| | $SiO_2$ | FeO | MnO | ZnO | MgO | |
|---|---|---|---|---|---|---|
| 1. *Crystals* | 30·76 | 33·78 | 16·25 | 10·96 | 7·60 | = 99·35 |
| 2. " | 30·23 | 35·52 | 16·91 | 10·68 | 5·63 | insol. 1·04 = 100·01 |
| 3. *Massive* | $\frac{2}{2}$ 30·54 | 34·78 | 17·74 | 9·48 | 6·09 | insol. 2·02 = 100·65 |

B.B. fuses with difficulty on the thin edges to a black slag. With the fluxes reacts for iron, manganese, and silica; on charcoal with soda gives a zinc coating. Gelatinizes with acids readily and completely, leaving sometimes a bright green residue of spinel.

Occurs at Sterling Hill, Sussex Co., N. J., with willemite, franklinite, jeffersonite, and spinel; also found at Franklin Furnace with gahnite.

A zinc chrysolite (Zinkfayalit *Germ.*) has been noted as a furnace product by Stelzner at Freiberg. It occurs in the slags in foliated aggregates of tabular crystals, rectangular in form, together with a zink spinel. An analysis of material consisting chiefly of these aggregates gave: $SiO_2$ 28·45, ZnO 18·55, FeO 41·98, $SnO_2$ 0·75, PbO 2·50, CuO 0·60, CaO 3·00, MgO 0·84, BaO 1·80, $Al_2O_3$ 1·31, S 1·70 = 101·48, deduct (O = S) 0·85 = 100·63. Jb. Min., **1**, 170, 1882.

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## 6. Phenacite Group. $R_2SiO_4$. Rhombohedral.

**380. Trimerite** $Mn_2SiO_4.Be_2SiO_4$ Pseudo-hexagonal $\dot{c} = 0·7233$

Triclinic $\left\{ \begin{array}{l} \breve{a} : \bar{b} : \dot{c} = 0·5773 : 1 : 0·5425 \\ \alpha = \beta = \gamma = 90° \end{array} \right.$

---

| | | | | $rr'$ | $\dot{c}$ |
|---|---|---|---|---|---|
| **381.** | **Willemite** | $Zn_2SiO_4$ | | 64° 30′ | 0·6775 |
| | Troostite | $(Zn,Mn)_2SiO_4$ | | | |
| **382.** | **Phenacite** | $Be_2SiO_4$ | Tetartohedral | 63° 24′ | 0·6611 |

As shown by Brögger, the pseudo-hexagonal species, Trimerite, connects the Phenacite Group proper with the Chrysolite Group; in composition it is intermediate between Tephroite and Phenacite.

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| | | | | $rr'$ | $\dot{c}$ |
|---|---|---|---|---|---|
| **383.** | **Dioptase** | $H_2CuSiO_4$ | Tetartohedral | 54° 5′ | 0·5342 |
| **384.** | **Friedelite** | $H_7(MnCl)Mn_4(SiO_4)_4$ | | 56° 17′ | 0·5624 |
| **385.** | **Pyrosmalite** | $H_7((Fe,Mn)Cl)(Fe,Mn)_4(SiO_4)_4$ | | 53° 49′ | 0·5308 |

The three species Dioptase, Friedelite, Pyrosmalite are very near to each other in form, as shown in the above axial ratios; they further approximate closely to the species of the Phenacite Group proper, with which they are further connected by the tetartohedrism of Dioptase.

They are also closely related among themselves in composition, since they are all acid ortho-silicates, and have the general formula $H_2RSiO_4 = H_8R_4(SiO_4)_4$, where (*e.g.* for Friedelite) in the latter form the place of one hydrogen atom is taken by the univalent radical (MnCl).

### 380. TRIMERITE. *G. Flink*, Zs. Kr., 18, 361, 1890.

Triclinic, pseudo-hexagonal. In thick tabular prismatic crystals hexagonal in form and angle. Axis $\dot{c} = 0{\cdot}7233$; $0001 \wedge 10\bar{1}1 = 39° 52'$ Flink[1].

**Forms:** $c$ ($0001$, $O$), $a$ ($11\bar{2}0$, $i$-2); $m$ ($10\bar{1}0$, $I$); $s$ ($33\bar{6}8$, $\frac{3}{4}$-2), $p$ ($33\bar{6}4$, $\frac{3}{2}$-2), $o$ ($12{\cdot}3{\cdot}\bar{15}{\cdot}8$, $\frac{15}{8}$-$\frac{5}{4}$).

Angles: $cs = 28° 29'$, $cp = {}^*47° 20'$, $pp' = 43° 8\frac{1}{2}'$.

The fundamental form assumed above shows the relation to phenacite. If $p$ be made $10\bar{1}1$, the forms, taken in the above order, become: $c$ ($0001$), $m$ ($10\bar{1}0$), $a$ ($11\bar{2}0$), $s$ ($10\bar{1}2$), $p$ ($10\bar{1}1$), $o$ ($21\bar{3}2$). The pyramid $o$ is present according to pyramidal hemihedrism.

Optically trimerite is shown by Brögger[2] to be triclinic with a prismatic angle of 60°. On this basis (if $m = 110$, $p = 111$) the axial ratio is $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}57735 : 1 : 0{\cdot}54248$; $\alpha=\beta=\gamma=90°$. See further the optical relations (Bgr.) explained below.

Cleavage: basal, distinct. Fracture conchoidal. Brittle. H.=6–7. G.=3·474 Bgr. Luster vitreous, brilliant. Color salmon-pink, pale yellowish red to nearly colorless in small crystals. Transparent to translucent.

A basal section shows strong double refraction, with composition of three individuals, the position of each corresponding to a revolution of 120° about the normal to the basal plane. There are also embedded lamellæ parallel in position. The ax. pl. is inclined 20° to the adjacent edge $c/m$. The ax. plane and $Bx_a$ are nearly $\perp c$, but in the lamellæ, seen also in sections ∥ $a$ ($11\bar{2}0$), a variation of 2½° on one side to 4° on the other is noted. Optical character $-$. Refractive indices:

| | | |
|---|---|---|
| $\alpha_r = 1{\cdot}7119$ Li | $\beta_r = \frac{2}{2}\,1{\cdot}7173$ | $\gamma_r = 1{\cdot}7220$ |
| $\alpha_y = 1{\cdot}7148$ Na | $\beta_y = \frac{2}{2}\,1{\cdot}7202$ | $\gamma_y = 1{\cdot}7253$ |
| $\alpha_{gr} = 1{\cdot}7196$ Tl | $\beta_{gr} = \frac{2}{2}\,1{\cdot}7254$ | $\gamma_{gr} = 1{\cdot}7290$ |
| $2H_{a.y} = 101° 12'$ | $2H_{o.y} = 120° 1'$ | $2V_y = 83° 29'$ |

**Comp.**—$(Mn,Ca)_2SiO_4.Be_2SiO_4$. If Mn : Ca = 2 : 1, the percentage composition is: Silica 39·8, glucina 16·6, manganese protoxide 31·3, lime 12·3 = 100. Iron also replaces part of the manganese.

**Anal.**—Flink, l. c.

$SiO_2$ 39·77 BeO 17·08 MnO 26·86 FeO 3·87 CaO 12·44 MgO 0·61 = 100·63

**Pyr.**—B.B. fusible with difficulty in thin splinters forming a black slag: gives the usual reactions for manganese and iron. Very slightly attacked by dilute hydrochloric acid, but readily decomposed by strong acid when pulverized, with the separation of flocculent silica.

**Obs.**—Of rare occurrence at the Harstig mine, Wermland, Sweden; it is found embedded in calcite; the crystals, sometimes coated with a web of actinolite needles, are implanted upon a rock consisting of a fine granular mixture of magnetite, grayish green pyroxene, garnet, etc. The largest crystal found was 12 mm. broad and 8 mm. thick.

Named from τριμερής, *in three parts*, in allusion to its optical structure.

**Ref.**—[1] L. c. [2] Ibid., p. 371 and 377.

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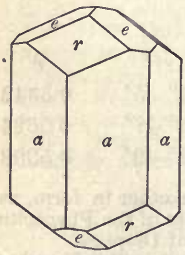
### 381. WILLEMITE. Siliceous Oxide of Zinc, Silicate of Zinc (fr. N. Jersey), *Vanuxem & Keating*, J. Ac. Philad., 4, 8, 1824. Willemite (fr. Moresnet) *Lévy*, Jb. Min., 71, 1830; Ann. Mines, 4, 513, 1843. Williamsite, Wilhelmite, Villemite, *alt. orthogr.* Anhydrous Silicate of Zinc. Hebetin (fr. Moresnet) *Breith.*, Char., 130, 1832. Troostite (fr. N. J.) *Shepard*, Min., 1st part, 154, 1832. Tephrowillemite *Koenig*, Proc. Ac. Philad., 187, 1889.

Rhombohedral. Axis $\dot{c} = 0{\cdot}6775$; $0001 \wedge 10\bar{1}1 = 38° 2\frac{1}{6}'$ E. S. D.[1]

1.



New Jersey.

**Forms**[2]**:** Moresnet $c$ ($0001$. $O$), $m$ ($10\bar{1}0$, $I$), $p$ ($30\bar{3}4$, $\frac{3}{4}$); for N. Jersey $a$ ($11\bar{2}0$, $i$-2), $r$ ($10\bar{1}1$, $R$), $e$ ($01\bar{1}2$, $-\frac{1}{2}$), $x$ ($21\bar{3}1$, $,1^3$).

| | | | |
|---|---|---|---|
| $cp = 30° 24'$ | $pp' = 51° 59'$ | $ax = 27° 51'$ | $ae'' = 90° 0'$ |
| $cr = 38° 2'$ | $rr' = {}^*64° 30'$ | $ar = 57° 45'$ | $mx = 29° 54'$ |
| $ce = 21° 22'$ | $ee' = 36° 47'$ | | |

In hexagonal prisms, sometimes long and slender, again short and stout. Also massive and in disseminated grains; fibrous.

Cleavage: $c$ easy, Moresnet; difficult, N. J.; $a$ easy, N. J. Fracture conchoidal to uneven. Brittle. H.= 5·5. G.= 3·89–4·18. Luster vitreo-resinous, rather weak. Color white or greenish yellow, when purest; apple-green, flesh-red, grayish white, yellowish brown; often dark brown when impure. Streak uncolored. Transparent to opaque. Optically +. Double refraction strong.

**Var.**—The crystals of Moresnet and New Jersey differ in occurring forms as above described. The latter are often quite large, of flesh-red or gray color, opaque, and pass under the name of *troostite;* they commonly contain manganese in considerable amount; this is also true of the clear honey-yellow or apple-green crystals in the form of slender hexagonal prisms, and further of the massive forms. *Tephrowillemite* is simply a kind of troostite, anal. 13; it has a brownish-gray color.

A white granular variety from the Trotter mine, Franklin, is nearly pure zinc silicate Clarke obtained: $SiO_2$ 27·41, ZnO 68·86, MnO (FeO) undet., ign. 0·25 = 96·52, Bull. **60**, U. S. G. Surv., p. 130.

**Comp.**—Zinc orthosilicate, $Zn_2SiO_4$ or $2ZnO.SiO_2$ = Silica 27·0, zinc oxide 73·0 = 100. Manganese often replaces a considerable part of the zinc, and iron is also present in small amount.

**Anal.**—1. Thomson, Min., **1**, 545, 1836 2, Monheim, Vh. Ver. Rheinl., 157, 1848, 5th Ed., p. 262. 3, Damour, Dx. Min., **1**, 554, 1862. 4, Lorenzen, Medd. Grönl., **7**, 1884. 5, Genth, Am. Phil. Soc., **24**, 43. 1887. 6, 7, Mixter, Am. J. Sc., **46**, 230, 1868. 7-12, Stone, Sch. Mines Q., **8**, 151, 1887. 13, Koenig, l. c. See 5th Ed. for other analyses (Sterling).

| | *Ordinary.* | G. | $SiO_2$ | ZnO | MnO | FeO | |
|---|---|---|---|---|---|---|---|
| 1. | Altenberg | 3·935 | 26·97 | 68·77 | — | 0·78 | $H_2O$ 1·25, $Al_2O_3$, etc., 1·44 = 99·21 |
| 2. | Stolberg | | 26·90 | 72·91 | — | 0·35 | = 100·16 |
| 3. | Greenland | | 27·86 | 71·51 | 0·37 | | = 99·74 |
| 4. | " | 4·11 | 26·01 | 74·18 | 0·41 | | insol. 0·10 = 100·70 |
| 5. | Socorro Co., New Mexico | 4·10 | 29·16 | 66·79 | — | — | ign. 1·18, gangue 3·33 = 100·46 |
| | *Manganesian*, incl. *Troostite.* | | | | | | |
| 6. | Sterling, *apple-green* | 4·16 | $\frac{2}{2}$ 27·40 | 66·83 | 5·73 | 0·06 | MgO *tr.*, $H_2O$ 0·18 = 100·20 |
| 7. | " " | 4·11 | $\frac{2}{2}$ 27·92 | 57·83 | 12·59 | 0·62 | MgO 1·14, $H_2O$ 0·28 = 100·38 |
| 8. | Franklin, *white* | 4·188 | 27·20 | 65·82 | 6·97 | 0·23 | = 100·22 |
| 9. | " *pale green* | 4·188 | 26·92 | 65·04 | 7·78 | 0·51 | = 100·25 |
| 10. | " *red and white* | 4·182 | 28·30 | 66·68 | 4·92 | 0·31 | = 100·21 |
| 11. | " *greenish yellow* | 4·165 | 27·48 | 63·88 | 8·33 | 0·49 | = 100·18 |
| 12. | " *dark red* | 4·132 | 27·14 | 64·38 | 6·30 | 1·24 | = 99·06 |
| 13. | " *Tephrowillemite* | | $\frac{2}{2}$ 27·75 | 60·61 | 10·04 | 1·80 | CaO *tr.* = 100·20 |

**Pyr., etc.**—B.B. in the forceps glows and fuses with difficulty to a white enamel; the varieties from New Jersey fuse from 3·5 to 4. The powdered mineral on charcoal in R.F. gives a coating, yellow while hot and white on cooling, which, moistened with solution of cobalt, and treated in O.F., is colored bright green. With soda the coating is more readily obtained. Decomposed by hydrochloric acid with separation of gelatinous silica. The N. J. variety phosphoresces with a green light when in the dark after being struck with a hammer.

**Obs.**—From Altenberg near Moresnet, between Liège and Aix-la-Chapelle, in crystals and massive, the crystals but a few millimeters in length; also at Stolberg, near Aix-la-Chapelle; at Musartut, Tunugdliarfik, in Greenland. In New Jersey at Mine Hill, Franklin Furnace, and at Sterling Hill near Ogdensburg, two miles distant, in such quantity as to constitute an important ore of zinc. It occurs intimately mixed with zincite and franklinite, and is found massive of a great variety of colors, from white to pale honey-yellow and light green to dark ash-gray and flesh-red; sometimes in reddish crystals (*troostite*) six inches long and an inch or more thick, embedded in franklinite and also in calcite; rarely in slender transparent prisms of a delicate apple-green color. Rare at the Merritt mine, Socorro Co., New Mexico, with mimetite, wulfenite, etc.

Named by Lévy after William I., King of the Netherlands.

**Artif.**—Obtained crystallized by Gorgeu (Bull. Soc. Min., **10**, 38, 1887) by heating one part of hydrated silica with 30 parts of an intimate mixture of sodium sulphate and $\frac{1}{2}$ to 1 equivalent of zinc sulphate. The fused mass treated in boiling water left characteristic hexagonal crystals with G. = 4·25 and consisting of: $SiO_2$ 26·4, ZnO 73·6.

Observed in furnace slag obtained from lead ores carrying zinc, in minute bright yellow crystals; the mass of the slag consisted of ferrous orthosilicate, fayalite. See Hutchings, Geol. Mag., **7**, 31, 1890. Cf. also Schulze and Stelzner, who describe the occurrence of a hexagonal zinc silicate in slender prismatic crystals, or radiating aggregates embedded in a semi-crystalline ground-mass with zinc spinel and tridymite. Jb. Min., **1**, 150, 1881.

**Ref.**—[1] Franklin Furnace willemite, contact goniometer; Lévy gives $pp' = 51° 30'$. [2] Cf. Dx., Min., **1**, 43, 1862, he adds $03\bar{3}2$ deduced from Breithaupt's figure (Min., **3**, 478, 1847), which is like fig. 1, and probably gives *r* above. Arzruni describes supposed twins from Altenberg with tw. pl. $\frac{3}{5}$-2 $(3 \cdot 3 \cdot \breve{6} \cdot 10)$, Pogg., **152**, 281, 1874.

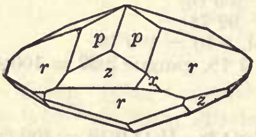
**382. PHENACITE.** Phenakit *N. v. Nordenskiöld*, Ak. H. Stockh., 160, 1833, Pogg., **31**, 57, 1834.

Rhombohedral; tetartohedral. Axis $\dot{c} = 0{\cdot}66107$; $0001 \wedge 10\bar{1}1 = 37° 21' 21''$ Rose–Koksharov[1].

**Forms**[2]:
*m* ($10\bar{1}0$, *I*)
*a* ($11\bar{2}0$, *i*-2)
*k* ($41\bar{5}0$, *i*-$\frac{5}{4}$)
*r* ($10\bar{1}1$, *R*)
*d* ($01\bar{1}2$, $-\frac{1}{2}$)
*z* ($01\bar{1}1$, $-$ 1)
*μ* ($02\bar{2}1$, $-$ 2)
*p* ($11\bar{2}3$, $\frac{2}{3}$-2 r)
*p*, ($2\bar{1}\bar{1}3$, $\frac{2}{3}$-2 l)
*o*, ($42\bar{2}3$, $\frac{4}{3}$-2 l)
*ν*, ($3\bar{1}\bar{2}4$, $\frac{1}{4}^3$ l)
*s*, ($3\bar{1}\bar{2}1$, $1^3$ l)
*λ* ($31\bar{4}2$, $1^2$ r)
*φ* ($13{\cdot}5{\cdot}\bar{1}\bar{8}{\cdot}8$, $1^{\frac{9}{4}}$ r)?
*ν* ($21\bar{3}4$, $\frac{1}{4}^3$ r)
*s* ($21\bar{3}1$, $1^3$ r)
*σ* ($3251$, $1^5$ r)
*z* ($1344$, $-\frac{1}{2}^3$ l)[3]
*ξ* ($13\bar{4}1$, $-$ $2^2$ l)
*x*, ($12\bar{3}2$, $-\frac{1}{2}^3$ l)
*δ* ($1456$, $-\frac{1}{2}^{\frac{5}{3}}$ l)
*x* ($\bar{1}3\bar{2}2$, $-\frac{1}{2}^3$ r)

*ak* = 19° 6′
*mr* = 52° 39′
*m′d* = 69° 7′
*m′μ* = 33° 13½′
*ap* = 66° 13′
*ao* = 48° 36′
*rr′* = 63° 24′
*dd′* = 35° 58½′
*μμ′* = 92° 51′
*rz* = 35° 19′
*rd* = 31° 42′
*ad* = 72° 0½′
*m′r* = 72° 20′
*pp′* = 40° 53′
*pp*, = 23° 16′
*ss*, = 34° 7′
*xx′* = 75° 57′
*xx*, = 26° 54′
*xx*,′ = 55° 26½′
*aσ* = 17° 57′
*as* = 28° 21′
*ar* = *58° 18′
*aν*, = 72° 50′
*ap*, = 78° 22′
*ad″* = 90°
*aμ* = 43° 36′
*ax* = 62° 17′
*ao* = 70° 42′
*ar′* = 90°
*rx*, = 27° 43′
*ro* = 19° 18′
*sr′* = 29° 57′

1.



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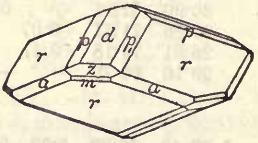

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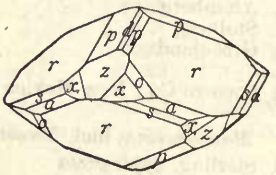

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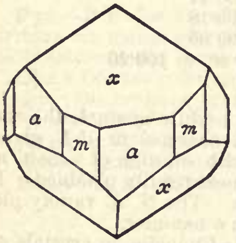

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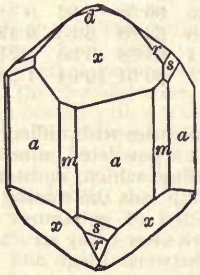

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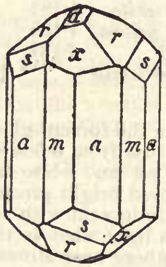

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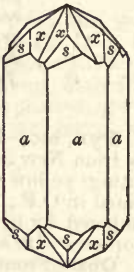

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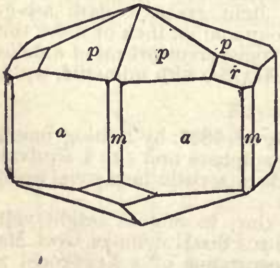

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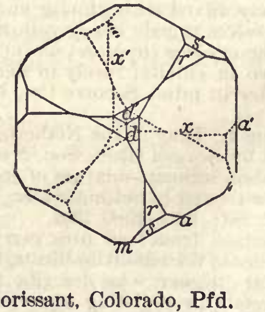

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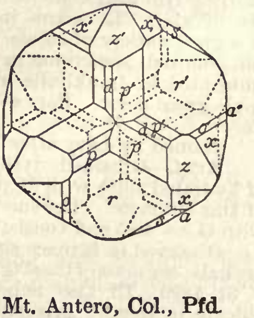

Figs. 1, Miask, Kk. 2, 3, Florissant, Colorado, Pfd. 4–7, Mt. Antero, Col., Pfd. 8, Tokovaya, Kk. 9, Basal section of 5; 10, do. of 3, Pfd.

Twins: penetration-twins with parallel axes, f. 7. Crystals commonly rhombohedral in habit, often lenticular in form, the prisms wanting; also prismatic, sometimes terminated by the rhombohedron of the third series, *x*. Faces often uneven; *x* rough, *a* striated vertically, also ‖ zone *a s r*.

Cleavage: *a* distinct; *r* imperfect. Fracture conchoidal. Brittle. H. = 7·5–8. G. = 2·97–3·00. Luster vitreous. Colorless; also bright wine-yellow, pale rose-red; brown. Transparent to subtranslucent.

Optically +. Refractive indices:

| | | | | |
|---|---|---|---|---|
| Framont | $\omega_r = 1·6508$ Li | $\omega_y = 1·6540$ Na | $\epsilon_r = 1·6673$ | $\epsilon_y = 1·6697$ Dx. |
| Ural | $\omega_r = 1·6495$ | $\omega_y = 1·6527$ | $\omega_{gr} = 1·6555$ Tl | $\epsilon_{gr} = 1·6703$ Pulfrich |

**Comp.**—Beryllium orthosilicate, $Be_2SiO_4$ or $2BeO.SiO_2$ = Silica 54·45, glucina 45·55 = 100.

**Anal.**—1, Hartwall, Pogg., **31**, 57, 1834. 2, Bischof, ibid, **34**, 525, 1835, Rg., Min. Ch., 553, 1860. 3, Khrushchov, Zs. Kr., **3**, 634, 1879. 4, F. H. Hatch, Ber. nied. Ges. Bonn, May 11, 170, 1885. 5, Penfield and Sperry, Am. J. Sc., **36**, 320, 1888.

| | | $SiO_2$ | BeO | |
|---|---|---|---|---|
| 1. Ural | G. = 2·969 | 55·14 | 44·47 | $Al_2O_3$,MgO *tr.* = 99·61 |
| 2. Framont | | 54·40 | 45·57 | CaO,MgO 0·09 = 100·06 |
| 3. Durango | | 54·71 | 45·32 | CaO,MgO 0·14 = 100·17 |
| 4. Switzerland | G. = 2·95 | 54·84 | 44·00 | $Fe_2O_3$ 0·59 = 99·43 |
| 5. Florissant, Colorado | G. = 2·96 | 54·44 | 45·58 | $Na_2O$ 0·21, $Li_2O$ *tr.*, ign. 0·26 = 100·49 |

**Pyr., etc.**—Alone remains unaltered; with borax fuses with extreme slowness, unless pulverized, to a transparent glass. With soda affords a white enamel; with more, intumesces and becomes infusible. Dull blue with cobalt solution.

**Obs.**—Occurs (in prismatic crystals) in mica schist at the emerald and chrysoberyl mine of Takovaya, 85 versts E. of Ekaterinburg, where the crystals are sometimes nearly 4 inches across, and one found weighs 1½ lbs.; also in small rhombohedral crystals on the east side of the Ilmen Mts., 5 versts N. of Miask, with topaz and green feldspar; also in highly modified crystals with quartz, in limonite, near Framont in the Vosges Mts.; in Switzerland with hematite at Reckingen in the Valais, with adularia, hematite (Eisenrosen), quartz. Also at the Cerro del Mercado, Durango, Mexico; part of the so-called phenacite from here is only apatite, but the occurrence has been recently substantiated by Khrushchov (anal. 3); according to him the crystals occur in a quartz porphyry and also loose embedded in clay.

In Colorado, in flat rhombohedral crystals with topaz on amazonstone, also embedded in it, at Topaz Butte, near Florissant, 16 miles from Pike's Peak; also in crystals often prismatic and sometimes an inch across on quartz and beryl at Mt. Antero, Chaffee County. In New Hampshire, in lenticular crystals with topaz on Bald Face Mt., North Chatham, a few miles west of Stoneham, Me. (Kunz). Also reported as occurring at the mica mines of Amelia Court House, Virginia (Yeates).

Named from φέναξ, *a deceiver*, in allusion to its having been mistaken for quartz.

**Artif.**—Obtained by Ebelmen in minute hexagonal prisms by fusion of $SiO_2$ and BeO with borax, cf. Mld., C. R., **105**, 1260, 1887.

**Ref.**—[1] Pogg., **69**, 143, 1846, Min. Russl., **2**, 308, 1857. [2] Cf. Slg., Jb. Min., **1**, 129, 1880, also earlier, N. Nd., l. c.; Beirich, Pogg., **34**, 519, 1835, **41**, 323, 1837; Rose, l. c.; Kk., l. c and ib., 3, 81; Websky, Switzerland, who notes some doubtful planes, in part vicinal, Jb. Min., **1**, 207, 1882. Also Dx., Colorado, Bull. Soc. Min., **9**, 171, 1886; also Pfd., Am. J. Sc., **33**, 130, 1887, **36**, 321, 1888, **40**, 491, 1890. [3] Dx., Min., **2**, p. IX, 1874.

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**383. DIOPTASE.** Achirit *B. F. J. Hermann*, 1788, N Act. Petrop., **13**, 339, 1802. Emeraudine *Delameth.*, T. T., **2**, 230, 1797. Kupfer-Schmaragd *Wern.*, 1800, Ludwig, **1**, 53, 233, 1803. Dioptase *H.*, Tr., 3 477, 1801. Emerald-Copper *Jameson*. Smaragdo-Chalcit *Mohs.*, Gundr., 1824. Emerald-malachite.

Rhombohedral; tetartohedral. Axis $\dot{c}$ = 0·53417; 0001 ∧ $10\bar{1}1$ = 31° 40′ Breithaupt-Koksharov[1].

**Forms:**
*a* $(11\bar{2}0, i\text{-}2)^2$
*k* $(21\bar{3}0, i\text{-}\frac{3}{2}\ r)^7$
*g* $(31\bar{4}0, i\text{-}\frac{4}{3}\ r)^7$
$(17\bar{8}0, -\ i\text{-}\frac{8}{7}\ l)^7$

*r* $(10\bar{1}1, R)^4$
σ $(20\bar{2}1, 2)^7$
*s* $(02\bar{2}1, -2)^3$
*t* $(21\bar{3}1, 1^3\ r)^{5,7}$
ξ $(31\bar{4}1, 2^2\ r)^7$

Zone *as*
β $(7·9·\bar{16}·1, -\ 2^8\ r\ l)^{7}$?
π $(35\bar{8}1, -\ 2^4\ l)^{5}$?
*x* $(13\bar{4}1, -\ 2^2\ l)^8$
*z* $(17\bar{8}3, -\ 2^{\frac{4}{3}}\ l)^6$

δ $(1·11·\bar{12}·5, -\ 2^{\frac{6}{5}}\ l)^7$
*u* $(1·17·\bar{18}·8, -\ 2^{\frac{9}{8}}\ l)^8$
*o* $(\bar{1}·19·\bar{18}·10, -\frac{17}{10}^{\frac{19}{17}}\ r)^{8}$?
α $(\bar{1}323, -\ \frac{1}{5}^3\ r\ l)^{7}$?

*ak* = 10° 54′
*ag* = 16° 6′
*al* = 23° 25′
*rr*′ = *54° 5′
*cs* = 50° 58′

*ss*′ = 84° 33½′
*sσ* = 45° 43′
*ar* = 62° 57½′
*aβ* = 7° 50′

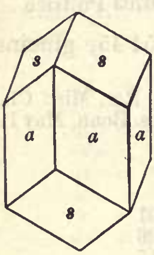
*aπ* = 15° 22½′
*ax* = 28° 48′
*az* = 39° 31′
*aδ* = 42° 30′

*au* = 44° 21′
*as* = 47° 43′
*ao* = 50° 42′
*at* = 33° 9′

Twins[7]: tw. pl. *r*, as geniculated twins. Commonly in prismatic crystals, *a*, with *s* (02$\bar{2}$1), fig. 1. Faces in zone *a s* striated ‖ edge *a*/*s*. The hemi-scalenohedrons, or rhombohedrons of the third series, sometimes characteristically developed as on the edge *a s* (f. 2), but often indistinctly indicated. Also indistinct crystalline aggregates; massive.

Cleavage: *r* perfect. Fracture conchoidal to uneven. Brittle. H. = 5. G. = 3·28–3·35. Luster vitreous. Color emerald-green. Streak green. Transparent to subtranslucent. Optically positive. Double refraction strong. Refractive indices: $\omega = 1·667$, $\epsilon = 1·723$ Mlr.[8] Pyroelectric.

1.



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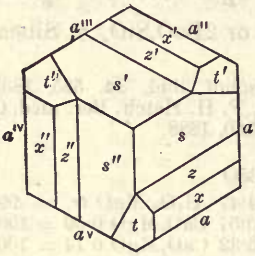

**Comp.**—$H_2CuSiO_4$ or $H_2O.CuO.SiO_2$ = Silica 38·2, cupric oxide 50·4, water 11·4 = 100. Loses water only at a red heat, the hydrogen consequently basic (Rg.).

Tschermak writes the formula $(CuOH)HSiO_3$.

**Anal.**—1, 2, Damour, Ann. Ch. Phys., **10**, 485, 1844; earlier Hess, Pogg., **16**, 360, 1829.

| | $SiO_2$ | CuO | $H_2O$ |
|---|---|---|---|
| 1. | 36·47 | 50·10 | 11·40 $Fe_2O_3$ 0·42, $CaCO_3$ 0·35 = 98·74 |
| 2. | 38·93 | 49·51 | 11·27 = 99·71 |

Groth assumes that chrysocolla is merely dioptase mingled with amorphous silica and other impurities. There seems little doubt, however, notwithstanding the impurity of much of the material analyzed, that chrysocolla deserves to be recognized as a definite hydrous species chiefly amorphous in structure. See further p. 699.

**Pyr., etc.**—In the closed tube blackens and yields water. B.B. decrepitates, colors the flame emerald-green, but is infusible. With the fluxes gives the reactions for copper. With soda and charcoal a globule of metallic copper. Gelatinizes with hydrochloric acid.

**Obs.**—Dioptase occurs in druses of well defined crystals on quartz, occupying seams in a compact limestone west of the hill of Altyn-Tübe in the Kirghese Steppes. In the gold washings at several points in Siberia, as on the R. Malaya in Transbaikal. At Rezbánya, Hungary on a bluish clay, or on wulfenite and calamine. From Copiapo, Chili, on quartz with other copper ores, also on limonite, crystals terminated by *r* (Rath), also crusts. G. = 3·325 Bauer. In fine crystals at the Mine Mindouli, two leagues east of Comba, between Bouanza and Brazzaville in the French Congo State, associated with hyaline silica and chrysocolla (Jannettaz, Bull. Soc. Min., **13**, 159, 1890).

At the copper mines of Clifton, Graham Co., Arizona, in brilliant crystals lining cavities in "mahogany ore" consisting of limonite and copper oxide; also 100 miles west, near Riverside P. O., Pinal Co.

Named by Haüy *dioptase*, from *διά, through*, and *ὄπτομαι, to see*, because the cleavage directions were distinguishable on looking through the crystal.

Named *Achirite* after Achir Mahméd, a Bucharian merchant, living at the fortress of Semipalatinsk, who had procured it in the region where it occurred, and who furnished the specimens that were taken in 1785 by Mr. Bogdanov to St. Petersburg. Although first named by Hermann, his description was not given to the St. Petersburg Academy before 1800, and the volume containing it was not published until 1802, a year after the appearance of Haüy's work.

**Ref.**—[1] Breith., Schweigg. J., **62**, 221, 1831, confirmed by Koksharov, Min., **6**, 285, 1870, both on cleavage forms. [2] Haüy, l. c., 1801. [3] Breith., l. c., he gives for *o*, $-\frac{12}{7}^{\frac{10}{9}}$ (*so* = 2° 52′), for *u*, $-2^{\frac{7}{8}}$ (*su* = 3° 22′), which symbols do not agree with the angles; the symbols given above were calculated by Websky. Kenngott suggests others slightly different.

[4] Lévy, Heuland, **3**, 92, 1837. [5] Credner. Jb. Min., 404, 1839; he gives no angles. [6] Websky Pogg., **69**. 543, 1846; corrects Breithaupt. [7] Kenng., Min. Unt., 93, 1850; review of preceding, the position of *k*, *g*, *l*, is uncertain; ξ may be the same as Websky's doubtful *v*; see, too, Hausm. Handb.. **2**, 746, 1847; *α*, *β* were observed as complete scalenohedrons. [8] Mlr., Phil. Mag., **21**, 278, 1842.

**384. FRIEDELITE.** *Bertrand*, C. R., **82**, 1167, 1876; Zs. Kryst., **1**, 86, 1877.

Rhombohedral. Axis $\dot{c} = 0·5624$; $0001 \wedge 10\bar{1}1 = {}^*33°$ Bertrand.

**Forms:** *c* (0001, *O*), *m* ($10\bar{1}0$, *I*). *r* ($10\bar{1}1$, *R*). Angles: *cr* = 33°, *rr′* = 56° 17′.

Crystals commonly tabular ‖ *c*; faces *m*, *r* often striated ‖ edge *m*/*r*. Also massive, with saccharoidal structure and distinct cleavage, passing into close compact forms with indistinct cleavage.

Cleavage: *c* perfect. H. = 4–5. G. = 3·07. Color rose-red. Powder pale rose. Transparent to translucent. Optically −. Double refraction strong.

**Comp.**—$H_7(MnCl)Mn_4Si_4O_{16}$ as written by Groth. Percentage composition: Silica 35·1, manganese protoxide 51·7 (or MnO 46·5, Mn 4·0), chlorine 5·2, water 9·2 = 101·2, deduct (O = 2Cl) 1·2 = 100.

**Anal.**—Gorgeu, Bull. Soc. Min., **7**, 3, 58, 1884.

$SiO_2$ 34·45 MnO 48·25 MgO 1·20 CaO 0·40 Mn 2·60 Cl 3·40 $H_2O$ 9·60 = 99·90

In an earlier analysis by Bertrand (l. c.) the chlorine was overlooked. The material used by Gorgeu was not entirely pure. Cf. Friedel, ib., p. 71.

**Pyr.**—B.B. fuses easily to a black glass. Gives off water in the closed tube on strong ignition. Reaction for manganese with the fluxes. Dissolves in hydrochloric acid, forming a jelly.

**Obs.**—Associated with rhodochrosite and alabandite at the manganese mine of Adervielle, vallée du Louron, Hautes Pyrénées. Named after the French chemist and mineralogist Ch. Friedel. See also p. 1035.

**385. PYROSMALITE.** Pirodmalit *Hausm.*, Moll's Efem., **4**, 390, 1808. Wesentlicher Bestandtheil Salzsaures Eisenoxyd, *id.*, ib. (fr. blowpipe trials of Gahn, its discoverer). Pyrosmalit *Karst.*, Tab., 103, 1808; *Hausm.*, Handb., 1068, 1813. Fer muriaté *H.*, 1812, Lucas Tabl., **2**, 418, 1813.

Rhombohedral. Axis $\dot{c} = 0·5308$; $0001 \wedge 10\bar{1}1 = 31°\ 30\tfrac{1}{4}'$ A. E. Nordenskiöld[1].

**Forms:** *c* (0001, *O*); *m* ($10\bar{1}0$, *I*); *r* ($10\bar{1}1$, 1), *z* ($01\bar{1}1$, − 1); *σ* ($20\bar{2}1$, 2), *s* ($02\bar{2}1$, − 2).

Angles: *cr* = 31° 30′, *cσ* = 50° 48′, *mr* = 58° 30′, *rr′* = 53° 49′, *rz* = 30° 17½′, *σs* = 45° 35, *σσ′* = 84° 18′.

Crystals thick prismatic or tabular in habit, usually with *m*, *r*, *z*, hence apparently hexagonal. Also massive, foliated.

Cleavage: *c* perfect; *m* imperfect. Fracture uneven, rather splintery. Somewhat brittle. H. = 4–4·5. G. = 3·06–3·19. Luster of *c* pearly; of other planes, less so. Color blackish green to pale liver-brown, passing into gray and pistachio-green; usually brown externally, and light greenish yellow internally. Streak paler than color. Optically −. Double refraction strong.

**Comp.**—$H_7((Fe,Mn)Cl)(Fe,Mn)_4Si_4O_{16}$ = Silica 34·9, iron protoxide 26·2, manganese protoxide 25·8, chlorine 5·1, water 9·2 = 101·2, deduct (O = 2Cl) 1·2 = 100. Here Fe : Mn = 1 : 1.

**Anal.**—1, Lang, J. pr. Ch., **83**, 424, 1861. Also Wöhler, Lieb. Ann., **156**, 85, 1870. 2, Ludwig, Min. Mitth., 211, 1875. 3, Engström, G. För. Förh., **3**, 116, 1876. 4, Gorgeu, Bull. Soc. Min., **7**, 58, 1884.

| | | | $SiO_2$ | FeO | MnO | CaO | MgO | $H_2O$ | Cl | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Nordmark | G. = 3·171 | $\frac{2}{2}$ | 35·43 | 30·72 | 21·01 | 0·74 | — | 7·75 | 3·79 | $Al_2O_3$ 0·24 | = 99·68 |
| 2. “ | G. = 3·153 | $\frac{3}{3}$ | 34·66 | 27·05 | 25·60 | 0·52 | 0·93 | 8·31 | 4·88 | | = 101·95 |
| 3. Dannemora | G. = 3·059 | $\frac{2}{2}$ | 34·03 | 26·21 | 27·40 | 0·36 | 1·36 | 7·34 | 3·52 | $Al_2O_3$ 1·24 | = 101·46 |
| 4. “ | G. = 3·19 | | 34·20 | 23·50[a] | 24·65 | 0·40 | 1·70 | 8·55 | 3·70 | $Al_2O_3$ *tr.* | = |

[a] $Fe_2O_3$ 2·92.

**Pyr., etc.**—In the closed tube yields water, which reacts acid. B.B. fuses at 2–2·5 to a black magnetic glass. With the fluxes gives reactions for iron and manganese. A bead of salt of phosphorus, previously saturated with oxide of copper, when fused with the pulverized mineral imparts a beautiful azure color to the flame (chlorine). Decomposed by hydrochloric acid, with separation of silica.

**Obs.**—Pyrosmalite occurs at Bjelkegruva, one of the iron mines of Nordmark in Wermland, Sweden, where it is associated with calcite, pyroxene, apophyllite, and magnetite. A hexagonal prism, in the museum at Stockholm, is nearly an inch in diameter and one and a quarter inches long, and weighs five and a half ounces. Also from the Kogrufva in Nordmark and at the iron mines at Dannemora in foliated masses with a green pyroxene.

Named from πῦρ, *fire*, ὀσμή, *odor*, in allusion to the odor when heated.

**Ref.**—Öfv. Ak. Stockh., **27**, 562, 1870. The rhombohedral character of the crystals may be assumed on the basis of the isomorphism with friedelite.

## 7. Scapolite Group. Tetragonal.

| | | |
|---|---|---|
| 386. | **Meionite** | ċ = 0·4393 |
| 387. | **Wernerite** | ċ = 0·4384 |
| 388. | **Mizzonite** | ċ = 0·4424 |
| | Dipyre | |
| 389. | **Marialite** | ċ = 0·4417 |

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| | | |
|---|---|---|
| 390. | **Sarcolite** | ½ċ = 0·4437 |

The species of the SCAPOLITE GROUP are tetragonal in crystallization, with nearly the same axial ratio, and further they are characterized by pyramidal hemihedrism. They are white or grayish white in color, except when impure, and then rarely of dark color. Hardness = 5–6·5; G. = 2·5–2·8. In composition they are silicates of aluminium with calcium and sodium in varying amounts; chlorine is also often present, sometimes only in traces. Iron, magnesia, potash are not present unless by reason of inclusions or of alteration, which last cause also explains the carbon dioxide often found in analysis.

The Scapolites are analogous to the Feldspars in that they form a series with a gradual variation in composition, the amount of silica increasing with the increase of the alkali, soda, being 40 p. c. in meionite and 64 p. c. in marialite. A corresponding increase is observed also in the amount of chlorine present. Furthermore there is also a gradual change in specific gravity, in the strength of the double refraction, and in resistance to acids, from the easily decomposed meionite, with G. = 2·72, to marialite, which is only slightly attacked and has G. = 2·63.

Tschermak[1] has shown that the variation in composition may be explained by the assumption of two fundamental end compounds, viz.:

| | | |
|---|---|---|
| Meionite | $Ca_4Al_6Si_6O_{25}$ | Me |
| Marialite | $Na_4Al_3Si_9O_{24}Cl$ | Ma |

By the isomorphous combination of these compounds the composition of the species recognized may be explained. These species are: Meionite, Wernerite or Common Scapolite, Mizzonite (and Dipyre), Marialite. The limits of each are explained in the following pages; it is to be noticed, however, that no sharp line can be drawn between them, and a single locality in some cases has afforded specimens having widely different composition.

Lacroix, who has given an exhaustive memoir on the scapolite rocks of many different localities (Bull. Soc. Min., **12**, 83–360, 1889), shows that optically the series is characterized by the decrease in the strength of the double refraction in passing from meionite to marialite. In the table below, quoted from him (p. 357), group I includes the compounds from Me to $Me_2Ma_1$; II from $Me_2Ma_1$ to $Me_1Ma_3$; III from $Me_1Ma_3$ to Ma.

| I. | $\omega_y$ | $\epsilon_y$ | $\omega-\epsilon$ |
|---|---|---|---|
| Hallesta | 1·594 | 1·557 | 0·037 |
| Christiansand | 1·592 | 1·555 | 0·037 |
| Somma, *Meionite* | 1·594 | 1·558 | 0·036 |
| Bolton, *Nuttalite* | 1·588 | 1·552 | 0·036 |
| Malsjö | 1·588 | 1·553 | 0·035 |
| Boltonite | 1·583 | 1·552 | 0·031 |
| L. Baikal, *Glaucolite* | 1·581 | 1·551 | 0·030 |
| Laurinkari | 1·583 | 1·553 | 0·030 |
| Arendal | 1·583 | 1·554 | 0·029 |

| II. | $\omega_y$ | $\epsilon_y$ | $\omega-\epsilon$ |
|---|---|---|---|
| Ersby | 1·570 | 1·547 | 0·023 |
| Arendal, Dx. | 1·566 | 1·545 | 0·021 |
| Pargas | 1·567 | 1·550 | 0·017 |
| III. | | | |
| Pyrenees, Dx., *Dipyre* | 1·558 | 1·543 | 0·015 |
| Pierrepont | 1·562 | 1·546 | 0·016 |

The Scapolites occur (1) in volcanic rocks, as in ejected masses on Mte. Somma (meionite); (2) in crystalline limestone, often as the direct result of contact metamorphism; (3) crystalline schists, augite-gneiss, etc.; (4) as an alteration product of a plagioclase feldspar sometimes on an extensive scale as with amphibole in the "gefleckter Gabbro" (Brögger and Reusch, Zs. G. Ges., **27**, 646, 1875) in connection with the apatite deposits of Ödegaarden near Bamle, Norway. Cf. Lcx., l.c., who has developed this subject at length; also Michel-Lévy, Bull Soc. Min., **1**, 43, 79, 1878; Judd, Min. Mag., 8, 186, 1889.

Meionite was the first species of the Scapolite group distinctly recognized. It is, however, probable that scapolite was included with lamellar pyroxene under the name of *White Schörl-Spar* (Skörlspat) by Cronstedt, who mentions Pargas, in Finland, as one of its localities. The names *Wernerite* and *Scapolite* were both introduced by d'Andrada (of Portugal) in the same article (Scherer's J., **4**, 35, 38, 1800), and applied to specimens from the same region in Norway. Wernerite is the *first* of the two in the article. Haüy used the names *Wernerite* and *Scapolite* (supposing the species distinct) in his Traité of 1801, but in his Mineralogical Course for 1804 or 1805 arbitrarily set aside the latter for *Paranthine.* Monteiro, a friend of d'Andrada's, and speaking in his behalf, protested in 1809 (J. Phys., **68**, 177) against the change, and after arguing that wernerite and scapolite were identical, both on chemical and crystallographic grounds, urged the adoption of the name *Wernerite* for the species. In the following pages the name Scapolite is retained for the group, so that the minerals may all be called *scapolites*, as those of the feldspar group are called feldspars; and the name Wernerite is applied to the most prominent division of the old species, including the common scapolite from many localities. In the fifth edition the compounds intermediate between meionite and wernerite were called paranthite, and those between wernerite and mizzonite were called ekebergite.

**Ref.**—[1] Ber. Ak. Wien, **88** (1), 1142, 1883, Min. Mitth., **7**, 400, 1886. Rammelsberg has also discussed the same subject recently, see Ber. Ak. Berlin, 589, 1885. Early papers on the composition of the species are those by Wolff, Inaug. Diss., Berlin, 1843; Rath, Pogg., **90**, 82, 288, 1863.

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**386. MEIONITE.** Hyacinte blanche de la Somma *de Lisle,* Crist., **2**, 289, 290, Pl. IV, f. 118, 1783. Meionite *H.*, Tr., **2**, 1801. Mionite *Century Dictionary,* 1890.

ERSBYITE. Wasserfreier Scolezit [fr. Pargas] *N. Nd.*, Schw. J., **31**, 417, 1821. Anhydrous Scolecite. Scolexerose *Beud.*, Tr., **2**, 55, 1832. Var. of Labrador *Frankenheim*, Syst. d. Kryst., 136, 1842. Ersbyit *A. E. Nd.*, Finl. Min., 129, 1853. Kalk-Labrador *Rg.*, Min. Ch., 595, 1860.

Tetragonal. Axis $\dot{c} = 0{\cdot}43925$; $001 \wedge 101 = 23° 42\frac{5}{6}'$ Scacchi-Koksharov[1].

**Forms:** *c* (001, *O*); *a* (100, *i-i*), *m* (110, *I*), *h* (210, *i-2*), *e* (101, 1-*i*); *r* (111, 1), *w* (331, 3); *z* (311, 3-3).

$ah = 26° 34'$
$mh = 18° 26'$
$ee' = 33° 2\frac{1}{2}'$
$ee'' = 47° 26'$

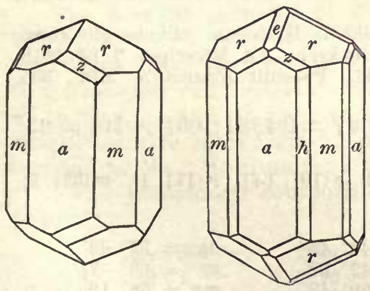
$ww' = 77° 5'$
$cr = 31° 51'$
$cw = 61° 47'$
$cz = 54° 15'$

$rr' = {}^{*}43° 49'$
$zz' = 42° 34'$
$zz^{vii} = 29° 44\frac{1}{2}'$

$mr = 58° 9'$
$ar = 68° 5\frac{1}{2}'$
$az = 39° 39'$

In crystals, either clear and glassy or milky white; also in crystalline grains and massive. The prismatic faces sometimes show vicinal prominences corresponding in form to the hemihedral character; with which also the etching-figures agree.

1. 2.



1, 2, Monte Somma. 1, Brezina; 2, after Rath.

Cleavage: *a* rather perfect, *m* somewhat less so; both often interrupted. Fracture conchoidal. Brittle. H. = 5·5–6. G. = 2·70–2·74; 2·734–2·737 Mte. Somma, Rath. Luster vitreous. Colorless to white. Transparent to translucent; often cracked within. Optically —. Double refraction weak. Indices, Dx.:

$$\omega_y = 1{\cdot}594 \text{ to } 1{\cdot}597 \qquad \epsilon_y = 1{\cdot}558 \text{ to } 1{\cdot}561$$

**Comp.**—$Ca_4Al_6Si_6O_{25}$ or $4CaO.3Al_2O_3.6SiO_2$ = Silica 40·5, alumina 34·4, lime 25·1 = 100. As explained by Tschermak, the varieties included range from nearly pure meionite to those consisting of meionite and marialite in the ratio of 3 : 1, *i.e.*, Me : Ma = 3 : 1. No sharp line can be drawn between meionite and the following species; see further p. 469.

**Anal.**—1, 2, Neminar, Min. Mitth., 51, 1875, 63, 1877. 3, Rath, Pogg., **90**, 87, 1853. 4, Rg., Min. Ch., Erg., 209, 1886. 5, Rath, Pogg., **144**, 384, 1871. 6, Wolff [Inaug. Diss., Berlin, 1843], Rg., Min. Ch. 7, Rath, Pogg., **90**, 195, 1853. Also Gmelin, Stromeyer, Wolff, 5th Ed., p. 320. Rath, Pogg., **119**, 268, 1863.

|  | G. | $SiO_2$ | $Al_2O_3$ | CaO | MgO | $Na_2O$ | $K_2O$ | Cl | $H_2O$[a] |  |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Vesuvius | 2·716 | 43·36 | 32·09 | 21·45 | 0·31 | 1·35 | 0·76 | 0·14 | 0·27 | $CO_2$ 0·72 = 100·45 |
| 2. " | 2·736 | 42·55 | 30·89 | 21·41 | 0·83 | 1·25 | 0·93 | — | 0·19 | $Fe_2O_3$ 0·41 = 98·46 |
| 3. Laach | 2·769 | 45·13 | 29·83 | 18·98 | 0·13 | 2·73 | 1·40 | — | 0·41 | = 98·61 |
| 4. *Ersbyite* |  | 44·47 | 30·69 | 20·54 | 0·16 | 2·49 |  | 0·20 | 1·07 | = 99·62 |
| 5. " | 2·723 | 44·26 | 30·37 | 20·17 | 0·15 | 2·75 | 1·15 | — | — | = 98·85 |
| 6. Pargas | 2·712 | 45·10 | 32·76 | 17·84 | — | 0·76 | 0·68 | — | 1·04 | = 98·18 |
| 7. Bolton | 2·788 $\frac{2}{2}$ | 44·40 | 25·52 | 20·18 | 1·01 | 2·09 | 0·51 | — | 1·24 | $Fe_2O_3$ 3·79 = 98·74 |

[a] Often simply = loss on ignition.

Sipöcz found in Vesuvian meionite 0·74 p. c. Cl, 0·22 $SO_3$, Tsch., l. c.

Paranthite (paranthine), the name given in the 5th Ed. to the compounds between the Vesuvian meionite and wernerite (*e.g.*, anals. 4–7) is Haüy's name (as already noted) derived from *παρανθεῖν*, *to wither*, because it readily loses its luster.

**Pyr., etc.**—B.B. fuses with intumescence at 3 to a white blebby glass. Decomposed by acid without gelatinizing (Rath). Gmelin states it to be fusible with difficulty on the edges, and both Gmelin and Kobell state that it gelatinizes with hydrochloric acid. An examination of a specimen received from Scacchi fully confirms Rath's conclusions.

**Obs.**—Occurs in small crystals in cavities, usually in limestone blocks, on Monte Somma; the cavities are often lined with green mica. Also in ejected masses with sanidine, magnetite, titanite, augite, apatite at the Laacher See.

*Ersbyite* is from Ersby near Pargas, Finland. A variety of scapolite from Bolton, Mass., *Nuttalite* (see p. 469) is near ersbyite in composition.

Named by Haüy from *μεῖον*, *less*, the pyramid being less acute than that of vesuvianite.

**Ref.**—[1] Min. Russl., **2**, 105; Pogg., Erg., **3**, 478, 1851. Cf. also Rg., **94**, 434, 1855; Dx., Min., **1**, 221, 1862; Rath, ib., **119**, 262, 1863; Brezina, Min. Mitth., 16, 1872.

**Artif.**—Attempts to form meionite by fusion have resulted in obtaining an orthosilicate corresponding in composition to $Na_2O.5CaO.4Al_2O_3.9SiO_2$, but characterized by positive optical character. With a mixture of $6CaO.4Al_2O_3.9SiO_2$, anorthite was formed. By fusing a labradorite glass with white marble, anorthite and a tetragonal mineral with negative character was obtained. Bourgeois, Bull. Soc. Min., **5**, 15, 1882, Reprod. Min., 132, 1884.

Doelter states that his synthetic experiments (unpubl.) prove the existence of a tetragonal mineral, corresponding to meionite, having the composition $CaAl_2(SiO_4)_2$. Allg. Chem. Min., p. 258, 1890.

### 387. WERNERITE.

**387. WERNERITE.** Wernerite (fr. Norway) *d'Andrada*, J. Phys., **51**, 244, 1800, Scherer's J., **4**, 35, 1800. Scapolite (fr. Norway) *d'Andrada*, ib., 246, and ib., 38, 1800. Rapidolith *Abildgaard*, Ann. Ch., **32**, 195, 1800. Wernerite, Scapolite, *H.*, Tr., **3**, **4**, 1801. Skapolith, Arcticit [= Wernerite] *Wern.*, 1803, Ludwig's Wern., **2**, 210 1804 Paranthine *H.*, Lucas Tabl., 205, 1806; H. Comp. Tabl., 45, 1809. Fuscit *Schumacher*, Verzeichn., 104, 1801. Chelmsfordite *J. F. & S. L. Dana*, Outl. Min. G. Boston, 44, 1818. Nuttallite *Brooke*, Ann. Phil., **7**, 316, 1824. Glaukolith *v. Fischer*, Sokolov's Bergwerks J.; John. Chem. Unters., **2**, 82, 1810; Glaucolite.

Sodait *Ekeberg*, Afh., **2**, 153, 1807. Natrolite of Hesselkulla *Wollaston*. Ekebergite *Berz.*, Årsb., 168, 1824. Ekebergit, Porzellanspath *J. N. Fuchs*, Denkschr. Ak. München, **7**, 65, 1818, Tasch. Min., **17**, 94, 1823. Porzellanit *Kbl.*, Taf., 52, 1853. Passauit *Naumann*, Min., 305, 1855. Ontariolite *C. U. Shepard*, Am. J. Sc., **20**, 54, 1880.

Tetragonal, with pyramidal hemihedrism. Axis $\dot{c} = 0·4384$; $001 \wedge 101 = 23°\ 40\frac{1}{3}'$ Schuster[1].

**Forms**[2]: *c* (001, *O*), *a* (100, *i-i*), *m* (110, *I*), *h* (210, *i*-2) *e* (101, 1-*i*), *r* (111, 1), *w* (331, 3), *z* (311, 3-3).

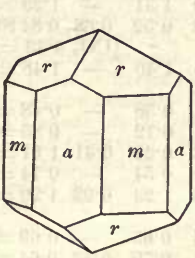
|  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|
| *ah* | = 26° 34′ | *cr* | = 31° 48′ | *rr′* | = *43° 45′ | *az* | = 39° 42′ |
| *mh* | = 18° 26′ | *cw* | = 61° 44′ | *zz′* | = 42° 32′ | *ar* | = 68° $7\frac{1}{2}'$ |
| *ee′* | = 32° 59′ | *cz* | = 54° 12′ | $zz^{vii}$ | = 29° 43′ | *mr* | = 58° 12′ |
| *ee″* | = 47° 21′ |  |  |  |  |  |  |

Crystals usually coarse, with rough uneven faces and often very large. The pyramidal hemihedrism sometimes shown (f. 3) in the development of the planes *z* (311) and $z_,$ (131). Also massive, granular, or with a faint fibrous appearance; sometimes columnar.

Cleavage: *a* and *m* rather distinct, but interrupted. Fracture subconchoidal. Brittle. H. = 5–6. G. = 2·66–2·73. Luster vitreous to pearly externally, inclining to resinous; cleavage and cross-fracture surface vitreous. Color white, gray, bluish, greenish, and reddish, usually light; streak uncolored. Transparent to faintly subtranslucent. Optically –. Double refraction weak. Indices:

Arendal $\omega_r = 1·566$ $\epsilon_r = 1·545$. See also p. 466.

1.



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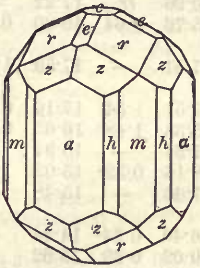
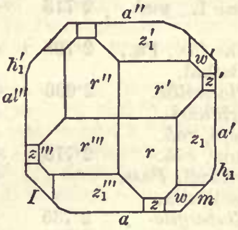


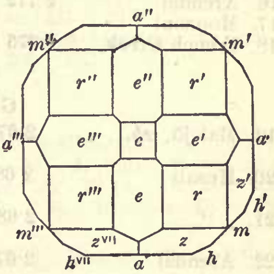
3.



Figs. 1, Common form. 2, 4, Grasse Lake, N. Y., Hovey. 3, Hirwensalo, Finland, Nd.

**Var.**—1. *Ordinary*. In crystals, white to gray, grayish green, brownish, and rarely, from impurity, nearly black. The prisms are sometimes several inches thick.

4.



*Nuttallite* (named after T. Nuttall) is white to smoky brown scapolite from Bolton, Mass. It has been shown to vary widely in composition; some kinds approach meionite, p. 467, and it is sometimes much altered. The crystals and massive variety of Chelmsford, Mass., of gray, greenish, and reddish shades of color, have been called *Chelmsfordite*.

*Passauite* or Porzellanspath is from Obernzell near Passau, Bavaria. Fuchs made the prisms probably about 92°, and so also did Schafhäutl. But Des Cloizeaux found that it was uniaxial and negative, and hence must be tetragonal in crystallization. Its colors are white to yellowish, bluish, and grayish white. The crystals are coarse, and irregularly grouped or single.

*Ontariolite* of *Shepard* is a glassy scapolite from Galway, Peterborough Co., Ontario; often black from inclusions, probably of graphite. It may prove, as suggested by Shepard, to belong with mizzonite and dipyre. G. = 2·608. Shepard's analysis gives $SiO_2$ 48·65 to 51·30, etc., but has little value because of the impurity of the material.

2. *Massive*. *Glaucolite* is of pale violet-blue, bluish, indigo-blue, to greenish gray colors, sometimes resembling cancrinite, but having the cleavage of scapolite. It is from near R. Sliudianka, near L. Baikal, Siberia, where it occurs in veins in granite The pink scapolite of Bolton is similar. Named from γλαυκός, *greenish gray* or *sea green*.

The so-called glaucolite of Weibye, from Norway, has been shown by Brögger to be sodalite (see p. 429), and a so-called glaucolite from L. Baikal also proved to be sodalite.

**Comp., Var.**—Intermediate between meionite and marialite and corresponding to a molecular combination of these in a ratio 3 : 1 to 1 : 2. The silica varies from 46 to 54 p. c., and as its amount increases the soda and chlorine also increase. Scapolites with silica from 54 p. c. to 60 p. c. are classed with mizzonite; they correspond to Me : Ma from 1 : 2 to 1 : 3 and upwards.

The percentage composition, for the simple compounds of Me : Ma, is as follows:

| Me : Ma | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | Cl | | |
|---|---|---|---|---|---|---|---|
| 3 : 1 | 46·10 | 30·48 | 19·10 | 3·54 | 1·01 | = | 100·23 |
| 2 : 1 | 48·03 | 29·16 | 17·04 | 4·76 | 1·35 | = | 100·34 |
| 1 : 1 | 51·90 | 26·47 | 12·90 | 7·15 | 2·04 | = | 100·45 |
| 1 : 2 | 55·85 | 23·73 | 8·67 | 9·62 | 2·75 | = | 100·62 |
| 1 : 3 | 57·85 | 22·35 | 6·53 | 10·87 | 3·10 | = | 100·70 |

The oxygen-equivalent of the chlorine is to be deducted.

**Anal.**—1, Rath, Pogg., **90**, 101. 1853. 2, E. S. Sperry, priv. contr. 3, Leeds, Am. J. Sc., **6**, 26, 1873. 4, Rath, l. c., p. 90. 5, Wolff, Rg., Min. Ch., 719, 1860. 6, Rg., Min. Ch., Erg., 210,

1886. 7, Wolff, l. c. 8, Schaffhäutl, Lieb. Ann., **46**, 340, 1843. 9, Wolff, l. c. 10, Sipöcz, Min. Mitth., 266, 1877, after deducting 6·82 $CaCO_3$. 11, Wolff, l. c. 12, Becke, Min. Mitth., 267, 1877, deducting 6·2 p. c. $CaCO_3$. 13, Rath, l. c., recalc. by Rg., deducting 1·68 p. c. $CaCO_3$. 14, Kbl., J. pr. Ch., **1**, 89, 1834. 15, Rg., Ber. Ak. Berlin. 605, 1885. 16, Wolff, l c. 17, Kiepenheuer, quoted by Rath, Ber. nied. Ges., p. 381, Aug. 4, 1879. 18, Genth, Am. J. Sc., **40**, 116, 1890. 19, Sipöcz, Min. Mitth., **4**, 265, 1881, and Tsch., l. c., p. 1153, where the chlorine percentages are corrected. 20, 21, Lacroix, Bull. Soc. Min., **12**, 175, 1889. 22, 23, Sipöcz, l. c. 24, Rg., l. c. 25, E. S. Sperry, priv. contr. 26, Rg., l. c.

| | G. | $SiO_2$ | $Al_2O_3$ | FeO | CaO | MgO | $Na_2O$ | $K_2O$ | Cl | $H_2O$[b] | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Pargas, *gnh.* | 2·654 | 45·46 | 30·96 | *tr.* | 17·22 | — | 2·29 | 1·31 | — | 1·29 | = 98·53 |
| 2. Grasse L., *ywh.* | 2·713 | 46·94 | 25·76 | 0·64 | 16·89 | 0·52 | 3·88 | 0·52 | 0·68 | 0·84 | $SO_3$ 0·25 [$CO_2$ 4·33 = 101·25 |
| 3. Bucks Co., Pa., | 2·708 | 47·47 | 27·51 | — | 17·59 | 1·20 | 3·05 | 1·40 | — | 1·48 | = 99·70 |
| 4. L. Baikal, *Glaucolite* | 2·666 | 47·49 | 27·57 | 1·54 | 17·16 | 0·47 | 4·71 | 0·58 | — | 0·48 | = 100 |
| 5. Laurinkari | | 48·15 | 25·38 | 1·48[a] | 16·63 | 0·84 | 4·91 | 0·12 | — | 0·85 | = 98·45 |
| 6. Malsjö, *rdh.* | | 48·06 | 27·34 | — | 15·94 | — | 6·33 | 0·22 | 0·41 | 1·61 | = 99·91 |
| 7. Bolton, *rdh.* | 2·718 | 48·79 | 28·16 | 0·32[a] | 15·02 | 1·29 | 4·52 | 0·54 | — | 0·74 | = 99·28 |
| 8. Obernzell, *Pass.* | | 49·20 | 27·30 | — | 15·48 | — | 4·53 | 1·23 | 0·92 | 1·20 | = 99·86 |
| 9. Hesselkulla, *Ekebergite* | 2·735 | 49·26 | 26·40 | 0·54[a] | 14·44 | — | 6·14 | 0·65 | — | 0·69 | = 98·12 |
| 10. Rossie, *gnh.* | 2·731 | 49·40 | 30·02 | 0·32 | 15·62 | — | 3·11 | 0·79 | 0·13 | 0·64 | = 100·03 |
| 11. Malsjö | 2·623 | 49·88 | 27·02 | 0·21[a] | 12·71 | 0·85 | 7·59 | 0·87 | — | 0·77 | = 99·90 |
| 12. Boxborough, *wh.* | 2·720 | 50·53 | 29·31 | 0·49 | 13·37 | 0·46 | 3·91 | 1·23 | 0·21 | 0·54 | = 100·05 |
| 13. Malsjö. *wh.* | 2·658 | 50·04 | 25·68 | — | 12·64 | 1·06 | 5·89 | 1·54 | — | 2·50 | = 99·35 |
| 14. Obernzell, *Passauite* | | 50·29 | 27·39 | — | 13·53 | — | 5·92 | 0·17 | — | — | = 97·30 |
| 15. St. Lawrence Co. | 2·621 | 50·73 | 25·49 | — | 10·24 | — | 11·09 | — | 0·09 | 1·96 | = 99·60 |
| 16. Arendal | 2·712 | 50·91 | 25·81 | 0·75[a] | 13·34 | 0·58 | 7·09 | 0·85 | — | 0·41 | = 99·74 |
| 17. Monzoni | | 52·19 | 23·54 | *tr.* | 9·61 | — | 12·65 | 2·11 | — | — | = 100·10 |
| 18. French Creek, | 2·675 | 52·30 | 23·68 | 0·58[a] | 12·36 | 0·05 | 6·29 | 0·77 | — | 1·50 | $CO_2$ 2·63 [= 100·16 |

| | G. | $SiO_2$ | $Al_2O_3$ | FeO | CaO | MgO | $Na_2O$ | $K_2O$ | Cl | $SO_3$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19. Malsjö, *wh.* | 2·675 | 52·48 | 25·56 | 0·39 | 12·44 | — | 6·52 | 0·79 | 1·70 | 0·58 | 0·61 | [$CO_2$ 0·14 = 101·21 |
| 20. Husab | 2·683 | 52·62 | 26·42 | *tr.* | 13·11 | — | 6·42 | 0·45 | 0·10 | 0·79 | 0·49 | [= 100·40 |
| 21. " | 2·682 | 53·24 | 25·60 | *tr.* | 12·83 | — | 7·03 | 0·47 | 0·12 | 0·66 | 0·50 | [= 100·45 |
| 22. Arendal | 2·676 | 52·57 | 24·24 | 0·26 | 11·57 | — | 7·19 | 0·42 | 1·63 | 0·90 | 0·69 | [$CO_2$ 0·39 = 99·86 |
| 23. Gouverneur, *grn.wh.* | 2·660 | 52·65 | 25·32 | 0·11 | 11·30 | 0·23 | 6·64 | 1·58 | 2·14 | 0·14 | 0·42 | [= 100·53 |
| 24. | | 52·90 | 24·95 | — | 10·54 | — | 8·10 | 1·53 | 2·33 | — | — | [= 100·35 |
| 25. Pierrepont | 2·688 | 53·10 | 23·11 | 0·27 | 10·00 | 0·04 | 8·16 | 0·71 | 2·14 | 1·31 | 0·49 | [$CO_2$ 2·15 = 101·48 |
| 26. Pargas | | 53·32 | 24·67 | — | 9·84 | — | 9·12 | — | 1·75 | — | 0·71 | [= 99·41 |

[a] $Fe_2O_3$.
[b] Usually simply ignition and hence perhaps = $H_2O$ + Cl.

F. D. Adams, who first called attention to the common occurrence of chlorine in scapolites, shows that it is present in many varieties and in amounts varying up to 1·47, 2·01, 2·41 p. c. in scapolites from Ripon; also 2·01 p. c. in a specimen from Kragerö; 1·78 in one from Trumbull, Conn., etc., Am. J. Sc., **17**, 315, 1879.

**Pyr., etc.**—B.B. fuses easily with intumescence to a white blebby glass. Imperfectly decomposed by hydrochloric acid.

**Obs.**—Occurs in metamorphic rocks, and most abundantly in granular limestone near its junction with the associated granitic or allied rock; sometimes in beds of magnetite accompanying limestone. It is often associated with light-colored pyroxene, amphibole, garnet, and also with apatite, titanite, zircon; amphibole is a less common associate than pyroxene, but in some cases has resulted from the alteration of pyroxene. The scapolite of Pargas, Finland, is in limestone; that of Arendal in Norway, and Malsjö in Wermland, occurs with magnetite in limestone.

The *passauite* is from Obernzell, near Passau, in Bavaria.

In *Vermont*, at Marlborough, massive. In *Mass.*, at Bolton and Boxborough, in crystals, sometimes large; at Chelmsford; Littleton; Chester; Carlisle; Westfield, massive; at Parsonsfield and Raymond, near Dr. Swett's house, crystals, with yellow garnet. In *Conn.*, at Monroe, white and nearly fibrous; a stone quarry at Paugatuck, Stonington, massive. In *N. York*, at Two Ponds in Orange Co., reddish white crystals with pyroxene, titanite, zircon, one crystal 10 in. long and 5 in diameter; at Fall Hill, Monroe, of white and bluish colors, massive, with lamellar pyroxene; in Warwick of the same county, near Amity, milk-white crystals with pyroxene, titanite, graphite; 5 m. S. of Warwick, and 2 m. N. of Edenville, near Greenwood Furnace, are other good localities; in Essex Co., perfect crystals and massive nearly fibrous, white and greenish white, abundant near Kirby's graphite mine, 4 m. N. E. of Alexandria, in Ticonderoga, associated with pyroxene; at Crown Point; in Lewis Co., in fine crystals, white, bluish, and dark gray, presenting the play of light not unusual with this variety; edges of the crystals often rounded; Grasse Lake, Jefferson Co., in fine crystals; at Gouverneur, in limestone, also at Macomb, St. Lawrence Co. In *N. Jersey*, at Franklin and Newton, and 3 m. W. of Attleborough, crystallized, in limestone; also at Vernon, Franklin, and Sparta a scapolite rock with pyroxene, amphibole, orthoclase, also titanite. In *Penn.*, at the Elizabeth mine, French Creek, Chester Co., in cavities of a brownish gray garnet with magnetite, pyrite, and remains of the hessonite from which it was probably formed.

In *Canada*, at G. Calumet Id., massive lilac colored; at Hunterstown, in large crystals, with titanite; at Grenville, with pyroxene; Templeton; Bedford; Portland and Wakefield, Ottawa Co.; Algona, Renfrew Co. Scapolite rocks occur at several points, in part a "scapolite diorite" like that of Norway, chiefly in the Laurentian, as at Arnprior on the Ottawa R.; L. Mazinaw, Addington Co.; Robertsville mine, Frontenac Co.; McDougal, Parry Sound; it is associated with crystalline limestone, also amphibolytes and diorytes (Adams & Lawson, Can. Rec. Sc., **3**, 185, 1888).

**Alt.**—The scapolites as a class are especially liable to alteration, and the products are numerous and varied. The introduction of water, or of carbon dioxide, is a common change. By the substitution of potash, the mineral passes to the state of *pinite* and *potash mica*. By the acquisition of iron it passes in some cases to *epidote*. By the introduction of magnesia, it may pass to *steatite;* or of magnesia and potash, to a *magnesia mica*. By a loss of bases, the proportion of silica left increases; and by a loss of silica also (which may become opal in its separation), the mineral passes to a *kaolin*-like compound, a common result of its alteration. Moreover, silica may remain, and the altered crystal become by additions a siliceous pseudomorph, as occurs at Pargas. Various alteration-products are more particularly mentioned on p. 473.

**Ref.**—[1] Arendal, quoted by Tschermak. The angles as given by Koksharov are the same as for meionite; the variation is in any case small. [2] Cf. Mlr., Min., 382, 1852.

## 388. MIZZONITE. *A. Scacchi*, Pogg., Erg., **3**, 478, 1852.

DIPYRE. Schorl blanchâtre de Mauléon (Pyrenees) (discovered by Gillet-Laumont in 1786), Leucolite, *Delameth.*, Sciagr., **1**, 289, **2**, 401, 1792. Dipyre *H.*, Tr., **3**, 1801. Schmelzstein *Wern.*, Steff. Orykt., **1**. 411, 1811. Couseranite *Charpentier*, Ann. Ch. Phys., **39**, 280, 1828. Couzeranite. Prehnitoid *Blomstrand*, Öfv. Ak. Stockh., **11**, 297, 1854. Riponite *Tschermak*, Ber. Ak. Wien, **88** (1), 1142, 1883.

Tetragonal. Axis $\dot{c} = 0·44235$; $001 \wedge 101 = 23° 51\frac{3}{4}'$, Scacchi-Koksharov[1].

**Forms:** *c* (001, *O*), *a* (100, *i-i*), *m* (110, *I*), *h* (210, *i*-2), *e* (101, 1-*i*), *r* (111, 1).

Angles: *ee'* = 33° 15', *ee''* = 47° 43½', *rr'* = *44° 3', *cr* = 32° 2', *ar* = 67° 58½'.

In small prismatic crystals, with *m* prominent. Prismatic faces vertically striated. Sometimes acicular.

Cleavage *a*, *m*. H. = 5·5–6. G. = 2·623 Rath. Luster vitreous. Colorless to white. Transparent to translucent. Refractive indices (see also p. 466):

| | | |
|---|---|---|
| Pouzac, *Dipyre* | $\omega_r = 1·558$ | $\epsilon_r = 1·543$ Dx. |
| | $\omega_y = 1·5673$ | $\epsilon_y = 1·5416$ Lattermann. |

**Var.**—*Mizzonite* occurs in clear crystals in ejected masses on Mte Somma.

*Dipyre* occurs in elongated square prisms, often slender, sometimes large and coarse, in limestone and crystalline schists, chiefly from the Pyrenees. *Couseranite* is the same mineral and from the same region, but as originally analyzed in a more or less altered form, see anal. below.

*Prehnitoid*, named from its resemblance to prehnite, is from Sweden.

**Comp.**—Intermediate between meionite and marialite and corresponding to a molecular combination varying from Me : Ma = 1 : 2 to Me : Ma = 1 : 3. For percentage composition, see p. 469.

**Anal.**—1, Rath, Pogg., **119**, 254, 1863. 2, Adams, Am. J. Sc., **17**, 315, 1879. 3, Damour, L'Institut, 16, 1862. 4, Schulze, quoted by Gdt., Jb. Min., Beil., **1**, 226, 1881. 5, Delesse, C. R., **18**, 944, 1844. 6, Pisani, Dx., Min., **1**, 227, 1862. 7, Blomstrand, l. c. 8, Michel-Lévy, Bull. Soc. Min., **1**, 43, 1878 also Lcx., ib., **12**, 253, 1889. 9, E. S. Sperry, priv. contr. 10, Jannettaz, Bull. Soc. Min., **12**, 445, 1889.

| | G. | $SiO_2$ | $Al_2O_3$ | FeO | CaO | MgO | $Na_2O$ | $K_2O$ | Cl | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Somma, *Mizzonite* | 2·623 | 54·70 | 23·80 | — | 8·77 | 0·22 | 9·83 | 2·14 | — | 0·13 = 99·59 |
| 2. Ripon, *Riponite* | 2·63 | $\frac{2}{2}$ 54·86 | 22·45 | 0·49[a] | 9·09 | *tr.* | 8·36 | 1·13 | 2·41 | 0·86[b] $SO_3$ 0·80 [= 100·45 |
| 3. Pouzac, *Dipyre* | 2·65 | 56·22 | 23·05 | — | 9·44 | *tr.* | 7·68 | 0·90 | — | 2·41[d] = 99·70 |
| 4. " " | 2·613 | $\frac{2}{2}$ 53·97 | 23·68 | — | 8·76 | 1·40 | 3·55 | 6·43 | — | 0·98 = 98·77 |
| 5. Libarens, " | 2·646 | 55·5 | 24·8 | — | 9·6 | — | 9·4 | 0·7 | — | — = 100 |
| 6. " " | 2·62 | 56·69 | 22·68 | 0·30[c] | 6·85 | 0·49 | 8·65 | 0·78 | — | 4·55[d] = 101·08 |
| 7. *Prehnitoid* | 2·50 | 56·00 | 22·45 | 1·19[a] | 7·79 | 0·36 | 10·07 | 0·46 | — | 1·04 = 99·36 |
| 8. Bamle | 2·63 | 59·66 | 22·65 | — | 7·32 | 2·60 | 8·13 | *tr.* | — | — = 100·36 |
| 9. Macomb, N. Y. | 2·601 | 57·59 | 21·27 | 0·27 | 5·59 | 0·29 | 10·48 | 0·40 | 3·02 | 0·76 $CO_2$ 1·06 [= 100·73 |
| 10. Chili | 2·6 | 57·4 | 19·6 | 3·4[a] | 6·2 | 0·4 | 8·8 | *tr.* | — | 3·41[d] CuO *tr.* |

[a] $Fe_2O_3$. [b] 0·72 hygroscopic. [c] MnO. [d] Ign.

**Pyr., etc.**—B.B. fuses easily, but with less intumescence than meionite. Only slightly acted upon by hydrochloric acid.

**Obs.**—*Mizzonite* occurs in trachytic bombs on Mte. Somma; the rock is gray and consists chiefly of sanidine and dark green augite; the mizzonite occurs in cavities, sometimes with calcite. Named from μείζων, *greater*, the axis of the prism being a little longer than in meionite.

*Dipyre* and *couseranite* are from various points, chiefly in the Hautes-Pyrénées, in granular limestone; at Pouzac, near Bagnères-de-Bigorre, with a white uniaxial mica; near Libarens, about a mile and a half from Mauléon, with mica or talc; at the baths of Aulus in the Dept. of Ariège; in a black schist on the right bank of the Lés, near Luzenac, Ariège; in the vicinity of Loutrin, near Angoumer, in blocks of granular limestone, with pyrite, titanite (see more particularly, Frossard, Bull. Soc. Min., **13**, 321, 1890); also at Biarritz and elsewhere in the Basses-Pyrénées. The *prehnitoid* is from a locality between Kongsberg and Solberg in Sweden. with coarsely crystallized hornblende; its hardness is stated by Blomstrand to be 7, and G. = 2 50. The scapolite associated with amphibole in the "geflecter Gabbro" or scapolite-dioryte of the apatite deposits near Bamle, Norway, is near dipyre in composition (see anal. 8 and p. 467) A scapolite belonging here occurs at the Llanca mine, district La Higuera, Coquimbo, Chili. According to Arzruni, dipyre (*rr'''* = 63° 49') occurs in saccharoidal limestone at Canaan, Ct.

*Riponite* (anal. 2) is from the township of Ripon, Ottawa Co.. Quebec, Canada.

The name *dipyre*, from δίς, *twice*, and πῦρ, *fire*, alludes to the two effects of heat, *fusion* and *phosphorescence*. *Prehnitoid* refers to a resemblance to *prehnite*.

**Alt.**—Dipyre undergoes very easy alteration, much easier than wernerite, and this it probably owes to the large percentage of soda. At all the localities the mineral occurs to a large extent in a crumbling state. Some of it appears to be changed to a greenish chlorite.

*Couseranite* is an altered form of dipyre. It occurs in the same region, and the dipyre may be seen passing into couseranite. Its square prisms are usually rough or rounded externally, and bluish black or grayish black to deep black in color, but sometimes whitish and blackish on the same specimen. It is often soft and fragile. Charpentier's mineral came from the department of Ariège (formerly Couserans). Analyses: 1, Dufrénoy, Ann. Mines, **4**, 327, 1828. 2, Pisani, Dx., Min., **1**, 234, 1862.

| | | $SiO_2$ | $Al_2O_3$ | FeO | MgO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| 1. | G. = 2·69 | $\frac{2}{2}$ 52·37 | 24·02 | — | 1·40 | 11·85 | 3·96 | 5·52 | — = 99·12 |
| 2. | | 58·33 | 20·20 | 1·90 | 7·20 | 0·99 | 0·76 | 8·82 | 2·35 = 100·55 |

Pisani's analysis was made on large square prisms from Pouzac. It has the composition of agalmatolite. Both of the analyses indicate the alteration by the amount of potash present.

**Ref.**—[1] On mizzonite, Somma, Scc. *rr'* = 44° 4', Kk. *rr'* = 44° 2', Min. Russl., **2**, 108, 1854; on dipyre from Pouzac, *rr'* = 44° 17', *er* = 22° 10', Dx., Bull. Soc. Min., **12**, 9, 1889.

**389. MARIALITE.** *Rath*, Zs. G. Ges., **18**, 635, 1866. [Not Marialite of Ryllo.]

Tetragonal. In crystals with *c* (001), *a* (100), *m* (110), *h* (210), *e* (101), *r* (111); angles near mizzonite, *rr'* = 44°.

H. = 5·5–6. G. = 2·566. Luster vitreous. Colorless, or white. Transparent to translucent.

**Comp.**—Approximating to the pure marialite of Tschermak, $Na_4Al_3Si_9O_{24}Cl$ = Silica 63·9, alumina 18·1, soda 14·7, chlorine 4·2 = 100·9, deduct (O = 2Cl) 0·9 = 100. The marialite of Rath corresponds closely to Me : Ma = 1 : 4.

**Anal.**—1, Rath, l. c., after deducting 4·5 p. c. magnetite: the specific gravity of the material analyzed was 2·626, or 2·566 correcting for admixed magnetite (G. = 5·18). 2, Rg., Min. Ch., Erg., 216, 1886.

| | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | Cl | |
|---|---|---|---|---|---|---|---|
| 1. | 62·72 | 21·82 | 4·63 | 9·37 | 1·15 | — | MgO 0·31 = 100 |
| 2. | 61·40 | 19·63 | 4·10 | *undet.* | — | 4·00 | |

**Pyr., etc.**—Like those of mizzonite.

**Obs.**—From a volcanic rock called piperno, occurring at Pianura, near Naples.

**Altered Scapolites.** The following are the characters of different altered scapolites. Analyses are given below and on pp. 322, 323, 5th Ed.

Atheriastite *Weibye,* Pogg., **79**, 302, 1850. Like scapolite in form; color greenish; opaque. From Arendal, with black garnet and keilhauite. Contains 7 p. c. water.

Stroganovite *Herm.,* J. pr. Ch., **34**, 178, 1845. Has the form of scapolite (Kk., Min. Russl., **3**, 95). Color yellowish to light oil-green; luster greasy; translucent; H.=5·5, G.=2·79. B.B. fuses easily with intumescence. From the R. Sliudianka near L. Baikal in Eastern Siberia. The analysis afforded 6·4 p. c. $CO_2$, corresponding to 11·4 p. c. of $CaCO_3$.

Algerite *Hunt,* Am. J. Sc., **8**, 103, 1849. Occurs in slender square prisms, sometimes 2 or 3 in. long, embedded in calcite. Yellowish to gray and usually dull. Brittle. H. = 3–3·5; some crystals more altered, 2·5. G. = 2·697–2·712 Hunt; 2·78 Crossley. From Franklin, Sussex Co., N. J. The varying results of analyses, and the presence of calcium carbonate, of magnesia, and the relations to known examples of altered scapolite, confirm the view derived from the form and appearances, that algerite is an altered scapolite, and related to *pinite.*

Wilsonite *Hunt,* Logan's Rep. Can., 1853, 1863, Am. J. Sc., **19**, 428, 1855. A massive mineral from Bathurst, Canada, affording square prisms by cleavage, and having H. = 3·5, G. = 2·765–2·776; luster vitreous, a little pearly on cleavage surfaces; color reddish white, rose-red, and peach-blossom red. According to Chapman (Am. J. Sc., **20**, 269, 1855) its crystallization and other characters are essentially those of scapolite. It is associated with apatite, calcite, and pyroxene. Hunt in Rep. G. Can., 1863, makes it a variety of gieseckite. Occurs also in northern N. York.

**Anal.**—1, Weibye & Berlin, Poff. **79**, 302, 1850. 2, Hermann, J. pr. Ch., **34**, 177, 1845; anal. as given by Rg., Min. Ch., 718, 1860, after deducting $CaCO_3$ (6·40 $CO_2$). 3, Crossley, Dana Min., 680, 1850. 4. Hunt, Rep. G. Canada, p. 483, 1863.

| | $SiO_2$ | $Al_2O_3$ | FeO | CaO | MgO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. *Atheriastite* | 38·00 | 24·10 | 5·60[a] | 22·64 | 2·80 | — | — | 6·95 | = 100·09 |
| 2 *Stroganovite* | 43·35 | 30·52 | 0·95[b] | 21·59 | — | 3·74 | — | — | = 100·15 |
| 3. *Algerite* | 49·96 | 24·41 | 1·48[b] | — | 5·18 | — | 9·97 | 5·06 | $CaCO_3$ [4·21 = 100·27 |
| 4. *Wilsonite* | $\frac{2}{2}$ 47·60 | 31·20 | — | 0·95 | 4·19 | 0·88 | 9·30 | 5·43 | = 99·55 |

[a] Incl. 0·78 MnO. [b] $Fe_2O_3$

Terenite *Emmons,* Rep. G. N. Y., 152, 1837. Has the form of scapolite, with H. = 2; G. = 2·53; luster a little pearly; color yellowish white or greenish; and is from a small vein in limestone at Antwerp, N. Y. It has not been analyzed, but is probably near algerite or wilsonite. The Pinitartiger Scapolit of *Schumacher* (Verz., 98, 1801), from Arendal, is probably similar to the algerite and other *pinite* pseudomorphs. It is described as occurring in crystals and massive, of a white, greenish, and other shades, and B.B. fusing easily. His *Talkartiger Scapolit,* from Arendal, appears to have been a *steatitic* pseudomorph, it being B.B. infusible.

*Mica from Arendal, Norway* (*Micarelle* of Abildgaard). The mica occurs embedded in quartz, and has, according to Rath, the form of 8-sided crystals of scapolite, 6 in. long. The crystals are covered with mica externally, and within consist throughout of an aggregation of the same mica. Cf. Wichmann, Zs. G. Ges., **26**, 701, 1874.

Gabbronite *Schumacher,* Verzeichn., 1801; Gabronite. Referred here by Sæmann, who observes that there are, in the École des Mines at Paris, crystals of it of the form of scapolite; Schumacher describes it as bluish gray, inclining to leek-green; also grayish mountain-green. luster feeble; fracture smooth like that of flint; G. = 2·947; having some resemblance to gabbro. The bluish gray variety from the Kenlig mine near Arendal, with black hornblende and calcite, and the other from Fredriksvärn, Norway, in syenite. Brögger refers the mineral to elæolite (p. 425).

Pseudo-Scapolite *N. Nordenskiöld,* Bidrag Finl. Min., 66, 1820. Wernerite altered to pyroxene. The crystals are large and contain crystals of pyroxene, which are most abundant toward the exterior; from Simonsby, near Pargas.

Paralogite *N. Nordensk.,* Bull. Soc. Moscow, **30**, 221, 1857. Has the form and angles of scapolite (Kk., Min. Russl., **3**, 187), and is probably altered wernerite. Colors white, bluish, reddish blue; G. = 2·665. The crystals, after action of acids, are full of worm-like holes, owing to the separation of the calcium carbonate present. From the lapis-lazuli locality in the L. Baikal region.

*Steatitic* pseudomorphs occur at Newton, N. J., and Arendal in Norway. A *siliceous* scapolite of Pargas, of a gray color, in limestone, contains 92·71 p. c. of silica. *Albite* is announced by Tschermak as occurring pseudomorphous after scapolite.

The passauite is the source, by its alteration, of a large bed of porcelain earth or kaolin. Part of the kaolin has the prismatic form of the passauite. Opal occurs in the kaolin as one result of the alteration

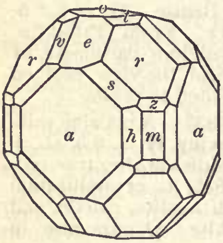
**390. SARCOLITE.** Sarcolite *Dr. Thompson* (of Naples), 1807. [Not Sarcolite du Vicentin (= Gmelinite) *Faujas, Vauq.*, Ann. Mus., **9**, 249, 1807, **11**, 42.] Analcime carnea *Mont. & Cov.*, Min. Vesuv., 1825.

Tetragonal; with pyramidal hemihedrism. Axis $\dot{c}$ = 0·88737; 001 ∧ 101 = 41° 35′ Brooke[1].

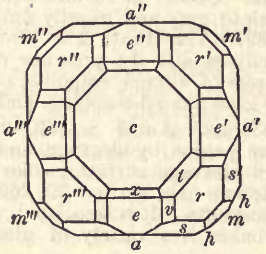
**Forms**[2]: *c* (001, *O*); *a* (100, *i-i*), *m* (110, *I*), *h* (210, *i*-2); *e* (101, 1-*i*); *t* (113, ⅓), *r* (111, 1), *z* (331, 3)[3]; *v* (313, 1-3), *s* (311, 3-3).

*ce* = 41° 35′ *cz* = 75° 7½′ *ee′* = 83° 10′ *ar* = 56° 26′
*ct* = 22° 42′ *cv* = 43° 5′ *rr′* = 67° 9′ *av* = 77° 31½′
*cr* = *51° 27′ *cs* = 70° 23′ *as* = 26° 40′ *ss′* = 49° 50′

1.



2.



1, 2, Mte. Somma. 1, Hbg.[3]; 2, Rath[4].

In small crystals, resembling the cubo-octahedron of the isometric system; often highly modified and sometimes hemihedral in the planes *v*, *s*.

Fracture conchoidal. Very brittle. H. = 6. G. = 2·545 Brooke; 2·932 Rg. Luster vitreous. Color flesh-red to rose-red, reddish white. Transparent to subtransparent. Optically +. Double refraction strong.

**Comp.**—An orthosilicate of aluminium, calcium, and sodium, $R_3Al_2Si_3O_{12}$ or $3RO.Al_2O_3.3SiO_2$, with R = Ca : $Na_2$ = 9 : 1, hence: Silica 39·9, alumina 22·6, lime 33·4, soda 4·1 = 100. The formula is analogous to that of the Garnet Group.

**Anal.**—Rg., Pogg., **109**, 570, 1860; earlier Scacchi, 5th Ed., p. 318.

$SiO_2$ $\frac{8}{3}$ 40·51 $Al_2O_3$ 21·54 CaO 32·36 $Na_2O$ 3·30 $K_2O$ 1·20 = 98·91

**Pyr., etc.**—B.B. fuses to a white enamel. With acids gelatinizes.

**Obs.**—Of rare occurrence in the ejected masses on Monte Somma, Vesuvius.

Named from σάρξ, *flesh*, and λίθος, *stone*, in allusion to the color.

**Ref.**—[1] Made cubic by Haüy, and early confounded with analcite, but shown to be tetragonal by Brooke, Phil. Mag., **10**, 189, 1831. Cf. also Mlr., Min., 381, 1852; Kk., who gives *ce* = 41° 30½′, Min. Russl., **2**, 109, 1854; Rg., *ce* = 41° 33′, l. c. [2] See Mlr., l. c. [3] Hbg., Min. Not., **1**, 14, 1856. [4] Ber. nied. Ges., p. 134, June 6, 1887.

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## 8. Melilite Group. Tetragonal.

| | | | |
|---|---|---|---|
| 391. | Melilite | $Na_2(Ca,Mg)_{11}(Al,Fe)_4(SiO_4)_9$ | $\dot{c}$ = 0·4548 |
| | Åkermanite (artif.) | $Ca_4Si_3O_{10}$? | $\dot{c}$ = 0·45 approx. |
| 392. | Gehlenite | $Ca_3(AlO)_2(SiO_4)_2$ | $\dot{c}$ = 0·4001 |

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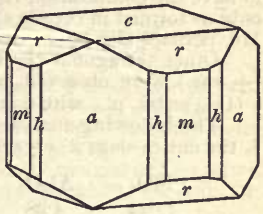
**391. MELILITE.** Mélilite *Delameth.*, T. T., **2**. 273, 1796; *Fl. Bellevue* (its discov. in 1790), J. Phys., **51**, 456, 1800. Humboldtilite *Mont. & Cov.*, Prodr., 375, 1822. Somervillite *Brooke*, Ed. J. Sc., **1**, 185, 1824. Zurlite *Ramondini*, Breislak Inst. Geol. **3**, 210, 1818. Mellilite.

Tetragonal. Axis $\dot{c}$ = 0·45483; 001 ∧ 101 = 24° 27½′ Des Cloizeaux[1].

**Forms**[1]: *c* (001, *O*); *a* (100, *i-i*), *m* (110, *I*), *h* (310, *i*-3); *r* (111, 1).

Angles: *ah* = 18° 26′, *rr′* = 44° 59′, *rr″* = *65° 30′, *ar* = 67° 30½′, *cr* = 32° 45′.

Cruciform twins rare, the vertical axes only slightly inclined or crossing nearly at right angles. Usually in short square prisms (*a*) or octagonal prisms (*a*, *m*), also in tetragonal tables.



Cleavage: *c* distinct; *a* indistinct. Fracture conchoidal to uneven. Brittle. H. = 5. G. = 2·9–3·10. Luster vitreous, inclining to resinous on a surface of fracture. Color white or pale yellow, honey-yellow, greenish yellow, reddish brown, brown. Translucent and in thin laminæ transparent; also opaque. Pleochroism distinct in yellow varieties. Sometimes exhibits optical anomalies. Optically −; also, in part, apparently isotropic or + (Vogt). Double refraction weak. Indices:

*Humboldtilite* $\omega_r = 1{\cdot}6312$ $\omega_y = 1{\cdot}6339$ $\epsilon_r = 1{\cdot}6262$ $\epsilon_y = 1{\cdot}6291$ Henniger[2].

**Comp.**—Perhaps $\overset{\text{II}}{R}_{12}\overset{\text{III}}{R}_4Si_9O_{36}$ or $Na_2(Ca,Mg)_{11}(Al,Fe)_4Si_9O_{36}$ for melilite (Rg.), but uncertain since the analyses fail to agree. If Ca : Mg = 8 : 3, and Al : Fe = 1 : 1, the percentage composition is: Silica 37·7, alumina 7·1, iron sesquioxide 11·2, lime 31·3, magnesia 8·4, soda 4·3 = 100. Potassium is also present. Groth writes the formula $(Ca,Mg)_6(Al,Fe)_2Si_5O_{19}$.

**Anal.**—1, Kbl., Schw. J., **64**, 293, 1832. 2–4, Damour, Ann. Ch. Phys., **10**, 59, 1844. 5, Schulze (on 0·38 gr.), Jb. Min., Beil., **2**, 383, 1883.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $Na_2O$ | $K_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Mte. Somma, *Humboldt.* | | 43·96 | 11·20 | 2·32[a] | 31·96 | 6·10 | 4·28 | 0·38 | = 100·20 |
| 2. " " " | | 40·69 | 10·88 | 4·43 | 31·81 | 5·75 | 4·43 | 0·36 | = 98·35 |
| 3. C. di Bove, *Melilite*, *yw.* | 2·95 | 39·27 | 6·42 | 10·17 | 32·47 | 6·44 | 1·95 | 1·46 | = 98·18 |
| 4. " " *brn.* | | 38·34 | 8·61 | 10·02 | 32·05 | 6·71 | 2·12 | 1·51 | = 99·36 |
| 5. Hochbohl | 2·99 | 44·76 | 7·90 | 5·16 | 27·47 | 8·60 | 2·65 | 0·33 | $H_2O$ 1·42, [FeO 1·39 = 99·68 |

[a] FeO.

**Pyr., etc.**—B.B. fuses at 3 to a yellowish or greenish glass. With the fluxes reacts for iron. Decomposed by hydrochloric acid with gelatinization.

**Obs.**—*Humboldtilite* occurs in cavernous blocks on Monte Somma with greenish mica, also apatite, augite; the crystals are often rather large, and covered with a calcareous coating; less common in transparent lustrous crystals with nephelite, sarcolite, and sparingly, apatite, wollastonite, lining cavities in an augitic rock.

*Melilite* of yellow and brownish colors, is found at Capo di Bove, near Rome, in leucitophyre with nephelite, phillipsite, gismondite, magnetite, and small black crystals of augite and hornblende. *Somervillite*, which Des Cloizeaux has shown to have the angles of this species, is found at Vesuvius in dull yellow crystals.

Melilite[3] is not uncommon in certain basic eruptive rocks, as the *melilite-basalts* of Hochbohl near Owen in Württemberg, of the Schwabian Alb, of Görlitz, the Erzgebirge; also in the nephelite basalts of the Hegau, of Oahu, Sandwich Islands, etc.; perovskite is a common associate. It usually appears in square, octagonal or rounded tables, which are lath-shaped for sections ⊥ *c*, and they show either fine striations or peculiar peg-shaped or spear-shaped inclusions to which the name "Pflockstructur" was given by Stelzner.

*Zurlite* occurs in opaque square or octagonal prisms in calcareous blocks on Monte Somma with humboldtilite; color whitish or asparagus-green; H. about 6; G. = 3·27; B.B. infusible; soluble in nitric acid. It is impure humboldtilite (Scacchi, Jb. Min., 261, 1853). Named after Sign. Zurlo. Melilite is named from μέλι, *honey*, in allusion to the color.

**Artif.**—Common in furnace slags, having been observed in square prisms at Russel's Hall, Tipton, Dowles, Wicks, etc., in England and Wales, near St. Etienne in France, near Charlevoi in Belgium, Königshütte in Upper Silesia, Mägdesprung in the Harz, and Easton, Pa. Cf. Percy, Rep. Brit. Assoc., 351, 1846; also Vogt, Ak. H. Stockh., Bihang, **9** (1), 105, 1884–85.

Obtained from fusion by Fouqué and Lévy in square prisms, Bull. Soc. Min., **2**, 108, 1879. Also by Bourgeois, who has obtained a series of compounds ($2RO.\frac{1}{2}R_2O_3.3SiO_2$) in part colorless, also ferriferous and again manganesian, the last of a violet tint with distinct dichroism, Ann. Ch. Phys., **29**, 450, 1883, and Reprod. Min., 122, 1884. Vogt has described a series of melilites from slags varying in optical character from the usual negative, through forms sensibly isotropic, to others which are positive, like åkermanite, p. 476.

**Ref.**—[1] Dx., Min., p. 215, 1862, he makes *r* = 221. [2] Rosenbusch, Mikr. Phys., 323, 1885. [3] Cf. Zirkel, Basaltgesteine, 77, 1870; also Stelzner, Jb. Min., Beil., **2**, 369, 1883.

**Åkermanite** *I. H. L. Vogt*, Ak. H. Stockh., Bihang, **9** (1), 126, 1884–85; Arch. Math. Nat., **13**, 310, 1890. A tetragonal species isomorphous with melilite and gehlenite. Inferred to have the composition $R_4Si_3O_{10}$ or $4RO.3SiO_2$ ; R = Ca chiefly, with also Mg,Mn,Fe. Known only as formed in certain slags on rapid cooling. Obtained in thin tabular crystals. Cleavage: 110, perhaps also 001. Optically uniaxial and +.

Other tetragonal crystals, also optically +, intermediate between åkermanite and melilite (+ var.) were observed, in part twins crossing at an angle of 48½°, and hence corresponding to *e* (101) as tw. pl., with $\dot{c}$ = 0·45. Named for the Swedish metallurgist, Richard Åkerman.

The following analyses by Damm (quoted by Vogt) belong to a compound near åkermanite, 1, the entire slag; 2, crystals separated from the slag.

| $SiO_2$ | $Al_2O_3$ | FeO | MnO | CaO | MgO | |
|---|---|---|---|---|---|---|
| 42·44 | 4·38 | 0·30 | 9·21 | 28·37 | 11·87 | $CaS_2$ 1·89 = 98·46 |
| 43·17 | 3·43 | *tr.* | 5·85 | 37·89 | 9·0[a] | = 99·34 |

[a] Approx.

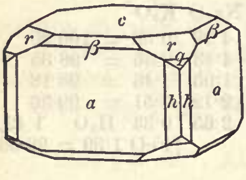
**392. GEHLENITE.** Gehlenit *Fuchs*, Schw. J., **15**, 377, 1815. Stylobat *Breith.*, Leonh. Taschenb., **10**, 600, 1816, Hoffm. Min., **4** b, 109, 1817.

Tetragonal. Axis $\dot{c}$ = 0·40006; 001 ∧ 101 = 21° 48¼′ Des Cloizeaux[1].

**Forms:** *c* (001, *O*); *a* (100, *i i*), *h* (310, *i*-3); *β* (703, $\frac{7}{3}$-*i*)?; *r* (111, 1), *s* (887, $\frac{8}{7}$), *q* (221, 2).

**Angles:** *cβ* = 43° 2′ *cr* = *29° 30′, *cs* = 32° 53′, *cq* = 48° 32′, *rr′* = 40° 45′, *ss′* = 45° 9′, *qq′* = 63° 59½′.

Crystals usually short square prisms; sometimes tabular; often resembling cubo-octahedrons.



Monzoni, Dx.

Cleavage: *c* imperfect; *a* in traces. Fracture uneven to splintery. Brittle. H. = 5·5–6. G. = 2·9–3·07. Luster resinous, inclining to vitreous. Color different shades of grayish green to liver-brown; none bright. Faintly subtranslucent to opaque. Streak white to grayish white. Optically negative. Double refraction weak.

**Comp.**—$Ca_3Al_2Si_2O_{10}$ or $3CaO.Al_2O_3.2SiO_2$ = Silica 30·9, alumina 26·2, lime 42·9 = 100.

Some ferric iron, replacing the aluminium, is present and some magnesium replacing the calcium.

The formula may be written (Groth) as a basic orthosilicate, $Ca_3(AlO)_2(SiO_4)_2$.

**Anal.**—1, Rg., Min. Ch., 732, 1860. 2, Dmr., Ann. Ch. Phys., **10**, 66, 1844. 3, Lemberg, Zs. G. Ges., **24**. 248, 1872. 4, 5, Kuhn, Lieb. Ann., **59**, 371, 1846. 6, 7, Janovsky, Ber. Ak. Wien, **69** (1), 28, 1874. The material of anal. 6 contained some vesuvianite.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | CaO | MgO | ign. | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Monzoni | | 29·78 | 22·02 | 3·22 | 1·63 | 37·90 | 3·88 | [1·38] | MnO 0·19 = 100 |
| 2. " | | 31·60 | 19·80 | 5·97 | — | 38·11 | 2·20 | 1·53 | $Na_2O$ 0·33 = 99·54 |
| 3. " | | 30·01 | 21·33 | 3·56 | — | 36·74 | 3·77 | 4·72 | = 100·13 |
| 4. " *olive* | $\frac{2}{2}$ | 30·47 | 17·79 | 7·30 | — | 36·97 | 2·99 | 3·62 | = 99·14 |
| 5. " *dark grn.* | $\frac{2}{2}$ | 29·52 | 19·00 | — | 7·25 | 36·55 | 1·41 | 5·55 | = 99·28 |
| 6. Orawitza *dark* | 3·01 | 30·73 | 22·24 | 0·41 | 3·01 | 37·93 | 6·10 | 0·37 | = 100·79 |
| 7. " *light* | 3·01 | 32·39 | 18·53 | 1·25 | 3·61 | 37·65 | 6·69 | 0·51 | = 100·63 |

**Pyr., etc.**—B.B. thin splinters fuse with difficulty (F. = 5·7, Kbl.) to a gray glass. With borax fuses slowly to a glass colored by iron. Gelatinizes with hydrochloric acid, yielding a solution containing both protoxide and sesquioxide of iron.

**Obs.**—Gehlenite is found at Mount Monzoni, in the Fassathal, in isolated or aggregated crystals, invested by calcite, formed as a contact mineral in limestone; also in the Fleimsthal; in rolled pebbles at Orawitza in the Banat inclosing grains of vesuvianite, Zeph., Ber. Ak. Wien, **69** (1), 26, 1874.

Named by Fuchs after his colleague, Gehlen.

**Alt.**—Gehlenite occurs altered to steatite, also to fassaite, and to grossular garnet (see below). A pseudomorph from Monzoni gave Lemberg (l. c.):

$SiO_2$ 28·75 $Al_2O_3$ 17·83 $Fe_2O_3$ 3·41 MgO 29·60 CaO 4·76 ign 15·93 = 100·28

An alteration product, inclosing the Orawitza gehlenite, of a red to brown color, H. = 3·5 amorphous, gave Janovsky:

G. = 1·87 Vrba $SiO_2$ 29·12 $Al_2O_3$ 31·46 $Fe_2O_3$ 8·86 $H_2O$ 30·56 = 100

Pseudomorphs after gehlenite from Monzoni have been described by Cathrein, consisting (1) of fassaite, and (2) of grossularite, Min. Mitth., **8**, 408, 412, 1887. Anal.—Cathrein:

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | CaO | MgO | ign. | |
|---|---|---|---|---|---|---|---|---|
| 1. *Fassaite* | 44·22 | 12·37 | 3·83 | 1·14 | 27·31 | 11·26 | 0·73 | = 100·86 |
| 2. *Grossularite* | 39·64 | 16·47 | 4·62 | 1·13 | 31·52 | 5·72 | 1·04 | = 100·14 |

**Artif.**—Not unfrequent among furnace scoria, in thin square tables, or 8-sided prisms, with cleavage parallel to the lateral planes of a square prism. Has been observed at Dawes' furnace, Oldbury in England, and at Holzhausen in Hesse. Also similarly at McVille, Armstrong, Penn. Diller, Am. J. Sc., **37**, 220, 1889. See also Vogt, ref. under åkermanite, p. 476.

Obtained by Bourgeois from fusion, in minute square prisms optically uniaxial and negative, compounds of various composition were obtained, but especially the pure $Ca_3Al_2Si_2O_{10}$, Ann. Ch. Phys., **29**, 448, 1883; Reprod. Min., 122, 1884.

**Ref.**—[1] Min., **1**, p. 214, 1862.

CACOCLASITE *H. C. Lewis*, Proc. Acad. Philad., Nov. 26, 1883, Amer. Nat., **18**, 416, 1884. A pseudomorphous mineral occurring with spinel, pyroxene, graphite, pyrrhotite, embedded in a blue calcite at Wakefield, Ottawa Co., Quebec. In square prisms or resembling cubo-octahedrons, with forms: *c* (001), *a* (100), *m* (110), *l* (201), *q* (221), *u* (211), *s* (621); apparently hemihedral in the zirconoid planes, but forms and angles somewhat uncertain. Approximate angle $cq = 50\frac{1}{2}°$, which gives $\dot{c} = 0·429$. No cleavage. H. = 5–6. G. = 3·053. Luster vitreous to resinous; surface of crystals shining and glazed as if vitrified. Color white or grayish white. Under the microscope is resolved into an amorphous ground-mass, a colorless mineral (tetragonal?), and grains of calcite.

Anal.—1, R. Haines (deducting calcite), quoted by Lewis. 2, 3, Genth, Am. J. Sc., **38**, 200, 1889.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $Na_2O$ | $K_2O$ | $H_2O$ | $P_2O_5$ | $CO_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 3·057 | 36·74 | 19·79 | 1·33 | 38·16 | 0·77 | 0·32 | 0·17 | 0·23 | 2·49 | — | = 100 |
| 2. | 3·337 | 31·52 | 17·34 | 0·51 | 40·95 | *tr.* | *tr.* | *tr.* | 1·04 | 2·19 | 6·73 | = 100·28 |
| 3. | 3·222 | 32 67 | 19·63 | 0·39 | 36·38 | 0·49 | 0·31 | 0·20 | 2·28 | 3·36 | 4·25 | = 99·96 |

Genth concludes that the material of anal. 2 contains: quartz 23·04 p. c., apatite 5·05, calcite 15·20; of anal. 3, quartz 11·63, apatite 7·74, calcite 9·66.

B.B. fuses with intumescence at 3. Hardly soluble in acids, but gelatinizes after fusion. Named from κακός, *bad*, κλάσις, *fracture*, in allusion to the want of cleavage, which, however, in a pseudomorph is not significant. The similarity to gehlenite in occurrence is worth noting, and the apparent relation to sarcolite in forms and in angle is also to be noted.

## 9. Vesuvianite Group. Tetragonal.

**393. Vesuvianite** $H_4Ca_{12}(Al,Fe)_6Si_{10}O_{43}$? $\dot{c} = 0·5372$

**393. VESUVIANITE.** Hyacinthus dictus octodecahedricus *Cappeler*, Prodr. Crist., 30, pl. 3 (fig. 261), 1723. Hyacinte pt., Hyacinte du Vesuve *de Lisle*, Crist., 234, 1772, pl. iv.; **2**, 291, pl. iv. 1783. Hyacinte volcanique *Demeste*, Lettr., **1**, 413. Hyacinth-Krystalle (fr. Wilui R.) *Pallas*, N. Nord., Beytr., St. Pet., **5**, 282, 1793; Wiluite pt. Vulkanischer Schorl *Widenmann*, Handb., 290, 1794. Hyacinthine *Delameth.*, Sciagr., **1**, 268, 1792, T. T., **2**, 323, 1796. Vesuvian *Wern.;* in Klapr. Beitr., **1**, 34, 1795, ib. (fr. Vesuv. and Siberia), **2**, 27, 33, 1797. Idocrase *H.*, J. Mines, **5**, 260, 1799; Tr., **2**, 1801.

Gahnit (fr. Gökum) *Lobo da Silveira*, Afh., 3, 276, 1810, anal. by Murray, Afh., **2**, 173, 1807; Loboit *Berz.* Frugårdit *N. Nordenskiöld*, Bidrag, **1**, 80, 1820; Frugardite. Egeran (fr. Eger, Bohemia) *Wern.*, Min. Syst., 3, 34, 1817. Cyprine (fr. Tellemark) *Berz.*, Löthr., 1821. Xanthite *Thomson*, Ann. Lyc. N. Y., **3**, 44, 1828. Gökumite (fr. Gökum) *Thoms.*, ib., 61, 1828. Heteromerit (fr. Zlatoust) *Herm.*, Vh. Min. Ges., 205, 1845–46. Jewreinowit *N. Nd.*, Verz. Finl. Min., 1852; Koksharov, Min. Russl., **1**, 116, 1853. Manganidokras *Lsx.*, Zs. Kr., **4**, 171, 1879. Mangan-vesuvian.

Tetragonal. Axis $\dot{c} = 0·537195$; 001 $\wedge$ 101 = 28° 14′ 40″ Kupffer[1].

**Forms**[2]:

*c* (001, *O*)

*a* (100, *i*-*i*)
*m* (110, *I*)
*h* (310, *i*-3)
*f* (210, *i*-2)
ψ (740, *i*-$\frac{7}{4}$)
φ (530, *i*-$\frac{5}{3}$)?

ν (102, $\frac{1}{2}$-*i*)
Ω (203, $\frac{2}{3}$-*i*)
*e* (101, 1-*i*)

ξ (302, $\frac{3}{2}$-*i*)
*u* (201, 2-*i*)
π (301, 3-*i*)

α (1·1·20, $\frac{1}{20}$)
β (1·1·10, $\frac{1}{10}$)
χ (119, $\frac{1}{9}$)
γ (118, $\frac{1}{8}$)
δ (117, $\frac{1}{7}$)
ε (116, $\frac{1}{6}$)
ζ (115, $\frac{1}{5}$)
η (114, $\frac{1}{4}$)
ϑ (113, $\frac{1}{3}$)

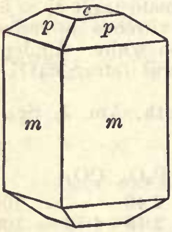
Π (5·5·13, $\frac{5}{13}$)[5]
ι (112, $\frac{1}{2}$)
κ (335, $\frac{3}{5}$)
λ (445, $\frac{4}{5}$)
Φ (778, $\frac{7}{8}$)[3]
*p* (111, 1)
μ (885, $\frac{8}{5}$)
*M* (995, $\frac{9}{5}$)[6]
*b* (221, 2)
*t* (331, 3)
Ψ (441, 4)[6]
*O* (551, 5)

Q (10·10·1,10)[7]

*w* (711, 7-7)
Σ (512, $\frac{5}{2}$-5)[5]
*v* (511, 5-5)
*Y* (17·4·4, $\frac{17}{4}$-$\frac{17}{4}$)?
*y* (411, 4-4)
*g* (20·5·2, 10-4)[4]
ρ (319, $\frac{1}{3}$-3)
σ (315, $\frac{3}{5}$-3)
τ (629, $\frac{2}{3}$-3)
*x* (313, 1-3)
*i* (312, $\frac{3}{2}$-3)

*s* (311, 3-3)
*q* (833, $\frac{8}{3}$-$\frac{8}{3}$)
ω (737, 1-$\frac{7}{3}$)
*n* (212, 1-2)
*l* (423, $\frac{4}{3}$-2)
*z* (211, 2-2)
*d* (421, 4-2)
*F* (13·7·1, 13-$\frac{13}{7}$)[4]
υ (747, 1-$\frac{7}{4}$)
*E* (531, 5-$\frac{5}{3}$)?
*r* (641, 6-$\frac{3}{2}$)[4]
Δ (544, $\frac{5}{4}$-$\frac{5}{4}$)[6]

1.



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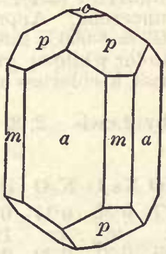

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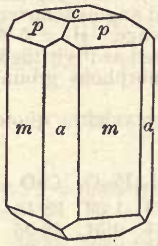

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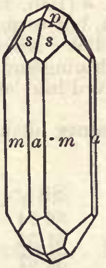

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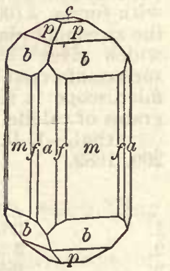

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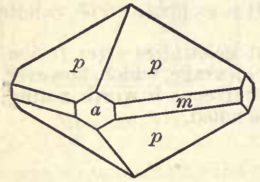

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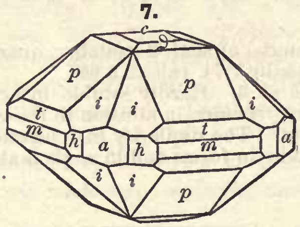
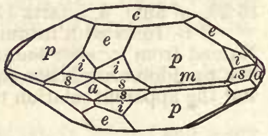


8.



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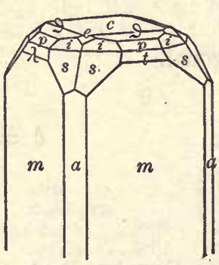

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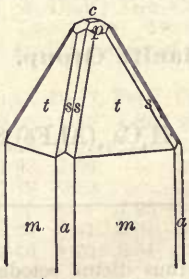
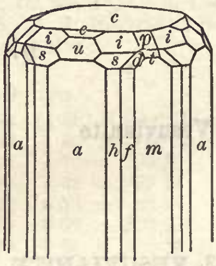


11.



Figs. 1–3, Common forms. 4, Ala, Strüver. 6, Monzoni. 7, Vesuvius, Pirsson. 8, Achmatovsk, Kk. 9, Zermatt, J. Stanley-Brown. 10, Zermatt, Pfd. 11, Sanford, Me.

*ah* = 18° 26′
*af* = 26° 34′

νν′ = 21° 8′
*ee*′ = 39° 6′
*uu*′ = 62° 20½′
ππ′ = 73° 51½′

νν″ = 30° 4′
ΩΩ″ = 39° 24½′
*ee*″ = 56° 29′
ξξ″ = 77° 43′
*uu*″ = 94° 6½′
ππ″ = 116° 22′

ϑϑ′ = 19° 59½′
*pp*′ = *50° 39′
*bb*′ = 72° 24½′
*tt*′ = 80° 43′

γγ″ = 10° 51′
εε″ = 14° 26′
ζζ″ = 17° 17′
ηη″ = 21° 30½′
ϑϑ″ = 28° 25′
κκ″ = 49° 1′
λλ″ = 62° 35′
*pp*″ = 74° 27′

*bb*″ = 113° 18′
*tt*″ = 132° 37′

*ii*$^{vii}$ = 23° 37½′
*vv*$^{vii}$ = 21° 14′
*yy*$^{vii}$ = 25° 32½′
*ss*$^{vii}$ = 31° 38′
*zz*$^{vii}$ = 40° 12′
*dd*$^{vii}$ = 48° 46′
*nn*$^{vii}$ = 26° 37½′

*c*ϑ = 14° 13′
*cp* = 37° 13½′
*ci* = 40° 21′

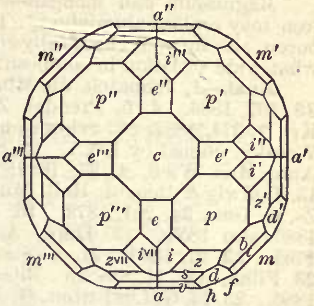
*cz* = 50° 13′
*cd* = 67° 24′

*aw* = 16° 48′
*av* = 22° 55′
*ay* = 27° 51′
*as* = 35° 10′
*aq* = 38° 24′
*az* = 46° 34½′
*ap* = 64° 40½′
*ae*′ = 90° 0′
*ai* = 52° 7′
*ad* = 34° 20′

Crystals commonly prismatic, often terminated by *c*, or by *c* and *p* alone; sometimes the prism wanting and the form a low pyramid; again sharp pyramidal, *t* (331), or terminated by the zirconoid *s* (311). Also massive; columnar, straight and divergent, or irregular; granular massive; cryptocrystalline.

Cleavage: *m* not very distinct; *a* and *c* still less so. Sometimes a lamellar structure ∥ *c*, and a tendency to scale off in thin layers often observed on all the faces of a crystal. Fracture subconchoidal to uneven. Brittle. H. = 6·5. G. = 3·35–3·45. Luster vitreous; often inclining to resinous. Color brown to green, and the latter frequently bright and clear; occasionally sulphur yellow, and also pale blue. Streak white. Subtransparent to faintly subtranslucent. Dichroism not usually strong: for $\omega$, colorless or yellowish; for $\epsilon$, reddish, yellowish, or greenish.

12.



12, Vesuvius, after Haidinger.

Optically −; also + rarely, as for viluite, Prendel. Double refraction very weak. Sometimes abnormally biaxial[8]. Color, optical character and refractive power often variable in successive concentric layers of the same crystal. Indices:

Ala, *green cryst.*, $\omega_y = 1{\cdot}719$–$1{\cdot}722$ $\epsilon_y = 1{\cdot}718$–$1{\cdot}720$ Dx.[9]
" $\omega_y = 1{\cdot}7235$ $\epsilon_y = 1{\cdot}7226$ Osann[9]

A division of a basal section into four diagonal biaxial sectors is very common.

An Ala vesuvianite gave Brezina: $2E_r = 62° 25'$. $2E_y = 62° 47'$. Klocke found the central portion of a section uniaxial, while the whole was divided into four biaxial sectors, the ax. plane normal to the edge, and the angle increasing toward the edge, the maximum axial angles being $2E_r = 28° 43'$ Li, $2E_y = 30° 32'$ Na, $2E_{gr} = 32° 30'$ Tl. Pressure served to diminish the axial angle in the sectors to which its direction was parallel, but increased it in the others. Variation of the axial angle with change of temperature has been shown by Doelter.

Sections of viluite ∥ *m* (Prendel) had normal extinction ∥ and ⊥ *c*. but consisted of two parts, A and B, each shaped like an hour-glass (A with axis ∥ and B ⊥ *c*). Sections ∥ *c* showed within the substance A, with feeble double refraction, nearly uniaxial; without, B, in parallel zones, with strong double refraction and an axial angle of 30° to 35°, the ax. plane parallel on each side to the outline of the crystal (*m* and *a*). Both parts were optically +. Upon heating to 200°–300°, the middle portion became uniaxial, and the axial angle of the exterior zones diminished to 10° when near a red heat; the change was permanent after long heating and sudden cooling. Further the parts A were found to be pyroelectrically + (on cooling), the parts B were −.

For the part A, G. = 3·290–3·295; for B, G. = 3·320–3·324. The highest value of G. obtained was 3·331. Separate analyses of the parts A and B of the crystals whose entire composition is given beyond (anal. 4, 5), gave nearly identical results, a slight apparent difference only in the amounts of $Fe_2O_3$ and FeO being shown.

**Var.**—1. *Ordinary.* Common color green, of various shades, to brown. Crystals usually short stout square prisms, also pyramidal. Sometimes massive, compact, and somewhat resembing jadeite, for which it has been mistaken (see below).

The mineral from Gökum in Finland has been called *Gahnite, Loboite, Gökumite*, and that from Frugård, *Frugårdite.* The last is in brown and green crystals, with G. = 3·349, Nd. *Jevreinovite*, which also is from Frugård, in the parish of Mäntzälä, is but little magnesian or not at all so; it occurs in pale brown to colorless crystals; G. = 3·39. *Heteromerite* occurs in small oil-green prisms in the district of Zlatoust, Ural. Egeran is a subcolumnar brown variety, from Eger in Bohemia.

So-called *colophonite* from Arendal has proved to be vesuvianite, though it had been previously referred to garnet.

*Xanthite* is a yellowish brown vesuvianite, from near Amity, N. Y., the crystals not differing from those of the common variety; it contains 2·80 p. c. MnO. A manganesian variety, from St. Marcel, Piedmont, has a sulphur to honey-yellow color. The *mangan-vesuvianite* (mangan-idocrase) from Jordansmühl contains 3·2 p. c. MnO (anal. 9), and that from Pajsberg contains 12·5 p. c. MnO (anal. 23).

2. *Cyprine.* Pale sky-blue or greenish blue; owing its color to a trace of copper, whence the name; from Tellemarken, Norway (anal. 26).

**Comp.**—A basic calcium-aluminium silicate, but of uncertain formula. The analysis of Ludwig-Renard gives $H_4Ca_{12}(Al,Fe)_6Si_{10}O_{43}$ or $H(OH)_3Ca_{12}(Al,Fe)_6(SiO_4)_{10}$.

Rammelsberg, who shows that the ratio of $\overset{\text{II}}{R} : \overset{\text{III}}{R} = 2 : 1$, while $\overset{\text{I}}{R} : \overset{\text{II}}{R}$ varies widely, regards the general formula as $4\overset{\text{I}}{R}_4SiO_4.\overset{\text{I}}{R}_6SiO_5 = \overset{\text{I}}{R}_{22}Si_5O_{21}$, which is more specially written $n\,\overset{\text{I}}{R}_{22}Si_5O_{21} + m\,(4\overset{\text{II}}{R}_{11}Si_5O_{21}.\overset{\text{III}}{R}_{22}Si_{15}O_{53})$.

Magnesium and manganese are often present and alkalies in small quantities, while ferric iron may replace aluminium. Titanium is also often present in small amount, and fluorine and boron, also further, chemically combined water. Specimens from different localities show a somewhat wide variation in composition not to be explained by simple replacement.

**Anal.**—1, Jannasch, Jb. Min., **2**, 132. 1883. 2, Id., ibid., **1**, 269, 1884 3, Rg., Zs. G. Ges., **38**, 507, 1886. 4, 5, Prendel, Zs. Kr., **17**, 96, 1889. 6, Rg., ib., **25**, 421, 1873. 7, Korn, Zs. Kr., **7**, 374, 1882. 8, Schumacher, Jb. Min., 817, 1878. 9, 10, Lsx., Zs. Kr., **4**, 171, 1879 (also Websky. quoted by Lsx.). 11, Schubert, Inaug. Diss., Brieg, 1880. 12, Berwerth (and Niessner), Ann. Mus. Wien, **4**, 87, 1889; also Rg., Jb. Min., **1**, 229, 1889, and Frenzel. ibid., p. 271. 13, Ludwig & Renard, Bull. Mus. Belg., **1**, 181, 1882. 14, 15, Rg., l. c., 1873; also Lemberg, Zs. G. Ges., **24**, 201, 1872. 16, Ludwig & Renard, l. c. 17, Rg., l. c., 1873. 18, Id., l. c., 1886 (also 1855). 19, Dmr., Ann. Ch. Phys., **23**, 157, 1871. 20, G. Nordenskiöld, G. För. Förh., **12**, 27, 1890. 21, A. Stenberg, ibid., p. 28. 22, Cossa, Att. Acc. Torino, **13**, 539, 1884. 23, Flink, Ak. H. Stockh., Bihang, **12** (2), 2, p. 56, 1887. 24, Igelström, Bull. Soc. Min., **9**, 22, 1886. 25, 26, G. Lindström, G. För. Förh., **10**, 286, 1888. 27, J. Lawrence Smith, Am. J. Sc., **8**, 435, 1874. 28–37, J. H. Vogel, Inaug. Diss., Göttingen, 1888.

**Pyr., etc.**—B.B. fuses at 3 with intumescence to a greenish or brownish glass. Magnus states that the density after fusion is 2·93–2·945. With the fluxes gives reactions for iron, and some varieties a strong manganese reaction. Cyprine gives a reaction for copper with salt of phosphorus. Partially decomposed by hydrochloric acid, and completely when the mineral has been previously ignited.

**Obs.**—Vesuvianite was first found among the ancient ejections of Vesuvius and the dolomitic blocks of Monte Somma. It has since been met with most abundantly in granular limestone; also in serpentine, chlorite schist, gneiss, and related rocks; often as a contact formation. It is often associated with grossular garnet and diopside, wollastonite, also epidote, titanite.

At Vesuvius it is hair-brown to olive-green, and occurs sometimes in highly modified crystals with garnet, mica, nephelite, glassy feldspar, etc.; in the Albani Mts.; on the Mussa Alp in the Ala valley, in Piedmont, it is in transparent green or brown brilliant crystals, in chlorite schist and serpentine with diopside, ripidolite, etc. Found also at Mt. Monzoni in the Fassathal; Cziklowa in Hungary; at Orawitza and Dognaczka; Haslau near Eger in Bohemia (*egeran*); near Jordansmühl, Silesia at Gleinitz, also at Johnsberg; Zermatt with almandite; in the Pfitschthal and the Zillerthal in Tyrol; at the Achmatovsk mine, Zlatoust, Ural; on the Vilui river, near L. Baikal (sometimes called *wiluite* or viluite, like the grossular garnet from the same region); at Pajsberg, Sweden; at Gökum a variety containing manganese, also at Jakobsberg; at Arendal, "*colophonite;*" at Egg, near Christiansand; from the Hamrefjeld in the Eker parish, between Kongsberg and Drammen; in Finland at Frugård, Lupikko, etc.

A massive form, mixed with diopside, occurs on the south side of the Piz Longhin, in the Bergellthal, and in rolled masses in the bed of the stream Ordlegna near Casaccia in the Upper Engadine. At first taken for "jadeite" (Fellenberg, Jb. Min., **1**, 103, 1889), but referred to vesuvianite by Damour and positively identified by the analyses of Berwerth (anal. 12), Rammelsberg and Frenzel.

In N. America, in *Maine* at Phippsburg and Rumford, just below the falls, in crystals and massive with yellow garnet, pyroxene, etc., in limestone; at Parsonsfield, with the same minerals, abundant; at Poland and Sandford (fig. 11). In *N. Hampshire*, at Warren with cinnamon-stone. In *Mass.*, near Worcester, in a quartz rock, with garnet, but exhausted. In *N. York*, ½ m. S. of Amity, grayish and yellowish brown crystals, sometimes an inch in diameter, in granular limestone; also at the village, and a mile east of the village, of yellow, greenish yellow, and yellowish brown colors. In *New Jersey*, yellowish brown in crystals at Newton, with corundum and spinel. In *California* near San Carlos in Inyo Co., with grossularite and datolite.

In *Canada*, at Calumet Falls, Litchfield, Pontiac Co., in large brownish yellow crystals in limestone with brown tourmaline; at Grenville in calcite, in wax-yellow crystals with garnet, pyroxene, zircon; at Templeton, Ottawa Co., Quebec, in brownish red crystals in a quartzose rock, and at Wakefield, green and bright yellow, with grossular garnet.

Named *Vesuvian* by Werner, from the first known locality. Werner supposed the mineral to be exclusively volcanic; but as this idea is not expressed, the name is no more objectionable than all others derived from the names of localities. The earlier name, *Hyacinthine,* is bad, as the mineral is not the hyacinth of either ancient or modern time. Haüy's later name, *Idocrase* (subjective, like many others of his) is from εἶδος, and κρασις, *mixture* in allusion to a resemblance between the crystalline forms and those of other species. Nothing in its signification, or in anything else, makes it right to substitute this for Werner's name In English, the word *vesuvian* has the objection of being an adjective in form and use; but this is avoided by giving it the mineralogical termination above employed.

*Loboite* was named for Lobo da Silveira; *gahnite* for the Swedish chemist Gahn; *xanthite* from ξανθός, *yellow;* heteromerite from ἕτερος and μέρος in allusion to a supposed variation from the normal composition.

| | G. | | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $Na_2O$ | $K_2O$ | $H_2O$ | F. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Vesuvius, *brown* | 3·448 | $\frac{3}{3}$ | 36·98 | — | 16·70 | 2·99 | 2·01 | 0·57 | 35·67 | 2·62 | 0·43 | 0·08[a] | 1·32 | 1·08 | = 100·45 |
| 2. Vilui | | | 36·17 | 1·30 | 12·23 | 2·18 | 1·49 | 0·15 | 35·81 | 6·05 | 0·45 | — | 0·72 | 0·22 | $B_2O_3$ 2·81 = 99·58 |
| 3. " | | | 36·76 | — | 11·86 | 5·94 | — | — | 35·83 | 6·04 | 0·58 | — | 0·79 | — | $B_2O_3$ 2·54 = 100·34 |
| 4 " | 3·331 | | 38·30 | 1·09 | 13·07 | 4·25 | | tr. | 35·92 | 5·83 | 0·37 | | 0·96 | | = 99·79 |
| 5. " | | | 38·49 | 1·28 | 12·99 | 5·08 | | 0·12 | 35·65 | 5·56 | 0·44 | | 0·97 | | = 100·58 |
| 6 Zermatt | | | 37·27 | 0·65 | 13·64 | 5·93 | 0·85 | — | 35·66 | 3·76 | 0·38 | — | 2·25 | — | = 100·39 |
| 7. Kedabék | 3·253 | | 36·81 | — | 15·46 | 5·42 | 0·69 | tr. | 35·57 | 3·66 | — | tr. | 2·06 | — | = 99·67 |
| 8. Tschammendorf | | | 37·80 | 1·77 | 16·28 | 1·56 | 3·11 | 0·94[b] | 34·76 | 2·42 | — | — | 2·29 | — | = 100·93 |
| 9. Johnsberg, *red* | | | 37·32 | — | 16·87 | 2·57 | 2·38 | 3·23 | 34·46 | 0·67 | — | — | 2·22 | — | = 99·72 |
| 10. Gleinitz, *colorless* | | | 37·57 | — | 16·30 | 1·82 | 2·76 | — | 36·26 | 1·75 | *und.* | — | 3·01 | — | = 99·47 |
| 11. Jordansmühl | | | 37·51 | — | 21·24 | 0·69 | — | — | 35·45 | 2·11 | — | — | 2·77 | — | = 99·77 |
| 12. Piz Longhin | 3·3 | | 40·98 | — | 14·07 | 2·07 | — | — | 33·83 | 4·67 | 0·72 | 0·12 | 2·34 | *und.* | = 98·80 |
| 13. Monzoni, *yw. brn* | 3·413 | | 37·50 | 0·28 | 16·23 | 3·76 | 0·33 | — | 36·31 | 3·13 | *tr.* | — | 2·14 | — | = 99·68 |
| 14. " *yw.* | | $\frac{2}{2}$ | 38·79 | — | 16·40 | 3·51 | — | — | 36·37 | 3·84 | 0·16 | 0·07 | 2·28 | — | = 101·42 |
| 15. " *brown* | | | 37·32 | — | 16·08 | 3·75 | 2·91 | — | 35·34 | 2·11 | 0·16 | | 2·08 | — | = 99·75 |
| 16. Ala, *green* | 3·427 | $\frac{3}{2}$ | 37·36 | 0·18 | 16·30 | 4·02 | 0·39 | — | 36·65 | 3·02 | *tr.* | — | 2·89 | — | = 100·81 |
| 17. " " | 3·388 | $\frac{3}{2}$ | 38·27 | — | 15·30 | 4·91 | 0·50 | — | 36·31 | 3·65 | 0·24 | | 2·49 | — | = 101·67 |
| 18. " | | | 38·05 | 0·64 | 14·66 | 3·80 | 0·92 | — | 37·31 | 2·56 | — | — | 2·68 | — | = 100·62 |
| 19. Arendal | 3·44 | | 36·32 | — | 16·70 | 6·20 | — | 1·40[b] | 34·86 | 0·73 | — | — | 2·58 | — | = 98·79 |
| 20. " *Colophonite* | 3·414 | | 35·45 | — | 12·18 | 7·29 | — | 1·88 | 34·01 | 4·56 | — | — | 3·14 | — | $B_2O_3$ 1·96 = 100·47 |
| 21. Eker | 3·64 | | 35·19 | 1·63 | 11·53 | 5·74 | — | 2·00 | 38·34 | 2·72 | — | — | 0·89 | 1·97 | = 100·01 |
| 22. Susa | 3·39 | | 37·46 | — | 15·51 | 5·39 | — | — | 35·98 | 1·97 | — | — | 3·40 | — | = 99·71 |
| 23. Pajsberg | | | 36·08 | — | 9·35 | 7·61 | — | 12·49 | 29·09 | 1·90 | 0·55 | 0·28 | 3·32 | — | = 100·67 |
| 24 Jakobsberg | | | 38·07 | — | 15·88 | 5·71 | — | 4·72 | 25·60 | 5·07 | — | — | — | — | CuO 2·16, PbO 1·80 = 99·01 |
| 25. Frugård, *Jevreinovite* | | | 39·15 | 0·19 | 18·27 | 1·14 | 1·57 | 0·10 | 34·98 | 2·39 | 0·06 | 0·07 | 0·55 | 1·73 | CuO 0·18 = 100·38 |
| 26. Tellemarken, *Cyprine* | | | 37·90 | 0·26 | 19·47 | 0·40 | 0·21 | 0·91 | 36·06 | 2·17 | 0·14 | 0·11 | 0·67 | 1·72 | CuO 0·73 = 100·75 |
| 27. San Carlos, Cal. | 3·445 | | 36·56 | — | 17·04 | 5·93 | — | 0·18 | 35·94 | 1·07 | — | 0·51 | 2·00 | — | = 99·23 |
| 28. Cziklowa, *yw. grn.* | 3·38 | | 37·00 | 0·12 | 17·51 | 1·53 | 0·83 | *tr.* | 36·56 | 3·82 | 0·51 | 0·02 | 2·61 | — | = 100·51 |
| 29. Corbássera, *yw. grn.* | 3·386 | | 37·18 | 0·40 | 17·12 | 2·94 | 0·62 | *tr.* | 34·35 | 3·56 | 0·29 | 0·36 | 2·99 | — | = 99·81 |
| 30. Canzocoli, *yw. brn.* | 3·404 | | 36·29 | — | 16·31 | 3·85 | 1·23 | — | 36·01 | 2·70 | 1·36 | 0·23 | 3·41 | — | = 101·39 |
| 31. Zermatt, *dk. brn.* | 3·488 | | 37·49 | 1·20 | 14·74 | 4·68 | 1·09 | *tr.* | 35·43 | 2·42 | 0·18 | 0·66 | 2·78 | — | = 100·67 |
| 32. Egg | 3·406 | | 36·68 | 0·41 | 16·70 | 2·62 | 2·76 | *tr.* | 34·97 | 2·51 | 1·18 | 0·25 | 1·15 | 1·32 | = 100·55 |
| 33. Haslau A, *dark brn.* | 3·419 | | 36·96 | 1·35 | 16·18 | 2·43 | 2·47 | *tr.* | 35·11 | 2·67 | 1·25 | 0·12 | 0·86 | 1·70 | = 101·10 |
| 34. " B, " " | | | 36·88 | 1·51 | 16·03 | 2·61 | 2·37 | *tr.* | 35·22 | 2·79 | 1·43 | 0·10 | 0·91 | 1·53 | = 101·38 |
| 35. Sandford, *brn.* | 3·419 | | 37·49 | — | 16·03 | 2·79 | 3·08 | 0·37 | 33·84 | 2·13 | 1·83 | 0·16 | 1·25 | 1·92 | = 100·89 |
| 36. Eker | 3·328 | | 36·99 | 0·89 | 15·43 | 3·46 | 1·51 | *tr.* | 35·81 | 3·04 | 0·81 | 0·18 | 0·87 | 1·35 | = 100·34 |
| 37. Arendal, *dk. brn.* | 3·38 | | 36·81 | 0·28 | 16·25 | 3·92 | 2·21 | 0·14 | 35·49 | 2·72 | 0·52 | 0·16 | 0·98 | 1·36 | = 100·84 |

[a] $Li_2O$.

[b] $Mn_2O_3$.

**Alt.**—Alteration nearly as in garnet, with a far greater tendency to become hydrated. Crystals from Maine often have the exterior, though still brilliant and glassy, separating easily from the part below, and equally so, parallel to all the smaller as well as larger faces, so that a pealed crystal has as brilliant and even planes as before. Pseudomorphs include steatite, mica, clinochlore, diopside, and garnet.

**Artif.**—Not certainly obtained by artificial methods as yet, though claimed by Mitscherlich and later Daubrée. From the fusion of vesuvianite, Doelter and Hussak have obtained a mixture containing meionite, melilite, anorthite, and a calcium-chrysolite; see Doelter and Hussak, Jb. Min., **1**, 173, 1884, also Doelter, Min. Mitth., **10**, 86, 1888.

**Ref.**—[1] Piedmont, Preisschrift, 96, 1825, confirmed by Kk. Mohs-Haid. give *pp'* = 50° 31'; Zeph. shows that crystals from different localities vary somewhat widely, cf. also Kk., Min. Russl., **1**, 92, 1853. **9**, 156, 1884; Svr. Zs. Kr., **1**, 251, 1877; Mem. Acc. Linc., **4**, 101, 1887, **5**, 305, 1888; or Jb. Min., **2**, 35, 1888: ibid., **1**, 1, 1891. The variation of angle as bearing upon the crystalline system has been particularly studied by Doelter, Zs. Kr., **5**, 289, 1881.

[2] Zeph., monograph, Ber. Ak. Wien, **49** (1), 6, 1864, **69** (1), 29, 1874. Cf. Gdt., Index, **2**, 193, 1888. [3] Erem., Vh. Min. Ges., **7**, 366, 1872. [4] Groth and Bücking, Min.-Samml. Strassb., 199, 1878. [5] Tarasov, Ural, Vh. Min. Ges., **14**, 139, 1879. [6] Korn, Kedabék, Caucasus, Zs. Kr., **7**, 371, 1882. [7] Zeph., Orawitza, Ber. Ak. Wien, **69** (1), 29, 1874.

[8] *Optical anomalies*, Mld., Ann. Mines, **10**, 133, 1876; Brezina, Min. Mitth., 98, 1877; Doelter, l. c.; Klocke, Jb. Min., **1**, 204, and **2**, 260, 1881; Prendel, l. c. *et al.* [9] *Indices*, Dx., Min., **1**, 280, 1862; Osann quoted by Rosenb., Mikr. Phys., 320, 1886. *Pyro-electricity*, Hankel, Pogg, **157** 162, 1876; also Prendel, l. c.

## 10. Zircon Group. $\overset{IV}{R}SiO_4$. Tetragonal.

| | | |
|---|---|---|
| **394. Zircon** | $ZrSiO_4$ | $\dot{c}$ = 0·6404 |
| **395. Thorite** | $ThSiO_4$ | $\dot{c}$ = 0·6402 |

By some authors, Zircon and Thorite are treated as oxides and included in the RUTILE GROUP (p. 233), to which they approximate closely in form. For example, Groth doubles the formula of Rutile and writes it $TiTiO_4$, which may then be regarded as corresponding to the $ZrSiO_4$ of Zircon. A similar form belongs also to the tantalate, Tapiolite, and to the phosphate, Xenotime; further, compound groups consisting of crystals of Xenotime and Zircon in parallel position are not uncommon.

**394. ZIRCON.** *Λυγκύριον* (= Lyncurium)? *Theophr.* [Pliny knew of no stone of the name Lyncurium, **36**, 13.] Chrysolithos? pt., *Plin.*, **37**, 42; Melichrysos? ib., 45; Crateritis? ib., 56. Not Chrysolithos (Gemmarii hodie etiam Hyacinthum vocant) *Germ.* Jacinth, *Agric.*, Foss., 295, Interpr., 464, 1546. Not Hyacinthus *Wall.*, 121, 1747. Jargon (in note acknowledging ignorance of it) *Cronst.*, 42, 1758. Jargon, Topazius pt. (clarus hyalinus, var. *f*), *Wall.*, 240, 1772. Grenat à prisme quadrilatère, etc., Hyacinte (fr. Expailly) *Faujas*, Viv., 187, and Errata, 1772. Hyacinte pt. (var. 1; angles and figs. given) [rest Vesuvianite, Meionite, Harmotome] *de Lisle*, Crist., 1772, **2**, 1783; Diamant brut, ou Jargon de Ceylan, ib., **2**, 229, 1783. Zircon (fr. Ceylon) *Wern.*, 1783; *Karsten*, Lempe Mag., **4**, 99, 1787. Zircon (a silicate of zirconia) *Klapr.*, Schrift. Nat. Fr. Berl., **9**, 1789, Beitr., **1**, 203. Zirconite. Ostranit *Breith.*, Uib., 1830, Char., 1832. Calyptolite *Shep.*, Am. J. Sc., **12**, 210, 1851. Engelhardit *E. v. Hofmann*, Kk., Min. Russl., **3**, 150, 1858. Circone *Ital.*, Scc. Turmali *Ceylonese Jewellers*, Prinsep, J. Asiat. Soc. Bengal, **1**, 357, 1832, and Mallet, Min. India, p. 111, 1887.

Azorite. New mineral from the Azores, *J. E. Teschemacher*, Am. J. Sc., **3**, 32, 1847. Azorite *Dana*, Min., 396, 681, 1850.

Tetragonal. Axis $\dot{c}$ = 0·640373; 001 ∧ 101 = 32° 38′ 4″ Kupffer[1].

**Forms**[2]:
*c* (001, *O*)
*a* (100, *i-i*)
*m* (110, *I*)
*e* (101, 1-*i*)
ζ (113, $\frac{1}{3}$)[3]
β (112, $\frac{1}{2}$)
*p* (111, 1)
*d* (553, $\frac{5}{3}$)[4]
φ (774, $\frac{7}{4}$)
*v* (221, 2)
*u* (331, 3)
*q* (551, 5)[4]
*z* (511, 5-5)
*y* (411, 4-4)
*x* (311, 3-3)

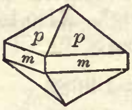
ee' = 44° 50'
ee'' = 65° 16'
ζζ' = 23° 35'
pp' = *56° 40' 26''
vv' = 76° 29'
uu' = 83° 9'
ζζ'' = 33° 36'

ββ'' = 48° 44'
pp'' = 84° 20'
vv'' = 122° 12'
uu'' = 139° 35'
zz' = 64° 4'
$zz^{\text{vii}}$ = 21° 37'
yy' = 57° 31'

$yy^{\text{vii}}$ = 26° 13'
xx' = 47° 17'
$xx^{\text{vii}}$ = 32° 57'
az = 20° 21'
ay = 24° 52'
ax = 31° 43'

ap = 61° 40'
ae' = 90° 0'
mp = 47° 50'
mv = 28° 54'
mu = 20° 12½'
mx = 36° 41'

1.



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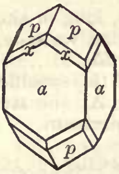

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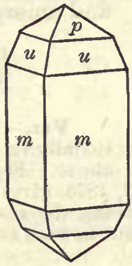

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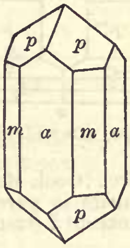
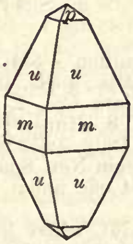


Figs. 1–5, Common forms.

6.



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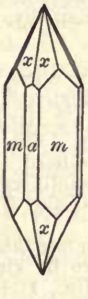

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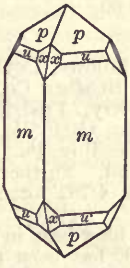

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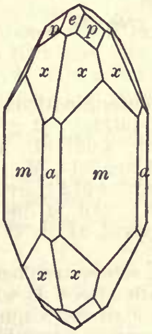

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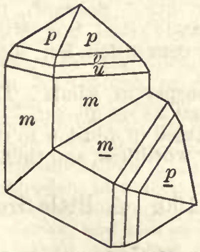

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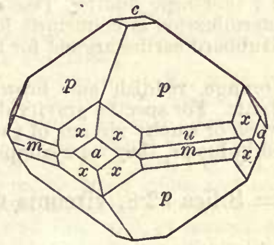


12.

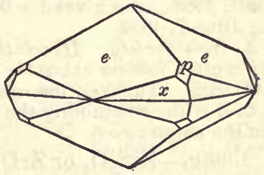


Fig. 6, Pitcairn, N. Y., Pfd. 7, Ural, Kk. 8, N. Carolina. 9, McDowell Co., N. C. 10, Renfrew Co., Canada, Hidden. 11, Cheyenne Mt., Colorado, Hovey. 12, Govt. Tomsk, Kk.

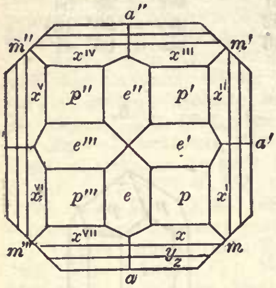
Twins[5]: tw. pl. *e* (101), geniculated twins like those of rutile and cassiterite. Commonly in square prisms, often elongated, sometimes pyramidal, *p* (111), and less often *u* (331), *e* (101); the basal plane rare. Faces of pyramids sometimes convex. Also in irregular forms and grains.

Cleavage: *m* imperfect; *p* (111) less distinct. Fracture conchoidal. Brittle.

H. = 7·5. G. = 4·68–4·70 most common, but varying widely; sometimes much lower, to 4·2, and also higher, to 4·86; density slightly increased by ignition, Church (see below). Luster adamantine. Colorless, pale yellowish, grayish, yellowish green, brownish yellow, reddish brown. Streak uncolored. Transparent to subtranslucent and opaque. Optically +. Double refraction strong. Sometimes abnormally biaxial, cf. Mld.[6] and beccarite (below); also made biaxial by heating, Madelung[6]. Also isotropic and amorphous by alteration. Indices:

Ceylon $\omega_y = 1·9239$ $\epsilon_y = 1·9682$
Miask $\omega_y = 1·9313$ $\epsilon_y = 1·9931$ Sanger[7]

13.



Saualpe, after Haidinger.

**Var.**—1. *Ordinary.* In square prisms, long or short, occasionally very large. Habit and color somewhat variable, see figs. above. Fig. 12 shows the Russian *engelhardite.*

Church (Geol. Mag., **2**, 322, 1875) gives the following determinations of the specific gravity, the numbers in parentheses being the results after prolonged ignition. All the stones were flawless except 2 (transparent but flawed) and 3 (opaque); 1 was slightly opalescent.

| | G. | | G. |
|---|---|---|---|
| 1. *Dark green, dull* | 4·02 | 6. *Brownish yellow* | 4·62 |
| 2. Fredriksvärn, *hair-brown* | 4·489 (4·633) | 7. *Brownish yellow* | 4·679 |
| 3. Henderson Co., N. C., *pale brown* | 4·54 (4·667) | 8. Ceylon, *pale green* | 4·691 |
| | | 9 *Brown* | 4·696 |
| 4. Ceylon, *greenish* | 4·579 (4·625) | 10 Mudgee, N. S. W., *deep red* | 4·705 (4·70) |
| 5. *Yellow* | 4·60 | 11. Expailly, *Jacinth* | 4·863 (4·863) |

Other determinations are as follows: Ceylon, G. = 4·183 (after ignition 4·534) Damour; Stockholm, 4·072–4·222 Svanberg; Renfrew Co., 4·552 Fletcher; Ilmen Mts., 4·599, 4·610 Svanberg; Ceylon, 4·681 id., 4·721 Cowry; Fredriksvärn, 4·2 Berlin; Madison Co., N. C., 4·607 Chandler; Litchfield, Me., 5·7 Gibbs; Grenville, Canada, 4·625–4·602 T. S. Hunt; Templeton, Canada, 4·482, 4·612 Harrington; Reading, Pa., 4·595 Wetherill; Lonedo, Italy, 4·673 Grattarola; Cheyenne Mt., Col., 4·709 Hillebrand. Further for hyacinth-red gems from New South Wales, Liversidge gives: G. = 4·697, 4·719, 4·782 for cut gems; also G. = 4·684 one uncut, weighing 2·46 grams.

*Azorite*, whose true nature has long been in question (see 5th Ed., p. 761, where its possible identity with zircon is suggested), has been proved to be zircon by Osann, who separated material enough for a quantitative analysis, see Jb. Min., **1**, 115, 1887. **1**, 126, 1888. It is in minute tetragonal pyramids, with *m* (110), *p* (110), *u* (331), colorless or of a pale greenish color. Observed in the sanidine-trachyte of São Miguel, one of the Azores; it is implanted in part upon sanidine, in part upon hornblende, and is associated with the still doubtful pyrrhite (see p. 728). Osann shows that the hardness is over 7 (not near fluorite, Teschemacher, nor 5, Schrauf), the specific gravity above 3·6. Osann's determination is confirmed by Ben-Saude (Bull. Soc. Min., **11**, 201, 1888), who gives $\dot{c} = 0·6417$; Hubbard earlier argued for the same conclusion, Ber. nied. Ges., June 7, 1886.

2. *Gem variety. Hyacinth:* the orange, reddish and brownish transparent kinds. The color is often lost on exposure to the light. For specific gravity determinations see above.

*Jargon.* The colorless and yellowish or smoky zircons of Ceylon, named in allusion to the fact that while resembling the diamond in luster, they were comparatively worthless; and thence came the name *zircon.*

**Comp.**—$ZrSiO_4$ or $ZrO_2.SiO_2$ = Silica 32·8, zirconia 67·2 = 100. A little iron ($Fe_2O_3$) is usually present.

**Anal.**—1–7, Cochran, Ch. News, **25**, 305, 1872. 8, Nylander, [Act. Univ. Lund., 2] Jb Min., 488, 1870. 9, Corsi, Boll. Com. Geol., **12**, 125, 1881. 10, Helms, quoted by Liversidge Min. N. S. W., 200, 1888. 11, Genth, Am. J. Sc., **40**, 116, 1890. 12, Koenig, Proc. Ac Philad., 11, 1877. Also 5th Ed., p. 274.

| | $SiO_2$ | $ZrO_2$ | $Fe_2O_3$ | | |
|---|---|---|---|---|---|
| 1. Ceylon, *colorless, Jargon* | 33·90 | 64·80 | — | = | 98·70 |
| 2. " " " | 33·05 | 66·71 | *tr.* | = | 99·76 |
| 3. " " " | 33·86 | 64·25 | 1·08 | = | 99·19 |
| 4. " *transparent* | 33·81 | 66·32 | *tr.* | = | 100·13 |
| 5. " *yellowish, Hyacinth* | 32 87 | 64·25 | 2 04 | = | 99·16 |

| | G. | $SiO_2$ | $ZrO_2$ | $Fe_2O_3$ | |
|---|---|---|---|---|---|
| 6. Norway, *dark brownish yellow* | | 32·53 | 64·05 | 2·85 = | 99·43 |
| 7. " " " " | | 33·61 | 64·40 | 0·90 = | 98·91 |
| 8. Expailly | | 33·23 | 66·03 | 0·62 = | 99·88 |
| 9. Tuscany | 4·655 | 33·11 | 66·82 | 0·35 | ign. 0·43 CaO,MgO *tr.* = **100·71** |
| 10. New South Wales | 4·675 | 32·99 | 66·22 | 0·43 | CaO 0·14 = 100·18 |
| 11. Madison Co., N. C. | 4·507 | 31·83 | 63·42 | 3·23 | ign. 1·20 = 99·68 |
| 12. El Paso Co., Col. | 4·538 | 29·70 | 60·98 | 9·20 | MgO 0·30 = 100·18 |

An alterėd zircon from the pegmatyte of the Schwalbenberg has been analyzed by Woitschach (Zs. Kr., **7**, 87, 1882), as follows; cf. cyrtolite below.

| $SiO_2$ | $ZrO_2$ | $ThO_2$ | $CeO_2$ | $SnO_2$ | $Y_2O_3$ | $Fe_2O_3$ | CaO | MgO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| 29·16 | 55·28 | 2·06 | *tr.* | 0·57 | 3·47 | 2·96 | 2·14 | 0·34 | 5·02 = 101·10 |

Spezia shows that the color of zircon is due to the state of oxidation of the iron, varying in O.F. and R.F., but this is not the cause of the change of density sometimes noted in ignition (see above). Att. Soc. Tosc., **12**, 37, 1876.

Sorby assumed the presence of a new element, "Jargonium," which is not confirmed by Cochran (l. c.) and others, cf. Ch. News, **20**, 7, 1869; also Proc. Roy. Soc., **17**, 511, 1869, **18**, 197, 1870. Traces of a number of elements have been spectrally identified by Linnemann, Ber. Ak. Wien, **91** (2), 1019 and **92** (2), 427, 1885 (in Ch. News, **52**, 220, etc., 1885); also the absorption lines of erbium (and didymium). The name "*polykrasilith*" (πολὺς, *many*, κράσις, *mixture*) is suggested as appropriate in view of the presence, as believed by the author, of the elements, Sn, Pb, Cu, Bi, Zr, Al, Fe, Co, Mn, Zn, Mg, U, Er, Ca, K, Na, Li.

**Pyr., etc.**—Infusible; the colorless varieties are unaltered, the red become colorless, while dark colored varieties are made white; some varieties glow and increase in density by ignition. Not perceptibly acted upon by salt of phosphorus. In powder is decomposed when fused with soda on the platinum wire, and if the product is dissolved in dilute hydrochloric acid it gives the orange color characteristic of zirconia when tested with turmeric paper. Not acted upon by acids except in fine powder with concentrated sulphuric acid. Decomposed by fusion with alkaline carbonates and bisulphates.

**Obs.**—Occurs in crystalline rocks, especially granular limestone, chloritic and other schists; gneiss, syenite; also in granite; sometimes in iron-ore beds.

*Zircon-syenite* is a coarse syenitic rock, containing crystals of zircon, with ægirite, elæolite, etc. Crystals are common in most auriferous sands. Sometimes found in volcanic rocks, probably in part as inclusions derived from older rocks. Microscopic examination shows it to be a not uncommon constituent of many crystalline rocks. Cf. Rosenb., Mikr. Phys., 310, 1886.

Found in alluvial sands in Ceylon; in the gold regions of the Ural, near Miask, Berezov, Nevyansk, etc.; at Laurvik and Hakedal in Norway; at Arendal, in the iron mines; at Hitterö; at Fredriksvärn, in zircon-syenite; in veins in the augite-syenite of the Langesund fiord; at Bilin in Bohemia; Sebnitz in Saxony; Pfitschthal in Tyrol; in lava at Niedermendig in the Eifel, in red crystals; at Expailly, near Le Puy in France; in Auvergne, in volcanic tufa; at Vesuvius with rhyacolite; with corundum, etc., at Lonedo, northern Italy; in Scotland, at Scalpay, Isle of Harris; at Strontian in Argyleshire; in the auriferous sands of the Croghan Kinshela Mtn., Ireland; in Greenland; at Santa Rosa in Antioquia, U. S. Colombia; in the gold regions of Australia, as at Mudgee, New South Wales, and many other points, especially in the auriferous gravels; also with topaz, and with cassiterite.

In N. America, in *Maine*, at Litchfield; at Mt. Mica in Paris; Greenwood; Hebron. In *Vermont*, at Middlebury. In *Conn.*, at Norwich, with sillimanite, rare; at Haddam (calyptolite) in minute crystals. In *N. York*, at Hall's mine in Moriah, Essex Co., cinnamon-red, in a vein of quartz; near the outlet of Two Ponds, Orange Co., with scapolite, pyroxene, and titanite, in crystals sometimes 1 in. in length; on Deer Hill, 1 m. S.E. of Canterbury, Orange Co., crystals abundant of a deep brownish red or black color, and occasionally 1½ in. in length; at Warwick, at the southern base of Mount Eve, chocolate-brown crystals in limestone and scapolite; near Amity, and also in Monroe and Cornwall, at several localities, of white, reddish brown, clove-brown, and black colors; at Diana in Lewis Co., in large brown crystals sometimes 2 in. long, with titanite and scapolite, rare; in St. Lawrence Co., with apatite, at Robinson's in the town of Hammond, near de Long's Mills, some of the crystals 1½ in. long and ½ in. wide, and occasionally containing a nucleus of carbonate of lime; also at Rossie; at Fine, in large prismatic crystals, of a greenish color; also at Pitcairn (f. 6); at Johnsburg, in Warren Co. In *N. Jersey*, at Franklin; at Trenton in gneiss. In *Penn.*, near Reading, in large crystals in magnetic iron ore; at Easton, in mica slate. In *N. Car.*, in the gold sands of Burke, McDowell, Polk, Rutherford, and other counties; especially abundant in Henderson Co., on the south side of the Blue Ridge near Green river, at the Freeman mine, where it occurs in a disintegrated granitic or gneissoid rock so abundantly that it has been mined in large quantities for technical purposes; up to 1889 this and the Jones mine are said to have yielded 30 *tons* of zircons (Hidden); in magnetite beds of the Unaka Mts.; also at other points. In *Colorado*, with astrophyllite, etc in the Pike's Peak region in El Paso Co.; at Cheyenne Mt., brilliant reddish brown to pink or green crystals (f. 11) in quartz often surrounded with kaolinite. In *California*, in the auriferous gravel of the north fork of the American river, and elsewhere, as at Spring valley, Cherokee, Butte Co.; Eagle Gulch and Rock Island Hill, Plumas Co.; Picayune Flat, Fresno Co.; Navarro R., Anderson valley, Mendocino Co.

In *Canada*, at Grenville, Argenteuil Co., in crystalline limestone, with wollastonite, titanite, graphite; St. Jérôme on the North River in Terrebonne Co.; Mille Isles; abundant and sometimes in very large crystals, with gigantic titanites, in the apatite deposits in Templeton and adjoining townships in Ottawa Co., Quebec; fine crystals, sometimes twins, in the Sebastopol township, Renfrew Co.; very large crystals in Brudenell township, Renfrew Co.; further in North Burgess, Lanark Co ; in syenite on Pic Island, L. Superior. The Renfrew crystals are sometimes upwards of 6 inches in length with a thickness of 2 inches or more.

The name *Hyacinth* was applied by the ancients to a bluish violet stone, regarded as our sapphire, and was derived from a flower (lily) so called of this color. [In modern mineralogy a *hyacinth-color* is reddish orange with a tinge of brown.] Intagli of zircon are common among ancient gems, and the fact that the *lyncurium* of Theophrastus was, as he says, used for engraved signets, while at the same time electric on friction, and often amber-colored, are the principal evidence that it was our zircon.

**Alt.**—Zircon is one of the least alterable of minerals, as it contains no protoxides, and only the most insoluble of dioxides. It, however, passes to a hydrous state, becoming isotropic and amorphous, and this is attended ultimately with a loss of silica and the addition of iron oxide and other impurities derived from infiltrating waters. *Auerbachite, malacon, œrstedite, tachyaphaltite, calyptolite, cyrtolite* (see beyond), are probably altered zircon.

**Artif.**—Formed in crystals by action of silicon chloride on zirconia (Daubrée); by action of silicon fluoride on zirconia, or of zirconium fluoride on quartz, beautiful transparent octahedrons resulting (Deville and Caron).

**Ref.**—[1] Preisschrift, p. 72, 1825. Kk., Min. Russl., **3**, 139, 1858, gives $pp' = 56^\circ\ 39'\ 39''$. Also Dbr., for Miask, $pp' = 56^\circ\ 39'\ 42''$; Pfitschthal, $56^\circ\ 39\ 14''$; Fredriksvärn, $56^\circ\ 39'\ 27''$; Ceylon, $56^\circ\ 40'\ 10''$, Pogg., **107**, 257, 1859.

[2] Cf. Haid., Min. Mohs., **2**, 368, 1825; also Gdt., Index, **3**, 353, 1891. Gehmacher has noted vicinal planes on the Pfitschthal zircons, Zs. Kr., **12**, 50. 1886. Cross and Hillebrand (Colorado, Am. J. Sc., **24**, 284, 1882) note a pyramid $\omega$, with $p\omega = 15^\circ\ 14'$, whence $\omega = 559$ probably, $\omega p = 15^\circ\ 27'$; they suggest the less probable symbol 14·14·25. [3] Hidden, Burgess, ib., **29**, 250, 1885. [4] Brögger, Norway, Zs. Kr., **16**, 103, 1890. [5] Hidden, Am. J. Sc., **21**, 507, 1881, Fletcher, Phil. Mag., **12**, 26, 1881. [6] Ann. Mines, **10**, 143, 1876. Cf. beccarite below and Madelung, Zs. Kr., **9**, 46, 1884. [7] Quoted by Rosenbusch, Mikr. Phys., 311, 1886.

BECCARITE *Grattarola*, Att. Soc. Tosc., **4**, 177, 1879, **7**, Proc. Verb., 82, 1890. A variety of zircon from Ceylon. Color olive-green. Optically biaxial, with apparent twinned structure; a basal section is divided into four sectors in polarized light. Form and other characters like zircon. G. = 6·54, 6·74. Analysis: $SiO_2$ 30·30, $ZrO_2$ 62·16, $Al_2O_3$ 2·52, CaO 3·62, ign. 0·32 = 98·92. Named for Dr. O. Beccari.

**Altered Zircon.**—The following tetragonal zircon-like minerals are in part, at least, altered zircon. They afford more or less water on ignition.

MALACON. Malakon *Scheerer*, Pogg., **62**, 436, 1844. $pp' = 55^\circ\ 3'$ to $55^\circ\ 20'$. H. = 6·5. G. = 3·90–3·91. Luster vitreous to subvitreous. Color brown, powder reddish brown or uncolored. From Hitterö in Norway; and Chanteloube, Haute Vienne, occurring in thin plates, over 3 to 4 mm. thick, and occasionally with crystals on their surface. Named from μαλακός, *soft*. Anal. 1–3 below.

A mineral found with columbite at Rosendal near Björkboda, Finland, has been referred to adelpholite of Nordenskiöld (p. 731), but an analysis by A. E. Nordenskiöld (anal. 7) shows that it is an altered zircon, near malacon or cyrtolite (Öfv. Ak. Stockh., **20**, 452, 1863, Pogg., **122**, 615, 1864).

TACHYAPHALTITE *Weibye*, Pogg., **88**, 160, 1853. Crystals like those of zircon, with forms *m* (110), *a* (100) and two octahedrons. H. = 5·5. G. = 3·6. Luster submetallic to vitreous. Color dark reddish brown. Streak dirty yellow. Subtranslucent. From granite veins in gneiss near Kragerö in Norway with titanite. Named from ταχύς, *quick*, and ἄφαλτος, the mineral flying readily from the gangue when struck.

ŒRSTEDITE *Forchhammer*, Pogg., **35**, 630, 1835. $pp' = 56^\circ\ 43\tfrac{1}{2}'$. H. = 5·5. G. = 3·629. Luster splendent, adamantine. Color reddish brown. From Arendal in Norway, and commonly on crystals of pyroxene. Named after H. Ch. Œrsted (1777–1851).

AUERBACHITE *Hermann*, J. pr. Ch., **73**, 209, 1858. $pp' = 57^\circ\ 17'$ and $pp^{iv} = 94^\circ\ 39'$ Kk. H. = 6·5. G. = 4·06. Luster greasy to vitreous, weak. Color brownish gray. From a siliceous schist, District of Alexandrovsk, Russia. Named after Dr. Auerbach, by whom the crystals were first studied.

Anal.—1, Scheerer, l. c. 2, Damour, Ann. Ch. Phys., **24**, 87, 1848. 3, Hermann, J. pr. Chem., **53**, 32, 1851. 4, J. P. Cooke, l. c. 5, 6, Knowlton, l. c. 7, A. E. Nordenskiöld, l. c. 8, Berlin, Pogg., **88**, 161, 1853. 9, Forchhammer, l. c. 10, Hermann, l. c.

| | $SiO_2$ | $ZrO_2$ | $Fe_2O_3$ | $U_2O_3$ | FeO | $Y_2O_3$ | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. *Malacon,* Hitterö | 31·31 | 63·40 | 0·41 | — | — | 0·34 | 0·11 | 3·03 | CaO 0·39 = 98·99 |
| 2. " Chanteloube | 30·87 | 61·17 | 3·67 | — | — | — | — | 3·09 | CaO 0·08, MnO 0·14 = 99·02 |
| 3. " Ilmen Mts. | 31·87 | 59·82 | — | — | 3·11 | -- | — | 4·00 | MnO 1·20 = 100 |
| 4. *Cyrtolite,* Rockport | 27·90 | 66·93 | 2·57[c] | — | — | — | — | 2·19 | = 99·59 |
| 5. " " | $\frac{3}{3}$ 26·38 | 60·78 | — | 1·59 | 3·63 | 2·07[d] | *tr.* | 4·56 | $SnO_2$ 0·47 = 99·48 |
| 6. " " | 26·18 | 64·60[a] | — | 1·40 | — | 1·40[d] | *tr.* | — | $SnO_2$ 0·41 = 98·97 |
| 7. *Adelpholite?* Finland | 24·33 | 57·42 | 3·47 | — | — | 3·93[d] | — | 9·53 | $SnO_2$ 0·61 = 99·29 |
| 8. *Tachyaphalt.*, Norway | 34·58 | 38·96 | 3·72 | — | — | 12·32[e]? | — | 8·49 | $Al_2O_3$ 1·85 = 99·92 |
| 9. *Œrstedite,* Arendal | 19·71 | 68·96[b] | — | — | 1·14 | — | 2·05 | 5·53 | CaO 2·61 = 100 |
| 10. *Auerbachite,* Russia | 42·91 | 55·18 | — | — | 0·93 | — | — | 0·95 | = 99·97 |

[a] With some FeO. [b] With some $TiO_2$. [c] With trace of manganese. [d] Cerium oxides. [e] $ThO_2$.

CYRTOLITE. Malacon, Altered Zircon, *J. P. Cooke,* Am. J. Sc., **43**, 228, 1867; Cyrtolite *W. J. Knowlton,* ib., **44**, 224. Form a combination of *m* (110) and *e* (101), and resembling a rhombic dodecahedron, the pyramidal faces *e* strongly curved. H. = 5–5·5; after ignition 7–7·5 Cooke. G. = 3·98–4·04 Cooke; 3·85–3·97 Knowlton. Luster somewhat adamantine. Color brownish red; powder the same. From Rockport, Mass., in granite, with danalite and cryophyllite. Named from *κύρτος, bent.* See analyses 4–6 above.

A mineral regarded as related to cyrtolite by *Nordenskiöld* (G. För. Förh., **3**, 229, 1876) has the following characters: In tetragonal crystals, *m* (110) and *e* (101), resembling a rhombic dodecahedron. Color yellow to yellowish brown. Translucent. H. = 5·5–6. G. = 3·29. Analysis:

| $SiO_2$ | $ZrO_2$ | $Er_2O_3,Y_2O_3$ | $Ce_2O_3$ | CaO | MgO | $H_2O$ | $Al_2O_3$ | FeO | |
|---|---|---|---|---|---|---|---|---|---|
| 27·66 | 41·78 | 8·49 | 3·98 | 5·06 | 1·10 | 12·07 | *tr.* | *tr.* | = 100·14 |

Occurs with fergusonite, arrhenite, xenotime, at Ytterby, Sweden.

An analysis by Blomstrand (Ak. H. Stockh., Bihang, **12** (2), No. 10, 1886) of the same mineral from Ytterby gave:

| $SiO_2$ | $ZrO_2$ | $Y_2O_3$[a] | FeO | CaO | MgO | CuO | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| $\frac{4}{4}$ 26·93 | 41·17 | 10·93 | 1·51 | 5·85 | *tr.* | 0·17 | 0·89 | 12·55 | Cerium earths *tr.* = 100 |

[a] $Y_2O_3$ = Yttrium earths.

The name *anderbergite* is proposed for the mineral, but as noted by Bäckström (Zs. Kr., **15**, 83, 1888) it is undoubtedly only a pseudomorph, and belongs with the uncertain minerals called cyrtolite.

A mineral having the external aspect of cyrtolite occurs rather abundantly in crystalline aggregates and massive, at Branchville, Conn.; also in Mitchell and Henderson counties, N. Carolina; further similarly and in large quantities in Llano Co., Texas (G. = 3·652) with gadolinite and other rare species. It has not been analyzed, and while probably altered and hydrated it seems probable that the original mineral may have been a more complex species than ordinary zircon. Cf. alvite below; also anal. by Woitschach, quoted on p. 485.

A mineral from the feldspar quarries at Alve near Arendal gave Lindström:

| $SiO_2$ | X[a] | $ZrO_2$ | PbO | $Fe_2O_3$ | $Y_2O_3$[b] | $Ce_2O_3$[c] | BeO[d] | MnO | CaO | MgO | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26·10 | 2·78 | 32·48 | 0·45 | 5·51 | 1·03 | 3·27 | 14·73 | 0·27 | 2·44 | 1·05 | 8·84 | $UO_3$ *tr.* = 98·95 |

[a] Metallic acids. [b] Yttrium earths. [c] Cerium oxides. [d] Incl. $Al_2O_3$ in small amount.

This is called *alvite* by Nordenskiöld, who quotes the above analysis (G. För. Förh., **9**, 28, 1887). He regards the anderbergite of Blomstrand as taking the place in the pegmatyte veins of southern Norway of the alvite of the Arendal region. The original alvite was described as follows:

ALVITE *D. Forbes & T. Dahll,* Nyt Mag., 8, 228, 1855. Tetragonal. Crystals like those of zircon. H. = 5·5. G. = 3·601 Alve; 3·46 Helle. Luster greasy. Color reddish brown, becoming grayish brown by alteration. Subtranslucent to opaque. A very small portion, somewhat altered, afforded:

| $SiO_2$ | $ThO_2$? | $ZrO_2$ | $Y_2O_3$ | $Ce_2O_3$ | $Al_2O_3$,BeO | $Fe_2O_3$ | CaO | $H_2O$ | $SnO_2$,CuO | |
|---|---|---|---|---|---|---|---|---|---|---|
| 20·33 | 15·13 | 3·92 | 22·01 | 0·27 | 14·11 | 9·66 | 0·40 | 9·32 | *tr.* | = 95·15 |

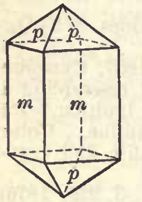
Yields water B.B., but is infusible; with the fluxes reacts for iron but not for titanium. Insoluble in acids. From Helle and Narestö in Norway, with feldspar and black mica.

A mineral from the granite of Devil's Head Mt., Douglas Co., Colorado, in the Pike's Peak region has been analyzed by Hillebrand (Proc. Soc. Col., 3, 44, 1888). Occurs in tapering indistinctly crystalline forms. Color brown. G. = 3·60 (1), 3·70 (2), 3·64 (3). It is spoken of as "an ill-defined zirconium-mineral," allied to cyrtolite. Sections show the presence of limonite as impurity.

| | $SiO_2$ | $ZrO_2$[a] | $Ce_2O_3$[b] | $Er_2O_3$ | $Y_2O_3$ | $Fe_2O_3$ | MnO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | $P_2O_5$ | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 20·64 | 48·55 | 1·20 | 4·76 | 2·48 | 5·97 | 0·57 | 2·04[c] | 0·10 | 0·50 | 12·00 | 1·75 | 0·42=100·98 |
| 2. | 20·06 | 47·99 | 1·41 | 4·77 | 2·27 | 5·53 | 0·47 | 2·12[d] | 0·20 | 0·46 | 12·87 | 1·64 | 0·25=100·04 |
| 3. | 19·21 | 51·00 | 0·60 | 4·55 | 3·13 | 4·86 | 0·33 | 2·15 | 0·17 | 0·42 | 12·97 | 0·93 | 0·42=100·74 |

[a] Incl. $SnO_2$,$Ta_2O_5$: in 1, 0·03 $SnO_3$, 0·71 $Ta_2O_5$. [b] Incl. $ThO_2$ and $(Di,La)_2O_3$: in 2, 1·16 $ThO_2$, 0·06 $Ce_2O_3$, 0·19 $(Di,La)_2O_3$. [c] Incl. 0·11 MgO. [d] 0·13 MgO.

**395. THORITE.** Thorit *Berz.*, Ak. H. Stockh., p. 1, 1829. Orangit *Bergemann*, Pogg., **82**, 561, 1851. Uranothorite *P. Collier*, J. Am. Ch. Soc., **2**, 73, 1880. Torit.



Norway; Bgr.

Tetragonal. Axis $\dot{c}$ = 0·6402. In square prisms *m* (110, *I*), with pyramid *p* (111, 1), also the zirconoid *z* (311, 33); *pp'* = 56° 40' Breithaupt.[1] The form resembles that of zircon. Also massive and compact.

Cleavage: *m* distinct. Fracture conchoidal. Brittle. H. = 4·5–5. G. = 5·19–5·40 orangite; 4·4–4·8 thorite. Luster of surface of fresh fracture vitreous to resinous; in part greasy. Color orange-yellow, brownish yellow; also black, inclining to brown. Streak light orange to dark brown. Transparent in thin splinters to nearly opaque. Optically uniaxial, positive, when unaltered, but becoming isotropic and amorphous.

**Var.**—1. *Thorite.* As originally described, occurs in black octahedral crystals (called isometric by Dufrenoy). G. = 4 630 Berz.; 4·686 Bergemann; 4·344–4·397 Chydenius. First found on the island Lövö, opposite Brevik. Later found in large crystals near Arendal.

2. *Orangite.* In bright orange-yellow tetragonal crystals, near zircon in angle; also massive, first described from the Brevik region. G. = 5·397 Bergemann; 5·34 Krantz; 5·19 Damour; 4·888–5·205 Chydenius. Sometimes forms the kernel of a crystal externally altered to thorite. Supposed by Bergemann to contain a new metal called by him *donarium.* See p. 1050,

The zircon-like tetragonal form was first recognized by Zschau[1], and more accurate measurements were later made by Breithaupt. The identity of thorite and orangite was early proved, and later it was shown that both were undoubtedly altered hydrous forms of an anhydrous thorium silicate isomorphous with zircon.

3. *Uranothorite.* Massive. Fracture subconchoidal. H. = 5. G. = 4·126. Luster resinous to subvitreous Color dark red-brown. Streak yellow-brown. B.B. infusible. From the Champlain iron region, N. Y., exact locality unknown (anal. 5); also a similar variety from Norway. anal. 3, 4.

**Comp.**—Originally anhydrous thorium silicate, $ThSiO_4$ or $ThO_2.SiO_2$ = Silica 18·5, thorina 81·5 = 100. All analyses show water, and sometimes uranium.

**Anal.**—1, Damour, C. R., **34**, 685, 1852, Ann. Mines, **1**, 587, 1852. Also incomplete analyses by Bergemann, Chydenius. 2, Berzelius, Ak. H. Stockh., p. **1**, 1829, also Pogg., **15**, 633, 1829 (the latter with the anal. in slightly different form). 3, Lindström, G. För. Förh., **5**, 500, 1881. 4, Nordenskiöld, ib., **3**, 228, 1876. 5, Parsons, quoted by Collier, J. Am. Ch. Soc., **2**, 73, 1880.

| | G. | $SiO_2$ | $ThO_2$ | $U_2O_3$ | PbO | $Fe_2O_3$ | $Al_2O_3$ | $Ce_2O_3$ | CaO | MgO | Alk. | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. *Orangite* | 5·19 | 17·52 | 71·65 | 1·13 | 0·88 | 0·59[a] | 0·17 | — | 1·59 | *tr.* | 0·47[c] | 6·14<br>[= 100·14 |
| 2. *Thorite* | 4·8 | 18·98 | 57·91 | 1·58 | 0·80 | 5·79[b] | 0·06 | — | 2·58 | 0·36 | 0·24[d] | 9·50<br>[$SnO_2$ 0·01, insol. 1·70 = 99·51 |
| 3. Hitterö, *Thorite* | | 17·47 | 48·66 | 9·00 | 1·26 | 6·59 | 0·12 | 3·12[e] | 1·39 | 0·05 | 0·30[f] | 10·88<br>[$P_2O_5$ 0·93 = 99·77 |
| 4. Arendal | 4·38 | 17 04 | 50·06 | 9·78 | 1·67 | 7·60 | — | 1·39 | 1·99 | 0·28 | — | 9·46<br>[$P_2O_5$ 0·86 = 100·13 |
| 5. L. Champlain | 4·126 | 19·38 | 52·07 | 9·96[g] | 0·40 | 4·01 | 0·33 | — | 2·34 | 0·04 | 0·11 | 11·31<br>[= 99·95 |

[a] Incl. 0·28 $Mn_2O_3$. [b] Incl. 2·39 $Mn_2O_3$. [c] Incl. 0·14 $K_2O$. [d] 0·14 $K_2O$.
[e] Incl. $Y_2O_3$. [f] $K_2O$ 0·18. [g] $UO_3$.

Composition discussed by Nilson, Öfv. Ak. Stockh., **39**, No. 7, 3, 1887. Investigation of absorption-lines, didymium chiefly, also erbium, samarium, thulium, etc., Krüss and Nilson, Öfv. Ak. Stockh., **44**, 364, 1887.

**Pyr., etc.**—In the closed tube yields water; the orange variety becomes dull brown, and, on cooling, orange again. B.B. on charcoal infusible, the edges only being slightly glazed; with borax a yellowish pearl, becoming colorless on cooling; with salt of phosphorus a colorless glass, which becomes milky and greenish on cooling; with borax an orange glass when hot, which becomes grayish on cooling. A little niter being added, the orange color remains after cooling.

With hydrochloric acid easily forms a jelly before, but not after, calcination. The black thorite becomes pale brownish red when heated; and on charcoal forms a yellowish brown slag.

**Obs.**—Found by Esmark in the augite-syenite on the island Lövö, opposite Brevik in Norway; also at other points on the Langesund fiord, as Barkevik, on Haö, Sigtesö, Arö. Masses of orangite weighing several ounces have been obtained. In large black crystals at Garta, Bjellan, the island Landbö, and other points near Arendal, from whence it has been obtained in large quantities. At Linland on the Lenes fiord near Lindesnäs with alvite and magnetite, both the black thorite and orangite; also at Svenör, the reddish brown variety.

A mass of a dark red-brown color (*uranothorite*) has been found in the Champlain iron region in northern New York; exact locality unknown.

**Ref.**—[1] See Zschau, Am. J. Sc., **26**, 359, 1858; B. H. Ztg., **25**, 114, 1866; Nd., Öfv. Ak. Stockh., **27**, 554, 1870, G. För. Förh., **3**, 226, 1876.

On the optical structure of the more or less altered forms, see Bgr., Zs. Kr., **16**, 116, 1890.

CALCIOTHORITE *W. C. Brögger*, G. För. Förh., **9**, 258, 1887; Zs. Kr., **16**, 127, 1890. Massive. Fracture conchoidal. Brittle. H. = 4·5. G. = 4·114 Cleve. Luster vitreous. Color deep red, resembling almandite garnet. Translucent. Optically isotropic, amorphous.

Composition: $5ThSiO_4.2Ca_2SiO_4 + 10H_2O$. Anal.—Cleve:

| $SiO_2$ | $ThO_2$ | $Ce_2O_3$ | $Y_2O_3$ | $Al_2O_3$ | $Mn_2O_3$ | CaO | MgO | $Na_2O$ | ign. |
|---|---|---|---|---|---|---|---|---|---|
| 21·09 | 59·35 | 0·39 | 0 23 | 1·02 | 0·73 | 6·93 | 0·04 | 0·67 | 9·39 = 99·84 |

B.B. becomes white but does not fuse. Gives off water. Gelatinizes with acid.

Found in reniform masses, as large as walnuts, embedded in analcite (derived from elæolite) and in feldspar on the islands Låven and Arö in the Langesund fiord, Norway.

EUCRASITE. Eukrasit *S. R. Paijkull*, G. För. Förh., **3**, 350, 1877. Fracture uneven. Brittle. H. = 4·5–5. G. = 4·39. Luster greasy. Color blackish brown. Streak brown. Slightly translucent in thin splinters. Optically isotropic, amorphous (Bgr., Zs., **16**, 129, 1890). Analysis:

| $SiO_2$ | $ThO_2$ | $TiO_2$ | $SnO_2$? | $ZrO_2$ | $MnO_2$ | $CeO_2$ | $Ce_2O_3$ | $Y_2O_3$ | $Er_2O_3$ | $Fe_2O_3$ | CaO | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16·20 | 35·96 | 1 27 | 1·15 | 0·60 | 2·34 | 5·48 | 8·55[a] | 4·33 | 1·62 | 6·02[b] | 4·95[c] | 2 59[d] | 9·15 = 100·21 |

[a] Incl. 2·42 $(La,Di)_2O_3$. [b] Incl. $Al_2O_3$ 1·77. [c] MgO 0·95. [d] $K_2O$ 0·11.

B.B. fusible (at 4) on the edges. The borax bead in the R. F. is violet, in the O. F. yellow. In hydrochloric acid partially soluble, with the evolution of chlorine. Completely soluble in sulphuric acid. Occurs near Barkevik, Langesund fiord, Norway. Named from εὖ, *well*, and κρᾶσις, *mixture*, because so complex in composition.

FREYALITE *Esmark; Damour*, Bull. Soc. Min., **1**, 33, 1878. Resembles some brown thorite. Scratches glass slightly. G. = 4·06–4·17. Color brown. Streak yellowish gray. Translucent in thin splinters. Luster resinous. An approximate analysis by Damour gave:

| $SiO_2$ | $ThO_2$ | $Ce_3O_4$ | $(La,Di)_2O_3$ | $Al_2O_3(ZrO_2?)$ | $Fe_2O_3$ | $Mn_3O_4$ | Alk. | $H_2O$ | ign. |
|---|---|---|---|---|---|---|---|---|---|
| 20·02 | 28·39 | 28·80 | 2·47 | 6·31 | 2·47 | 1·78 | 2·33 | 7·40 | 0·82 = 100·79 |

B B. swells up but does not fuse. In the closed tube decrepitates, gives off water, and becomes white. With salt of phosphorus in R. F. dissolves, forming an opal-like glass, which in O. F. becomes brown, and on cooling is colorless and translucent. With borax in O. F. gives a transparent brown bead, becoming almost colorless on cooling, and showing in the spectroscope an absorption band on the border of the red and orange (Di). Dissolves readily in acid, giving gelatinous silica. With hydrochloric acid chlorine is given off.

From the neighborhood of Brevik (Barkevik), Norway. Named for the Scandinavian goddess, Freya.

AUERLITE *W. E. Hidden* and *J. B. Mackintosh*, Am. J. Sc., **36**, 461, 1888.

Tetragonal. Form a square prism with pyramid, resembling zircon in habit and angles. H. = 2·5–3. G. = 4·42–4·77. Luster resinous. Color dull yellowish white to dark orange-red. Translucent to opaque.

Analysis:—

| $SiO_2$ | $P_2O_5$ | $ThO_2$ | $H_2O,CO_2$ | $Fe_2O_3$ | CaO | MgO | $Al_2O_3$($ThO_2$ *tr.*) | |
|---|---|---|---|---|---|---|---|---|
| 7·64 | 7·46 | 70·13 | 11·21 | 1·38 | 0·49 | 0·29 | 1·10 | = 99·70 |

Other trials gave: $SiO_2$ 9·25, 8·25, $P_2O_5$ 7·59, $ThO_2$ 69·23, $Fe_2O_3$ 1·42, $H_2O$ 10·7, 9·88, $CO_2$ 1·00.

This is interpreted as corresponding to a silico-phosphate of thorium, $ThO_2.(SiO_2.\frac{1}{3}P_2O_5) + 2H_2O$. It cannot be regarded as certain, however, that the phosphoric acid belongs to the original mineral, which as found is certainly more or less altered. It is to be noted, in this connection, that parallel intergrowths of zircon and auerlite are described, and others of zircon and the phosphate, xenotime, are not uncommon; also further, that silica is commonly present in the phosphate, monazite, and sometimes in small amount in xenotime. That it really belongs to the constitution of the mineral in these cases has been seriously questioned.

B.B. infusible; becomes brown on ignition, but turns orange again on cooling.

Occurs in disintegrated granite or gneiss, in Henderson Co., N. C.; the localities are the Freeman mine, Green River, and on Price land 3 miles southwest; it is associated with zircon, and sometimes implanted upon it in parallel position.

Named for Dr. Carl Auer von Welsbach.

## 11. Danburite-Topaz Group. Orthorhombic.

$$\overset{\text{II}}{R}\overset{\text{III}}{R}_2(SiO_4)_2 \text{ or } (\overset{\text{III}}{R}O)\overset{\text{III}}{R}SiO_4.$$

| | | | |
|---|---|---|---|
| 396. **Danburite** | $CaB_2(SiO_4)_2$ | | $\breve{a} : \bar{b} : \acute{c} = 0·5444 : 1 : 0·4807$ |
| 397. **Topaz** | $(Al(O,F_2))AlSiO_4$ | | $\breve{a} : \bar{b} : \acute{c} = 0·5285 : 1 : 0·4770$ |
| 398. **Andalusite** | $(AlO)AlSiO_4$ | | $\tfrac{1}{2}\bar{b} : \breve{a} : \tfrac{2}{3}\acute{c} = 0·5070 : 1 : 0·4749$ <br> or $\breve{a} : \bar{b} : \acute{c} = 0·9861 : 1 : 0·7025$ |
| 399. **Sillimanite** | $Al_2SiO_5$ | Orthorhombic | $\breve{a} : \bar{b} = 0·970 : 1$ |
| 400. **Cyanite** | $Al_2SiO_5$ | Triclinic | |

$\breve{a} : \bar{b} : \acute{c} = 0·8994 : 1 : 0·7090$; $\alpha = 90° 5\tfrac{1}{2}'$, $\beta = 101° 2'$, $\gamma = 105° 44\tfrac{1}{2}'$.

The close resemblance in angle and habit between Danburite and Topaz, and further the relation in form between Topaz and Andalusite (though less close), make it probable that Groth's formulas for the two last mentioned species, given above, should be accepted, and that they should be included with Danburite in a single group of orthosilicates. To Sillimanite the same formula as that of Andalusite probably belongs (Groth, Clarke), while Cyanite is uncertain; Groth regards it as a basic metasilicate $(AlO)_2SiO_3$ instead of a basic orthosilicate.

**396. DANBURITE.** *Shepard*, Am. J. Sc., 35, 137, 1839.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·544444 : 1 : 0·480739$ E. S. Dana[1].

100 ∧ 110 = 28° 33′ 57″, 001 ∧ 101 = 41° 26′ 39″, 001 ∧ 011 = 25° 40′ 32″.

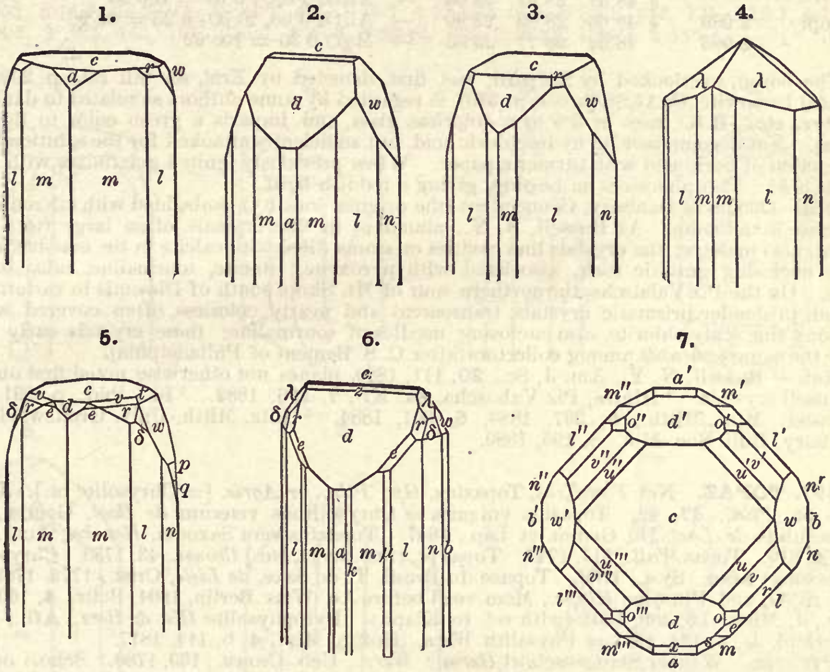
**Forms**[1]:
$a$ $(100, i\text{-}\bar{\imath})$
$b$ $(010, i\text{-}\breve{\imath})$
$c$ $(001, O)$
$k$ $(320, i\text{-}\bar{\tfrac{3}{2}})$
$m$ $(110, I)$
$\mu$ $(560, i\text{-}\breve{\tfrac{6}{5}})^4$
$M$ $(230, i\text{-}\breve{\tfrac{3}{2}})$
$\nu$ $(590, i\text{-}\breve{\tfrac{9}{5}})^4$
$l$ $(120, i\text{-}\breve{2})$
$\rho$ $(370, i\text{-}\breve{\tfrac{7}{3}})^4$
$\upsilon$ $(250, i\text{-}\breve{\tfrac{5}{2}})^4$
$\xi$ $(130, i\text{-}\breve{3})^4$
$\tau$ $(3·10·0, i\text{-}\breve{\tfrac{10}{3}})^4$
$n$ $(140, 1\text{-}\breve{4})$
$z$ $(103, \tfrac{1}{3}\text{-}\bar{\imath})$
$\zeta$ $(203, \tfrac{2}{3}\text{-}\bar{\imath})^3$
$d$ $(101, 1\text{-}\bar{\imath})$
$x$ $(301, 3\text{-}\bar{\imath})$
$t$ $(021, 2\text{-}\breve{\imath})$
$w$ $(041, 4\text{-}\breve{\imath})$
$\alpha$ $(092, \tfrac{9}{2}\text{-}\breve{\imath})^5$
$f$ $(061, 6\text{-}\breve{\imath})^2$
$g$ $(071, 7\text{-}\breve{\imath})^2$
$p$ $(081, 8\text{-}\breve{\imath})$
$i$ $(0·10·1, 10\text{-}\breve{\imath})^4$
$h$ $(0·11·1, 11\text{-}\breve{\imath})^4$
$q$ $(0·16·1, 16\text{-}\breve{\imath})$
$o$ $(111, 1)$
$e$ $(221, 2)$
$s$ $(321, 3\text{-}\bar{\tfrac{3}{2}})$
$u$ $(124, \tfrac{1}{2}\text{-}\breve{2})$
$v$ $(122, 1\text{-}\breve{2})$
$r$ $(121, 2\text{-}\breve{2})$
$\lambda$ $(142, 2\text{-}\breve{4})$
$\delta$ $(141, 4\text{-}\breve{4})$
$\beta$ $(9·4·10, \tfrac{9}{10}\text{-}\bar{\tfrac{9}{4}})^6$ ?
$y$ $(13·4·14, \tfrac{13}{14}\text{-}\bar{\tfrac{13}{4}})^2$ ?
$\sigma$ $(572, \tfrac{7}{2}\text{-}\breve{\tfrac{7}{5}})^3$

Schuster[4] adds many vicinal planes, including the following in the prismatic zone: 10·19·0, 7·15·0, 5·11·0, 5·12·0, 7·18·0, 5·14·0, 7·20·0, 5·16·0.

$kk'''$ = 39° 54′
$mm'''$ = *57° 7′ 54″
$MM'$ = 101° 31½′
$ll'$ = 85° 8′
$nn'$ = 49° 20′
$zz'$ = 32° 48′
$\zeta\zeta'$ = 60° 58′
$dd'$ = *82° 53′ 18″
$xx'$ = 138° 38′
$tt'$ = 87° 45′
$ww'$ = 125° 3′
$ff'$ = 141° 46′
$pp'$ = 150° 51′
$qq'$ = 165° 11′
$co$ = 45° 9′
$ce$ = 63° 33½′
$cu$ = 18° 4½′
$cv$ = 33° 8′
$cr$ = 52° 33′
$n\lambda$ = 43° 23′
$oo'$ = 77° 2′
$rr'$ = 64° 57′
$\lambda\lambda'$ = 35° 18½′
$\delta\delta'$ = 44° 20′
$oo'''$ = 39° 38′
$ss'''$ = 37° 31′
$vv'''$ = 47° 29′
$rr'''$ = 71° 34′
$\lambda\lambda'''$ = 82° 40′
$md$ = 54° 27′
$mw$ = 64° 54′

Habit prismatic, resembling topaz. Also in indistinct embedded crystals, and disseminated masses.

Cleavage: *c* very indistinct. Fracture uneven to subconchoidal. Brittle. H. = 7–7·25. G. = 2·97–3·02. Color pale wine-yellow to colorless, yellowish white, dark wine-yellow, yellowish brown. Luster vitreous to greasy, on crystal surfaces brilliant. Transparent to translucent. Streak white.



Figs. 1–3, 5–7, Russell, N. Y. 4, Switzerland, after Hintze.

Ax. pl. ‖ *c*. Optically −, and $Bx_a \perp b$ for red, yellow, green; optically +, and $Bx_a \perp a$ for blue. Ax. angles for Russell, E. S. D.[1]; for Danbury, Dx.[6]; for Switzerland, Hintze[2].

Russell:

For Li $2H_{a.r} = 100° 33'$ $2H_{o.r} = 106° 35'$ ∴ $2V_{a.r} = 87° 37'$ $\beta_r = 1·634$

Na $2H_{a.y} = 101° 30'$ $2H_{o.y} = 105° 36'$ ∴ $2V_{a.y} = 88° 23'$ $\beta_y = 1·637$

$CuSO_4$ $2H_{o.bl} = 104° 36'$ $2H_{a.bl} = 102° 13'$ ∴ $2V_{o.bl} = 90° 56'$ $\beta_{bl} = 1·646$

Danbury: $2H_r = 99° 16'–100° 30'$ $2H_y = 100° 20'–101° 2'$ $2H_{bl} = 101° 42'–102° 16'$

Switzerland:

For Li $2H_{a.r} = 101° 1'$ $2H_{o.r} = 105° 56'$ ∴ $2V_{a.r} = 88° 4'$ $\beta_r = 1·6283$

Na $2H_{a.y} = 101° 46'$ $2H_{o.y} = 105° 38'$ ∴ $2V_{a.y} = 88° 29'$ $\beta_y = 1·6342$

Tl $2H_{a.gr} = 102° 48'$ $2H_{o.gr} = 104° 44'$ ∴ $2V_{a.gr} = 89° 14'$ $\beta_{gr} = 1·6383$

$CuSO_4$ $2H_{o.bl} = 104° 18'$ $2H_{a.bl} = 103° 15'$ ∴ $2V_{o.bl} = 90° 24'$

Also measured $\beta_r = 1·6303$ $\beta_y = 1·6337$ $\beta_{gr} = 1·6366$

" " $\gamma_r = 1·6331$ $\gamma_y = 1·6363$ $\gamma_{gr} = 1·6393$

" calculated $\alpha_r = 1·6258$ $\alpha_y = 1·6317$ $\alpha_{gr} = 1·6356$

**Comp.**—$CaB_2Si_2O_8$ or $CaO.B_2O_3.2SiO_2$ = Silica 48·8, boron trioxide 28·4, lime 22·8 = 100.

**Anal.**—1, Smith and Brush, Am. J. Sc., **16**, 365, 1853. 2, Comstock, ib., **20**, 117, 1880. 3, Whitfield, ib., **34**, 285, 1887. 4, Bodewig, Zs. Kr., **8**, 217, 1883. 5, Id., ib., **7**, 391, 1882. 6, Ludwig, Ber. Ak. Wien, **86** (1), 270, 1882.

| | G. | | $SiO_2$ | $B_2O_3$ | CaO | ign. | |
|---|---|---|---|---|---|---|---|
| 1. Danbury | | $\frac{2}{2}$ | 48·15 | 27·44 | 22·37 | 0·50 | $Al_2O_3,Fe_2O_3,Mn_2O_3$ 0·86, MgO 0·40 = 99·72 |
| 2. Russell | 3·003 | $\frac{2}{2}$ | 48·23 | 26·93 | 23·24 | 0·63 | $Al_2O_3,Fe_2O_3$ 0·47 = 99 50 |
| 3. " | | | 49·70 | 25·80 | 23·26 | 0·20 | $Al_2O_3,Fe_2O_3$ 1·02 = 99·98 |
| 4. " | | $\frac{3}{3}$ | 48·57 | 28·61 | 23·03 | — | $Al_2O_3,Fe_2O_3$ 0·34 = 100·55 |
| 5. Skopi | 2·986 | $\frac{2}{2}$ | 48·66 | 28·09 | 22·90 | — | $Al_2O_3$ 0·08, $Fe_2O_3$ 0·23 = 99·96 |
| 6. " | 2·985 | | 48·52 | 28·77 | 23·03 | — | MgO 0·30 = 100·62 |

The boron, overlooked by Shepard, was first detected by Erni, see 5th Ed., p. 299. The doubtful barsowite, $CaAl_2Si_2O_8$ (see p. 340), is regarded by some authors as related to danburite.

**Pyr., etc.**—B.B. fuses at 3·5 to a colorless glass, and imparts a green color to the O. F. (boron). Not decomposed by hydrochloric acid, but sufficiently attacked for the solution to give the reaction of boric acid with turmeric paper. When previously ignited gelatinizes with hydrochloric acid. Phosphoresces on heating, giving a reddish light.

**Obs.**—Occurs at Danbury, Connecticut (the original locality), embedded with microcline and oligoclase in dolomite. At Russell, N. Y., abundant in fine crystals, often large (to 4 in. in length), also massive; the crystals line cavities or seams filled with calcite in the massive mineral or the enclosing granitic rock, associated with pyroxene, titanite, tourmaline, mica, quartz, pyrite. On the Piz Valatscha, the northern spur of Mt. Skopi south of Dissentis in eastern Switzerland, in slender prismatic crystals, transparent and nearly colorless, often covered with or enclosing fine scaly chlorite, also enclosing needles of tourmaline; these crystals early passed under the name *bementite* among collectors (after C. S. Bement of Philadelphia).

**Ref.**—[1] Russell, N. Y., Am. J. Sc., **20**, 111, 1880, planes not otherwise noted first observed on Russell crystals. [2] Hintze, Piz Valatscha, Zs. Kr., **7**, 296, 1882. [3] Id., ibid., p. 591, 1883. [4] Schuster, Min. Mitth., **5**, 397, 1883, **6**, 301, 1884. [5] Götz, Mitth. Univ. Greifswald, 1886. [6] Danbury, Bull. Soc. Min., **3**, 195, 1880.

**397. TOPAZ.** Not *Τοπάζιος*, Topazius, *Gr.*, *Plin.*, or *Agric.* [= Chrysolite pt.]. Chrysolithos pt. *Plin.*, **37**, 42. Topasius vulgaris = Chrysolithos veterum *de Boot*, Gemm., 1636. Chrysolithus *de Laet*, De Gemm. et Lap., 1647. Topazius vera Saxonia, *Henckel*, Act. Ac. N. Cur., **4**, 316. Topas *Wall.*, 117, 1747. Topas pt. [rest Beryl, etc.] *Cronst.*, 43, 1758. Chrysolithus (fr. Saxony) *Linn.*, Syst., 1768. Topaze du Bresil, T. de Saxe, *de Lisle*, Crist., 1772, 1783, with figs. Si, Al, and Fluorine *Klapr.*, Mem read before Ac. Wiss. Berlin, 1804, Beitr., **4**, 160, 1807; *Vauq.*, J. Mines, **16**, 469, 1804 (with ref. to Klapr.). Pyrophysalite *His. & Berz.*, Afh., **1**, 111, 1806, Gehl. J., **3**, 124, 1807 = Physalith *Wern.*, Hoffm. Min., **4**, b, 114, 1817.

PYCNITE. Weisser Stangenschörl *Germ.; Wern.*, Ueb. Cronst., 169, 1780. Schorl blanc en prismes striées (fr. Altenberg) *Sage*, Min., **1**, 204, 1777; *de Lisle*, Crist., **2**, 420, 1783. Schörlartiger Beryl [var. of Beryl] *Wern.*, Bergm. J., **1**, 374, 388, 1789. Stangenstein [species] *Karst.*, Mus. Lesk., 1789; Tab., 20, 69, 1800. Schorl blanchâtre *Delameth.*, Sciagr., **1**, 289; Leucolite pt. *id.*, T. T., **2**, 275, 1797. Schorlite *Klapr.*, Crell's Ann., **1**, 395, 1788. Shorlite *Kirwan*, Min., **1**, 286, 1794. Pycnite *H.*, Tr., **3**, 1801. Si + Al + F, *Bucholz*, Schw. J., **1**, 385, 1803.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·528542 : 1 : 0·476976$ Koksharov[1].

$100 \wedge 110 = 27° 51' 30''$, $001 \wedge 101 = 42° 3' 52''$, $001 \wedge 011 = 25° 30' 0''$.

**Forms**[2]:
*a* $(100,\ i\text{-}\bar{\imath})$
*b* $(010,\ i\text{-}\breve{\imath})$
*c* $(001,\ O)$

*N* $(210,\ i\text{-}\bar{2})$
*m* $(110,\ I)$
*O* $(560,\ i\text{-}\tfrac{6}{5})$
*Q* $(450,\ i\text{-}\tfrac{5}{4})$
*R* $(340,\ i\text{-}\tfrac{4}{3})$
𝔱 $(7·10·0,\ i\text{-}\overset{\smile}{\tfrac{10}{7}})$
*M* $(230,\ i\text{-}\tfrac{3}{2})$
*T* $(580,\ i\text{-}\tfrac{8}{5})$
λ $(470,\ i\text{-}\tfrac{7}{4})$
𝔯 $(7·13·0,\ i\text{-}\overset{\smile}{\tfrac{13}{7}})$
*L* $(8·15·0,\ i\text{-}\overset{\smile}{\tfrac{15}{8}})$
𝔩 $(120,\ i\text{-}\breve{2})$

𝔲 $(5·11·0,\ i\text{-}\overset{\smile}{\tfrac{11}{5}})$
π $(250,\ i\text{-}\tfrac{5}{2})$
*g* $(130,\ i\text{-}\breve{3})$
*n* $(140,\ i\text{-}\breve{4})$
μ $(150,\ i\text{-}\breve{5})$
*U* $(160,\ i\text{-}\breve{6})$

ω $(102,\ \tfrac{1}{2}\text{-}\bar{\imath})$
*h* $(203,\ \tfrac{2}{3}\text{-}\bar{\imath})$
δ $(405,\ \tfrac{4}{5}\text{-}\bar{\imath})$
*p* $(101,\ 1\text{-}\bar{\imath})$
*V* $(302,\ \tfrac{3}{2}\text{-}\bar{\imath})$
*d* $(201,\ 2\text{-}\bar{\imath})$
ρ $(401,\ 4\text{-}\bar{\imath})$
*P* $(701,\ 7\text{-}\bar{\imath})$

*H* $(023,\ \tfrac{2}{3}\text{-}\breve{\imath})$
β $(011,\ 1\text{-}\breve{\imath})$

*X* $(043,\ \tfrac{4}{3}\text{-}\breve{\imath})$
*J* $(053,\ \tfrac{5}{3}\text{-}\breve{\imath})$
*F* $(0·12·7,\ \tfrac{12}{7}\text{-}\breve{\imath})$
*f* $(021,\ 2\text{-}\breve{\imath})$
γ $(0·16·7,\ \tfrac{16}{7}\text{-}\breve{\imath})$
*G* $(052,\ \tfrac{5}{2}\text{-}\breve{\imath})$
*k* $(031,\ 3\text{-}\breve{\imath})$
𝔨 $(0·10·3,\ \tfrac{10}{3}\text{-}\breve{\imath})$
*y* $(041,\ 4\text{-}\breve{\imath})$
*w* $(081,\ 8\text{-}\breve{\imath})$

𝔡 $(2·2·13,\ \tfrac{2}{13})$
𝔢 $(229,\ \tfrac{2}{9})$
ϵ $(112,\ \tfrac{1}{2})$
*D* $(335,\ \tfrac{3}{5})$
*i* $(223,\ \tfrac{2}{3})$
𝔣 $(445,\ \tfrac{4}{5})$

*u* $(111,\ 1)$
*S* $(665,\ \tfrac{6}{5})$
*Z* $(332,\ \tfrac{3}{2})$
𝔤 $(553,\ \tfrac{5}{3})$
𝔥 $(16·16·9,\ \tfrac{16}{9})$
*o* $(221,\ 2)$
𝔦 $(16·16·7,\ \tfrac{16}{7})$
*e* $(441,\ 4)$
Ꝟ $(14·14·1,\ 14)$

τ $(312,\ \tfrac{3}{2}\text{-}\bar{3})$
χ $(213,\ \tfrac{2}{3}\text{-}\bar{2})$
α $(212,\ 1\text{-}\bar{2})$
*q* $(423,\ \tfrac{4}{3}\text{-}\bar{2})$
*Y* $(211,\ 2\text{-}\bar{2})$
*z* $(14·8·15,\ \tfrac{14}{15}\text{-}\tfrac{7}{4})$
𝔵 $(10·8·7,\ \tfrac{10}{7}\text{-}\tfrac{5}{4})$

ξ $(10·8·9,\ \tfrac{10}{9}\text{-}\tfrac{5}{4})$
η $(463,\ 2\text{-}\breve{\tfrac{3}{2}})$
ψ $(122,\ 1\text{-}\breve{2})$
*x* $(243,\ \tfrac{4}{3}\text{-}\breve{2})$
*E* $(364,\ \tfrac{3}{2}\text{-}\breve{2})$
*v* $(121,\ 2\text{-}\breve{2})$
σ $(7·14·4,\ \tfrac{7}{2}\text{-}\breve{2})$
*r* $(241,\ 4\text{-}\breve{2})$
*s* $(133,\ 1\text{-}\breve{3})$
*t* $(265,\ \tfrac{6}{5}\text{-}\breve{3})$
ϑ $(132,\ \tfrac{3}{2}\text{-}\breve{3})$
ι $(261,\ 6\text{-}\breve{3})$
*W* $(143,\ \tfrac{4}{3}\text{-}\breve{4})$
𝔣 $(142,\ 2\text{-}\breve{4})$
φ $(283,\ \tfrac{8}{3}\text{-}\breve{4})$
ν $(195,\ \tfrac{9}{5}\text{-}\breve{9})$

Grünhut[2] adds the following vicinal planes (in addition to some included in the tabulated list above), all in the prismatic zone: 𝔪 (50·53·0), 𝔫 (25·28·0), 𝔬 (25·36·0), 𝔭 (25·41·0), 𝔮 (25·43·0), 𝔩 (25·49·0), 𝔳 (4·21·0). Cf. also Feist, Zs. Kr., **12**, 434, 1886.

The following forms, mostly rare or doubtful, have been noted on Mexican topaz[3]. That all the apparent planes observed on the curiously modified edges of these crystals deserve crystallographic symbols seems to the author very improbable; it is to be noted that in many cases *all* the pyramidal edges of a crystal show similar replacements, sometimes single, often double.

610, 410; 605, 805, 905; 025, 045, 065, 085; 052; 18·18·5, 15·15·11; 12·2·7, 823, 26·12·19?, 412, 311, 623, 10·4·3, 645, 641, 13·9·13, 432?, 10·8·5, 13·11·6?; 8·10·5, 341, 10·14·7, 573, 7·12·1, 8·12·5, 352, 8·14·7, 16·28·11, 18·34·1, 483, 8·20·7, 4·10·5, 4·10·3, 8·20·1, 263, 131, 4·12·1, 4·16·5, 281, 4·18·7, 2·10·5, 152, 151, 2·10·3, 4·20·3, 8·52·9?, 172, 2·16·3?, 1·10·2, 1·14·3?.

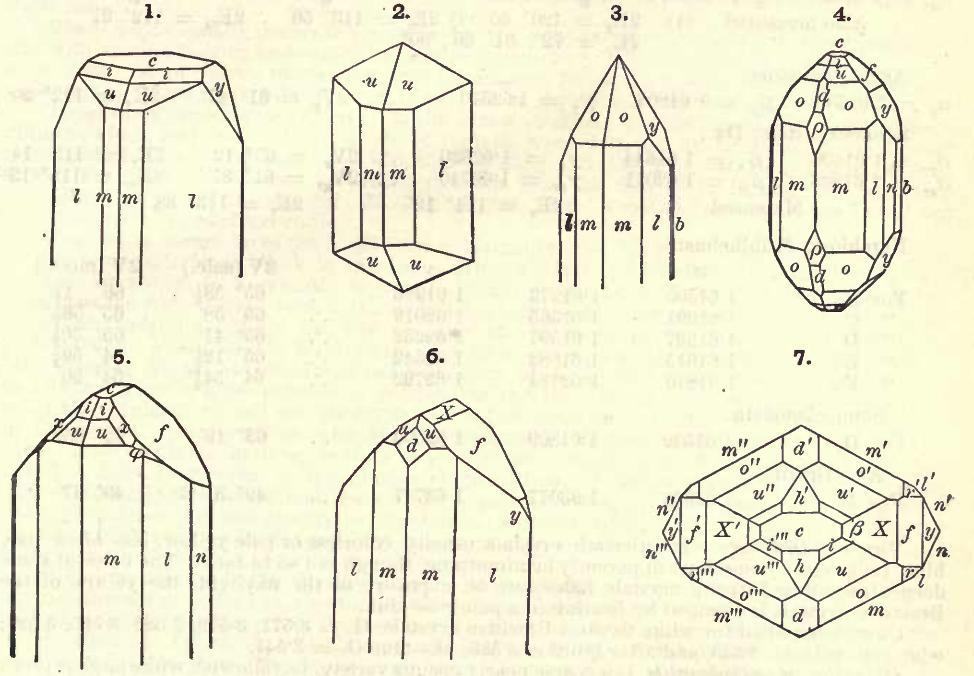


Fig. 1, Alabashka, Ural. 2, Brazil. 3, Durango, Bkg. 4, Utah, J. Stanley-Brown. 5, Schneckenstein. 6, Japan. 7, Ural, Rose.

*mm'''* = *55° 43′
*ll'* = 86° 49′
*gg'* = 64° 29′
*nn'* = 50° 38′

*ωω'* = 48° 34′
*hh'* = 62° 4′
*pp'* = 84° 8′
*dd'* = 122° 1′
*ρρ'* = 148° 21′

*ββ'* = 51° 0′
*XX'* = 64° 55′
*cf* = *43° 39′

*ff'* = 87° 18′
*kk'* = 110° 6′
*yy'* = 124° 41′
*ww'* = 150° 38′

*cε* = 27° 2′
*ci* = 34° 14′
*cu* = 45° 35′
*cZ* = 56° 51′
*co* = 63° 54′
*ce* = 76° 14′

*cχ* = 31° 54′
*cα* = 43° 2′

*cq* = 51° 13′
*cY* = 61° 49½′
*cψ* = 33° 17′
*cx* = 41° 12′
*cE* = 44° 34′
*cr* = 69° 9′
*cs* = 29° 25′
*ct* = 34° 5′

*ii'* = 59° 39′
*uu'* = 78° 20′
*oo'* = 105° 7′
*ee'* = 118° 21′

*xx'* = 53° 50′
*vv'* = 66° 17′
*rr'* = 79° 55′
*ss'* = 30° 23′
*tt'* = 34° 47½′

*ii'''* = 30° 29′
*uu'''* = 39° 0′
*oo'''* = 49° 37½′
*qq'''* = 22° 59′
*χχ'''* = 15° 31′
*ττ'''* = 16° 8′

Crystals commonly prismatic, *m* predominating; or *l* (120) and the form then a nearly square prism resembling andalusite. Faces in the prismatic zone often vertically striated, and often showing vicinal planes. Sometimes apparently hemimorphic. Also firm columnar; granular, coarse, or fine.

Cleavage: *c* highly perfect; also very imperfect ∥ *d* (201) and *f* (021) as shown by the percussion figures (Mgg.[4]). Fracture subconchoidal to uneven. Brittle.

H. = 8. G. = 3·4–3·65. Luster vitreous. Color straw-yellow, wine-yellow, white, grayish, greenish, bluish, reddish. Streak uncolored. Transparent to subtranslucent.

Optically +. Ax. pl. ∥ *b*. Bx ⊥ *c*. Axial angles very variable in crystals from different localities and even in plates from the same crystal. Cf. Dx. and Mld.[6]; the latter regards topaz as pseudo-orthorhombic and monoclinic. Refractive indices and axial angles[5]:

Brazil, Dx.:

$\alpha_y = 1{\cdot}6120$ $\beta_y = 1{\cdot}6150$ $\gamma_y = 1{\cdot}6224$ $\therefore$ $2V_y = 65°\ 14'$ $2E_y = 121°\ 1'$
$\alpha_{gr} = 1{\cdot}6149$ $\beta_{gr} = 1{\cdot}6174$ $\gamma_{gr} = 1{\cdot}6236$ $\therefore$ $2V_{gr} = 65°\ 3'$ $2E_{gr} = 120°\ 49'$
Also measured (1) $2E_y = 120°\ 40'$ (2) $2E_r = 113°\ 50'$ $2E_{bl} = 112°\ 27'$
" " $2E_y = 72°, 81°\ 30', 90°$.

Again, Feussner:

$\alpha_y = 1{\cdot}61559$ $\beta_y = 1{\cdot}61808$ $\gamma_y = 1{\cdot}62510$ $\therefore$ $2V_y = 61°\ 47'$ $2E_y = 112°\ 20'$

Schneckenstein, Dx.:

$\alpha_r = 1{\cdot}61400$ $\beta_r = 1{\cdot}61644$ $\gamma_r = 1{\cdot}62320$ $\therefore$ $2V_r = 62°\ 12'$ $2E_r = 113°\ 14'$
$\alpha_{gr} = 1{\cdot}61835$ $\beta_{gr} = 1{\cdot}62071$ $\gamma_{gr} = 1{\cdot}62740$ $\therefore$ $2V_{gr} = 61°\ 37'$ $2E_{gr} = 112°\ 12'$
Measured $2E_r = 114°\ 13'$ $2E_r = 113°\ 38'$

Nerchinsk, Mühlheims:

| | $\alpha$ | $\beta$ | $\gamma$ | | 2V (calc.) | 2V (meas.) |
|---|---|---|---|---|---|---|
| For B | 1·61000 | 1·61273 | 1·61926 | ∴ | 65° 58½′ | 66° 1½′ |
| " C | 1·61091 | 1·61365 | 1·62019 | ∴ | 65° 58′ | 65° 56½′ |
| " D | 1·61327 | 1·61597 | 1·62252 | ∴ | 65° 41′ | 65° 30½′ |
| " E | 1·61615 | 1·61882 | 1·62542 | ∴ | 65° 12½′ | 64° 59½′ |
| " F | 1·61870 | 1·62134 | 1·62792 | ∴ | 64° 54½′ | 64° 30′ |
| Schneckenstein: | | | | | | |
| For D | 1·61549 | 1·61809 | 1·62500 | ∴ | 63° 19′ | 62° 33′ |
| Also Brazil: | | | | | | |
| For D | 1·62936 | 1·63077 | 1·63747 | ∴ | 49° 31′·3 | 49° 37′ |

**Var.**—1. *Ordinary.* In prismatic crystals usually colorless or pale yellow, less often pale blue, pink, etc. Sometimes apparently hemimorphic, though not so in fact. The color of some deep wine-yellow Russian crystals fades out on exposure to the daylight; the yellow of the Brazilian crystals is changed by heating to a pale rose-pink.

Church obtained for white flawless Brazilian crystals: G. = 3·571, 3·572, 3·585, 3·595, 3·597; wine-yellow G. = 3·539, and after ignition 3·533; sky-blue G. = 3·541.

*Physalite*, or *pyrophysalite*, is a coarse nearly opaque variety, in yellowish white large crystals from Finbo; it intumesces when heated, and hence its name from φυσαλίς, *bubble*, and πῦρ, *fire*.

2. *Pycnite.* Structure columnar, but very compact. Has been considered a distinct species on the ground of composition and crystallization (made monoclinic by Forchhammer). But Rose made out that the cleavage was the same, and the form probably the same; and Des Cloizeaux showed that the optical characters were those of topaz. Finally Rammelsberg's analysis (11) gives the same composition. Named from πυκνός, *thick*.

**Comp.**—$(Al(O,F_2))AlSiO_4$ Groth. The ratio of O : 2F = 5 : 1, whence the empirical formula $Al_{12}Si_6O_{25}F_{10}$ = Silicon 15·5, aluminium 29·9, fluorine 17·6, oxygen 36·9 = 100, or Silica 33·3, alumina 56·5, fluorine 17·6 = 107·4, deduct (O = 2F) 7·4 = 100.

**Anal.**—1–5, Rg., J. pr. Ch., **96**, 7, 1865. 6, 7, Klemm, Inaug. Diss., Jena, 1873. 8, Sommerlad, Zs. G. Ges., **36**, 647, 1884. 9, Whitfield, Am. J. Sc., **29**, 378, 1885 (also Genth, Am. Phil. Soc., Oct. 2, 1885). 10, Hillebrand, U. S. G. Surv. Bull., **20**, p. 71, 1885. 11, Rg., l. c. 12, Klemm, l. c. Also 5th Ed., p. 378.

| | G. | | $SiO_2$ | $Al_2O_3$ | F |
|---|---|---|---|---|---|
| 1. Brazil | 3·561 | $\frac{2}{2}$ | 33·73 | 57·39 | 16·12 = 107·24 |
| 2. Schneckenstein | | $\frac{2}{2}$ | 33·53 | 56·54 | 18·62 = 108·69 |
| 3. Schlackenwald | 3·520 | $\frac{2}{2}$ | 33·37 | 56·28 | 18·54 = 108·19 |
| 4. Trumbull | 3·514 | | 32·38 | 55·32 | 16·12 = 103·82 |
| 5. Adun Chalon | 3·563 | | 33·56 | 56·28 | 18·30 = 108·14 |
| 6. Altenberg, *cryst.* | 3·523 | $\frac{3}{3}$ | 33·32 | 56·35 | 17·45 = 107·12 |
| 7. Miask | 3·521 | | 33·47 | 56·53 | 17·17 = 107·17 |
| 8. Mt. Bischoff, Tasmania, *mass.* | 3·456 | | 33·24 | 57·02 | 17·64 CaO 0·83 = 108·73 |

| | | G. | $SiO_2$ | $Al_2O_3$ | F | |
|---|---|---|---|---|---|---|
| 9. | Stoneham, Me. | 3·51 | 31·92 | 57·38 | 16·99 | $Na_2O$ 1·33, $K_2O$ 0·15, $H_2O$ 0·20 [= 107·97 |
| 10. | Pike's Peak, Col. | 3·578 | 33·15 | 57·01 | 16·04 | = 106·20 |
| 11. | Altenberg, *Pycnite* | 3·533 | 33·28 | 55·86 | 18·28 | = 107·42 |
| 12. | Finbo, *Pyrophysalite* | 3·49 | 33·64 | 56·21 | 17·11 | = 106·96 |

The oxygen equivalent of the fluorine (= 6 to 7 p. c.) is to be deducted.

**Pyr., etc.**—B.B. infusible. Fused in the closed tube, with previously fused and pulverized salt of phosphorus, etches the glass, giving off silicon fluoride which forms a ring of $SiO_2$ above. With cobalt solution the pulverized mineral gives a fine blue on heating. Only partially attacked by sulphuric acid.

A variety of topaz from Brazil, when heated, assumes a pink or red hue, resembling the Balas ruby.

**Obs.**—Topaz usually occurs in gneiss or granite, with tourmaline, mica, and beryl, occasionally with apatite, fluorite, and cassiterite; also in talcose rock, as in Brazil, with euclase, etc., or in mica slate. With quartz, tourmaline, and lithomarge, forms the topaz rock of Werner (*topazosème*, Haüy). Less frequently it occurs in cavities in rhyolyte and similar volcanic rocks.

Topaz often contains inclusions of liquid carbon dioxide. Minute crystals of three or four different kinds, and two or three kinds of liquids, were detected by Brewster in crystals of topaz, Edinb. Trans., **10**, and later Edinb. N. Phil. J., **16**, 130, Proc. R. Soc. Edinb., **4**, 548, **5**, 95. For later observations see Hartley, J. Ch. Soc., **31**, 241, 1877: Erhard and Stelzner, Min. Mitth., **1**, 450, 1878; also Nd., Jb. Min., **1**, 242, 1886. Crystals from San Luis Potosi are sometimes red with enclosed rutile.

Fine topaz comes from the Urals, from Alabashka, not far from Mursinka in the region of Ekaterinburg; from Miask in the Ilmen Mts.; also the gold-washings on the R. Sanarka, in Govt. Orenburg; in Nerchinsk, beyond L. Baikal, in the Adun-Chalon Mts., etc., one crystal from near the river Urulga, now in the imperial cabinet at St. Petersburg, being 11⅝ in. long, 6½ in. broad; weighing 22½ lbs. av., and magnificent also in its perfect transparency and wine-yellow color. Found also in Kamshatka, of yellow, green, and blue colors; in the province of Minas Geraes, Brazil, at Ouro Preto and Villa Rica, of deep yellow color, either in veins or nests in lithomarge, or in loose crystals or pebbles; at the tin mines of Schlackenwald, Zinnwald, and Ehrenfriedersdorf, and smaller crystals at Schneckenstein and Altenberg; sky-blue crystals in Cairngorm, Aberdeenshire; the Mourne mountains, Ireland, small limpid crystals with beryl, albite and mica, in drusy cavities in granite; and St. Michael's Mount, Cornwall; on the island of Elba, in cavities in the granite of San Piero. *Physalite* occurs in crystals of great size, at Fossum, Norway; Finbo, Sweden, in a granite quarry, and at Broddbo in a boulder; one crystal from this last locality, at Stockholm, weighed eighty pounds. *Pycnite* is from the tin mine of Altenberg in Saxony; also those of Schlackenwald, Zinnwald in Bohemia, and Kongsberg in Norway.

Topaz occurs also in the Mercado Mtn., in Durango, Mexico, along with cassiterite, magnetite, and durangite; at La Paz, province of Guanajuato; at San Luis Potosi in rhyolyte, sometimes enclosing rutile. At Hauneib in Damaraland in Southwest Africa (Hintze, Zs. Kr., **15**, 505, 1889). At Mt. Bischoff, Tasmania, with tin ores; also similarly in New South Wales. In Japan in pegmatyte from Otani-yama, Province of Omi, near Kioto; at Nakatsu-gawa, Province of Mino.

In the United States, in *Maine*, at Stoneham, in albitic-granite in fine clear crystals, also in coarse crystals of great size; it is associated with beryl, columbite, fluorite, triplite, etc. In *Conn.*, at Trumbull, with fluorite and diaspore in small yellow or clear white crystals, also in others large and coarse; at Middletown rare; at Willimantic, with columbite. In *N. Car.*, at Crowder's Mountain. In *Colorado*, in fine crystals colorless or pale blue from the Pike's Peak region, sometimes implanted with phenacite upon amazonstone, also with zircon, smoky quartz, etc.; at Nathrop, Chaffee Co., in wine colored crystals with spessartite in lithophyses in rhyolyte; also similarly in minute crystals in the rhyolyte of Chalk Mt. In *Utah*, in fine transparent colorless crystals with quartz and sanidine in the rhyolyte of the Thomas Range, 40 miles north of Sevier Lake.

The name topaz is from τοπάζιος, an island in the Red Sea, as stated by Pliny. But the topaz of Pliny was not the true topaz, as it "yielded to the file." Topaz was included by Pliny and earlier writers, as well as by many later, under the name *chrysolite*.

**Alt.**—Topaz is found altered both to steatite, and kaolin or lithomarge. Alteration, especially of large opaque crystals, is not uncommon; thus in Saxony and Bohemia, at Kårarfvet, Falun, Sweden, also at Trumbull and Stoneham. The usual result is the change to damourite. Cf. Clarke and Diller, Am. J. Sc., **29**, 378, 1885. The pure Stoneham topaz gave anal. 9, above; a surrounding greenish layer (1) below, and an outside purple zone (2), Whitfield, ibid.; the final product is damourite, anal. 3; Chatard, ib., 28, 22, 1884. Cf. also Atterberg, G. För. Förh., **2**, 402, 1875.

| | | G. | $SiO_2$ | $Al_2O_3$ | F | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | *Green zone* | 3·42 | 35·15 | 53·18 | 12·88 | 1·32 | 0·17 | 1·52 | 1·28 | 0·90 | = 106·40 |
| 2. | *Purple zone* | 2·82 | 44·52 | 46·19 | 0·40 | 0·30 | 0·14 | 2·30 | 2·82 | 3·74 | MnO 0·21 = 100·62 |
| 3. | *Damourite* | | 45·19 | 33·32 | — | *tr.* | 0·36 | 11·06 | 1·57 | 4·48 | FeO 4·25, MnO 0·58 [= 100·81 |

**Artif.**—Obtained by Friedel and Sarasin by the action of hydrofluosilicic acid on silica and alumina in the presence of water at 500°.

**Ref.**—[1] Ural, Min. Russl., **2**, 198, 1854. Note that ć of Kk. and many authors = 2ć Dana, and earlier of Mohs, Naumann, etc.; Grünhut proposed a new position to show relation to andalusite, which, however, is not to be recommended. The axial ratio varies somewhat widely for crystals from different localities, cf. Breith., Handb., **3**, 725 *et seq.*, 1847; Groth, Zs. G. Ges., **22**, 381, 1870; Grünhut, Zs. Kr., **9**, 124, 1884.

[2] See Grünhut, l. c., for list with authorities, also original observations. A recent critical summary, with literature, etc., is given by Gdt., Index, **3**, 223, 1891; cf. earlier, Rose, Reis, Ural, **2**, 80, 1842 *et al.;* Kk., l. c., also **3**, 195, 378, 1858; Mlr. Min., 353, 1852; Dx., Min., **1**, 470, 1862. Groth, Altenberg, Schlackenwald, l. c.; Btd., Framont, Zs. Kr., **1**, 297, 1877; Lasp., Saxony, Bohemia, ib., p. 347; Rath, Mt. Bischoff, ib., **4**, 428, 1880; Corsi, Elba, ib., **5**, 604, 1881; Kk., l. c., **9**, 97, 299; Hidden and Washington, Zacatecas, Am. J. Sc., **33**, 507, 1887; Erem., Ilmen Mts., Vh. Min. Ges., **24**, 463, 1888. [3] On crystals from Mexico see Dx., Bull. Soc. Min., **9**, 135, 1886; N. v. Koksharov, Jr., Vh. Min. Ges., **23**, 49, 1887, and Min. Russl., **9**, 97; Bkg., Zs. Kr., **12**, 424, 451, 1886.

[4] Percussion figures, Mügge, Jb. Min., **1**, 60, 1884. [5] *Refractive indices:* Dx., Min., **1**, 475, 1862, N. R., 102, 1867; he shows that the indices obtained by Rudberg (Pogg., **17**, 22, 1829) are in error at least as regards the values for the lines B, C, D. See further Feussner, Zs. Kr., **7**, 507, 1883; Mühlheims, Zs. Kr., **14**, 225, 226, 1888. Measurement of indices of refraction and axial angles from various localities are given by Groth, l. c. *Etching-figures*, Baumhauer, Jb. Min., 5, 1876; also natural on crystals from San Luis Potosi, Pelikan, Min. Mitth., **11**, 331, 1890. [6] Abnormal optical character, Mld., Ann. Mines, **10**, 155, 1876; Mack., Wied. Ann., **28**, 153, 1886; Mgg., Jb. Min., **1**, 60, 1884.

*Pyro-electricity*, Riess and Rose, Pogg., **59**, 384, 1843; Hankel, Abh. Sächs. Ges., **9**, 1870; Friedel, Bull. Soc. Min., **2**, 31, 1879; Friedel and Curie, ibid., 8, 16, 1885; Mack. Wied. Ann., **28**, 153, 1886. *Elasticity*, Voigt, Nachr. Ges. Göttingen, 561, 1887.

**398. ANDALUSITE.** Spath adamantin d'un rouge violet (fr. Forez) *Bourn.*, J. Phys., **34**, 453, 1789. Feldspath du Forez *Guyton*, Ann. Ch., **1**, 190, 1789. Andalousite (fr. Spain and Forez) *Delameth.*, J. Phys., **46**, 386, 1798. Andalusite. Feldspath apyre *H.*, Tr., **4**, 1801. Micaphilit, Micafilit (fr. Lahmerwinkel) *Brunner*, Moll's Ann. B. H., **3**, 294, 1804, Efem., **1**, 51, 1805; Micaphyllit, *bad orthogr.* Stanzait (fr. Bavaria at Stanzen near Bodenmais and Herzogau) *Flurl*, Gebirgs-Form. Churpfalzbaierischen Staaten, 5, 1806. Hartspat *Wern.* Macle hyaline *Cordier*.

Silex niger cum cruce candida: darinn ein weiss Kreutz, *Gesner*, Foss., 45, 1565. Lapis crucifer (fr. Compostella) quem Hispani vocat cruciatum, *Mercati*, Metallotheca Vaticana, 237, 1617. Pierres de Macles (fr. id.) *Robien*, N. idées sur la Format. d. Foss., 108, 1751 (with fig.). Spanish Shirl, Cross-Stone, *Hill*, Foss., 152, 1771. Pierre de Croix, Macle basaltique, Schorl en prismes—dont les angles obtus sont de 95°, *de Lisle*, Crist., 1772, **2**, 440, 1783. Crucite *Delameth*, T. T., **2**, 292, 1797. Chiastolith *Karst.*, Tab., 28, 73, 1800. Chiastolite. Macle *H.*, Tr., **3**, 1801. Hohlspath *Wern.*, 1803, Ludwig's *Wern.*, 210, 1804. Chiast. ident. with Andal. *Bernhardi*, Moll's Efem., **3**, 32, 1807, *Beud.*, Tr., 363, 1824.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}98613 : 1 : 0{\cdot}70245$ Des Cloizeaux[1].
$100 \wedge 110 = 44^\circ\ 36'$, $001 \wedge 101 = 35^\circ\ 27\frac{5}{6}'$, $001 \wedge 011 = 35^\circ\ 5\frac{1}{6}'$.

| | | | | |
|---|---|---|---|---|
| **Forms:** | *c* (001, *O*) | *m* (110, *I*) | *r* (101, 1-ī) | *o* (111, 1) |
| *a* (100, *i*-ī) | *k* (210, *i*-2̄) | *g* (120, *i*-2̆) | *s* (011, 1-ĭ) | *z* (121, 2-2̆) |
| *b̄* (010, *i*-ĭ) | | | *t* (031, 3-ĭ)[3] | |

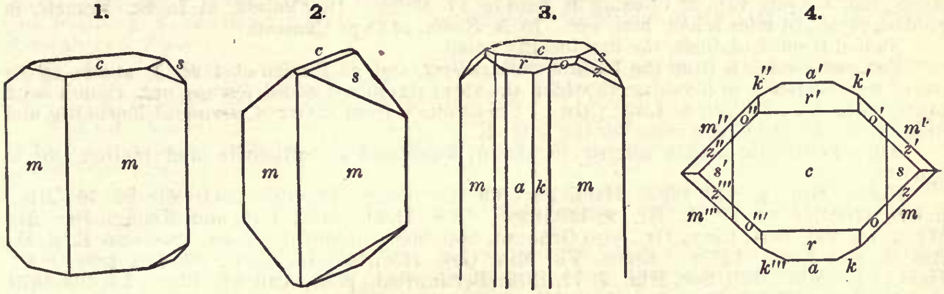
| | | | |
|---|---|---|---|
| *kk'''* = 52° 30′ | *ss'* = 70° 10′ | *oo'''* = 59° 33′ | *mz* = 36° 49′ |
| *mm'''* = *89° 12′ | *co* = 45° 1′ | *zz'* = 44° 53′ | *mr* = *65° 36′ |
| *gg'* = 53° 46′ | *cz* = 57° 35½′ | *zz'''* = 97° 42′ | *ms* = 66° 12′ |
| *rr'* = 70° 56′ | *oo'* = 60° 28½′ | | |

Usually in coarse prismatic forms, the prisms nearly square in form. Massive, imperfectly columnar; sometimes radiated and granular.

Cleavage: *m* distinct, sometimes perfect (Brazil); *a* less perfect; *b* in traces. Fracture uneven, subconchoidal. Brittle. H. = 7·5. G. = 3·16–3·20. Luster vitreous; often weak. Color whitish, rose-red, flesh-red, violet, pearl-gray, reddish-brown, olive-green. Streak uncolored. Transparent to opaque, usually subtranslucent.

Pleochroism strong in some colored varieties: $\mathfrak{c}$ (= $\breve{a}$) olive-green, $\mathfrak{b}$ (= $\bar{b}$) olive-green, $\mathfrak{a}$ (= $\acute{c}$) blood-red to rose-red. Absorption strong, $\mathfrak{a} > \mathfrak{b} > \mathfrak{c}$. Sections normal to an optic axis are idiophanous[4] or show the polarization brushes distinctly. Optically —. Ax. pl. ∥ *b*. Bx ⊥ *c*. Axial angles:

Brazil $\alpha_r = 1{\cdot}632$ $\beta_r = 1{\cdot}638$ $\gamma_r = 1{\cdot}643$ $\therefore$ $2V_r = 84° 30'$ Dx.
" $2H_{a.r} = 96° 30'$ $2H_{o.r} = 113°$ $\therefore$ $2V_r = 83° 37$ Dx $2H_a = 96° 33$ Btd.



Figs. 1, 2, Common forms. 3, 4, Upper Providence, Delaware Co., Penn.

**Var.**—1. *Ordinary.* H. = 7·5 on the basal face, if not elsewhere. Crystals coarse, square prismatic in form, often soft on the surface from incipient alteration.

2. *Chiastolite* or *Macle.* Stout crystals having the axis and angles of a different color from the rest, owing to a regular arrangement of carbonaceous impurities through the interior, and hence exhibiting a colored cross, or a tesselated appearance in a transverse section. H. = 3–7·5, varying much with the degree of impurity. The following figures show sections of some crystals. Fig. 5, by C. T. Jackson in J. Soc. N. Hist., Bost., 1, 55; figs. *a* and *b* are from opposite extremities of the same crystals; so also *c* and *d*; *e* and *f*.

5.

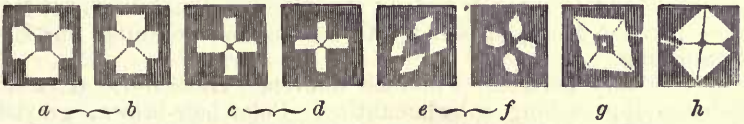
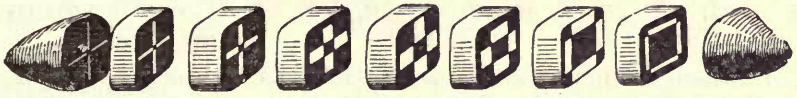


Fig. 6 shows the successive parts of a single crystal, as dissected by B. Horsford of Springfield, Mass. The forms of the white and black portions vary much. Bernhardi showed in 1807 (l. c.) that the central column sometimes widened *from the middle* toward each end.

6.



**Comp.**—$Al_2SiO_5 = (AlO)AlSiO_4$ or $Al_2O_3.SiO_2$ = Silica 36·8, alumina 63·2 = 100.

A little iron is usually present; analyses see 5th Ed., p. 372. Damour obtained for the Brazilian mineral: $SiO_2$ 37·24, $Al_2O_3$ 62·07, $Fe_2O_3$ 0·61 = 99·92, Dx., Min., 1, 336, 1862.

**Pyr., etc.**—B.B. infusible. With cobalt solution gives a blue color after ignition. Not decomposed by acids. Decomposed on fusion with caustic alkalies and alkaline carbonates. See also sillimanite, p. 499.

**Obs.**—Most common in argillaceous schist, or other schists imperfectly crystalline; also in gneiss, mica schist, and related rocks; rarely in connection with serpentine. The variety chiastolite is commonly a contact mineral in clay-slates, *e.g.*, adjoining granitic dikes. Sometimes associated with sillimanite with parallel axes.

Found in Spain, in Andalusia; in the Tyrol, Lisens Alp, in large cryst. with cyanite; in Saxony, at Bräunsdorf, Robschütz, Munzig, Penig; in Moravia, at Goldenstein; Bavaria, at Wunsiedel, Lahmerwinkel. Rabenstein, etc.; Austria, at Felling, near Krems, in serpentine; France, Dept. of Var. near Hyères; Barèges in the Pyrenees; Russia, Yushakova near Mursinka in the Ural; Mankova, etc., in Nerchinsk (*chiastolite*). In Ireland at Killiney Bay, in mica schist; near Balahulish in Argyleshire; Cumberland, England. In Brazil, province of Minas Geraes. in fine crystals and as rolled pebbles.

In N. America, in *Maine*, at Mt. Abraham, Bangor, Searsmont, Camden, S. Berwick; also in fine pink crystals in quartz with pyrrhotite at Standish. *N. Hamp.*, at White Mtn. Notch; Boar's Head, near Rye; at Charleston. *Vermont*, near Bellows Falls. *Mass.*, at Westford, abundant in cryst., sometimes rose-colored; Lancaster, both varieties; Sterling, chiastolite. *Conn.*, at Litchfield and Washington, good cryst. *Penn.*, in Delaware Co., near Leiperville, large cryst.; at Marple, Upper Providence, and Springfield, good cryst.; one weighing 7½ lbs., and a group of crystals, free from the gangue, of about 60 lbs. *California*, along the Churchillas rivers, San Joaquin val., at crossing of road to Ft. Miller. In *Canada*, at L. St. Francis, in reddish cryst., in mica schist, both var. In *N. Scotia*, at Cape Canseau.

Named from Andalusia, the first locality noted.

The name *macle* is from the Latin *macula, a spot*, and, as Robien observes, it alludes to the use of the "*mascle*" in heraldry, in which the word signifies *a voided lozenge*, or a rhomb with open centre (l. c., 1751, in de Lisle, Crist.). Chiastolite is from χιάστος, *arranged diagonally*, and hence from *chi*, the Greek name for the letter X.

**Alt.**—Andalusite occurs altered to kaolin; sometimes to muscovite (and pinite); also to cyanite.

**Ref.**—[1] Min., p. 173, 1862. Haid. gave 89° 10′, Pogg., **61**, 295, 1844; Mlr. 89° 16′, Min., p. 284; Grünhut 89° 15′, Zs. Kr., **9**, 120, 1884. [2] Cf. Haid., Mlr., l. c., and Kenng., Ber. Ak. Wien, **14**, 269, 1854; Lévy, Dx., also Grünhut, note some doubtful planes. See also E. S. D., Am. J. Sc., **4**, 473, 1872. [3] Erem., Vh. Min. Ges., 135, 1863; Id., ibid., **24**, 451, 1888. [4] Cf. Haid., l. c.; Mld., Bull. Soc. Min., **2**, 77, 1879; Bertin, ibid., p. 54, Ann. Ch. Phys., **15**, 405, 1878, and Zs. Kr., **3**, 454, 1879.

**399. SILLIMANITE** or FIBROLITE. Faserkiesel (fr. Bohemia) *Lindacker*, Mayer's Samml. phys. Aufs., **2**, 277, 1792; Bergm. J., **2**, 65, 1792. Fibrolite (fr. the Carnatic) *Bournon*, Phil. Trans., 289, 335, 1802; = Bournonite *Lucas*, Tabl., **2**, 216, 1813. Bucholzit (fr. Tyrol) *Brandes*, Schw. J., **25**, 125, 1819. Sillimanite (fr. Conn.) *Bowen*, Am. J. Sc., **8**, 113, 1824. Wörthite *Hess*, Pogg., **21**, 73, 1830. Xenolit *Nordensk.*, Act. Soc. Sc. Fenn., 1, 371, Pogg., **56**, 643, 1842. Bamlit *Erdmann*, Ak. H. Stockh., 19, 1842. Monrolite (fr. Monroe, N. Y.) *Silliman*, Am. J. Sc., **8**, 385, 1849.

Orthorhombic. Axes $\breve{a} : \bar{b} = 0{\cdot}970 : 1$. Forms: $a$ ($100$ $i$-$\bar{\imath}$), $b$ ($010$, $i$-$\breve{\imath}$), $m$ ($110$, $I$), $h$ ($230$, $i$-$\breve{\tfrac{3}{2}}$). Angles[1] $mm''' = 88° \ 15'$, $hh' = {}^*69°$. Prismatic faces striated and rounded. Commonly in long slender crystals not distinctly terminated; often in close parallel groups, passing into fibrous and columnar massive forms; sometimes radiating.

Cleavage: $b$ very perfect. Fracture uneven. H. = 6–7. G. = 3·23–3·24. Luster vitreous, approaching subadamantine. Color hair-brown, grayish brown, grayish white, grayish green, pale olive-green. Streak uncolored. Transparent to translucent.

Pleochroism sometimes distinct: $\mathfrak{c}$ dark clove-brown, $\mathfrak{b}$ light brownish, Rosenbusch. Optically +. Double refraction strong. Ax. pl. $\parallel b$. Bx $\perp c$. Dispersion $\rho > v$.

$$2E_r = 44° \qquad 2E_{gr} = 42°\text{–}43° \qquad 2E_v = 37°\text{–}38°. \qquad \beta_r = 1{\cdot}660, \text{ Dx.}$$
$$\alpha = 1{\cdot}659 \qquad \beta = 1{\cdot}661 \qquad \gamma = 1{\cdot}680, \text{ Lcx.}^2$$

**Var.**—1. *Sillimanite.* In long, slender crystals, passing into fibrous forms, with the fibers separable. G. = 3·238, Norwich, Ct., Dana; 3·232, id., Brush; 3·239, Yorktown, Norton.

Also densely compact, and in this form used for utensils and implements by prehistoric man in western Europe, and sometimes called "jade." See Damour (C. R., **61**, 318, 1865), who gives for a specimen from Haute Loire, with G. = 3·209: $SiO_2$ 37·18, $Al_2O_3$ 61·17, $Fe_2O_3$ 0·70, ign. 1·06 = 100·11. Also F. W. Clarke (Proc. U. S. Mus., **11**, 128, 1888), who gives for a specimen from Brittany, with G. = 3·147: $SiO_2$ 34·66, $Al_2O_3$ 63·24, $Fe_2O_3$ *tr.*, MgO 0·37, ign. 1·31 = 99·58. On Spanish fibrolite implements (jade), see Quiroga, abstr. in Zs. Kr., **6**, 270, 1881.

2. *Fibrolite.* Fibrous or fine columnar, firm and compact, sometimes radiated; grayish white to pale brown, and pale olive-green or greenish gray. *Bucholzite* and *monrolite* are here included; the latter is radiated columnar, and of the greenish color mentioned. G. = 3·24, fibrolite, Bournon; 3·19–3·21, id., Dmr.; 3·239, bucholzite, Chester, Pa., Erdmann; 3·04–3·1, monrolite, B. Silliman; 3·075, id., Brush.

*Bamlite*, from Bamle, Norway, resembles the monrolite, being columnar subplumose, silky; G. = 2·984, and color greenish white or bluish-green. The analysis of Erdmann gave a large excess of silica (56·90 p. c.); but L. Sæmann observes that there are minute prisms of quartz among the fibers of bamlite. A bamlite from the gneiss of Larangeiras, Brazil, with G. = 3·18, gave Dom Pedro Augusto von Sachsen-Coburg: $SiO_2$ 57·50, $Al_2O_3$ 41·50 = 99·00; this is probably also impure from the presence of quartz, Min. Mitth., **10**, 460, 1889.

*Xenolite* also resembles fibrolite closely, excepting in the high specific gravity, 3·58, which suggests an identity rather with cyanite. But the prisms are stated to have the angle 89°, which is the angle of andalusite; and Des Cloizeaux states that it is optically like fibrolite, and not like cyanite. In rolled pebbles from Peterhof, Finland, and near St. Petersburg. Named from ξένος, *stranger*. Komonen (l. c.) obtained: $SiO_2$ 47·44, $Al_2O_3$ 52·54 = 99·98.

*Wörthite* is hydrous, and is probably a somewhat altered and impure form. H. = 7·25, color white, translucent. Optically like the above. An analysis gave Hess (l. c.): $SiO_2$ 40·58, $Al_2O_3$ 53·50, MgO 1·00, $H_2O$ 4·63 = 99·71. From Peterhof with xenolite. Cf. Fischer, Vh. Ges. Freiburg, **5**, 29; Lcx.², l. c., p. 154. Named for Von Wörth, a secretary of the Russian Mineralogical Society.

**Comp.**—$Al_2SiO_5$ or $Al_2O_3.SiO_2$ = Silica 36·8, alumina 63·2 = 100; the rational formula probably $(AlO)AlSiO_4$ like andalusite (Groth).

Analyses (5th Ed., p. 374 and above) in general agree closely, but Wiik gives (Zs. Kr., **2**, 496, 1878) for sillimanite from St. Michel: $SiO_2$ 47·33 $Al_2O_3(Fe_2O_3$ *tr*) 52·21 = 99·54, yielding the orthosilicate formula $Al_4(SiO_4)_3$, like xenolite above; cf. also anal. 5, 6, 5th Ed., p. 374.

**Obs.**—Occurs in gneiss, mica schist, and related crystalline rocks, usually in slender prisms aggregated in lines, sometimes associated in parallel position with andalusite (Lcx.²); iolite is also a common associate; rarely as a contact mineral.

Observed in many localities, thus near Moldau and Schüttenhofen in Bohemia (*faserkiesel*); at Fassa in Tyrol (*bucholzite*); in the Carnatic with corundum (*fibrolite*); at Bodenmais in Bavaria; Tillenberg near Eger in Bohemia; Marschendorf in Moravia; Freiberg, Saxony; in France, in the vicinity of Issoire in boulders, and also in the canton of Paulhaguet; near Pontgibaud and other points in Auvergne; in the Dept. Basse-Loire near Nantes and elsewhere. In gneiss in Aberdeenshire, Scotland; Sievenberg, Heteroland, South Africa. Greenish gray sillimanite in quartz-forms rolled masses in the diamantiferous sands of Diamantina, Minas Geraes, Brazil.

In the United States, in *Massachusetts*, at Worcester. In *Connecticut*, at the falls of the Yantic, near Norwich, with zircon, monazite, and corundum; at Willimantic; at Chester, near Saybrook (*sillimanite*); at Humphreysville. In *N. York*, at Yorktown, Westchester Co., 10 m. N.E. of Sing Sing; near the road leading from Pine's Bridge to Yorktown P. Office, in distinct crystals, with monazite, tremolite, and magnetite, the crystals often running through the magnetite; in Monroe, Orange Co. (*monrolite*), with mica, garnet, magnetite, etc. In *Penn.*, at Chester on the Delaware, near Queensbury forge; in Delaware Co., in Birmingham, Middletown, Concord, Aston, Darby; sometimes, as at Mineral Hill, associated with corundum and derived from its alteration (Genth). In *Delaware*, at Brandywine Springs. With corundum at the Culsagee mine, Macon Co., *N. Carolina*, and from Laurens, *S. Carolina*.

Named *fibrolite* from the fibrous massive variety (*Germ.*, Faserkiesel); *bucholzite*, after the German chemist Bucholz; *sillimanite*, after Prof. Benjamin Silliman of New Haven (1779–1864).

**Artif.**—A compound near sillimanite was early (1858) formed by St. Claire Deville and Caron by reaction at a high temperature of silica on aluminium fluoride, or of aluminium on silicon fluoride. Similar results have been obtained by Frémy and Feil (1877) and later more definitely by Vernadsky, who further shows that cyanite is transformed at 1320°–1380° into sillimanite, and the same is true of andalusite, both with the disengagement of heat. A similar transformation seems to take place in the case of dumortierite and topaz. See Bull. Soc. Min., **12**, 447, 1889, **13**, 256, 1890, also further under cyanite.

**Ref.**—¹ Dx., Min., **1**, 178, 1862; Bull. Soc. Min., **4**, 258, 1881. ² Lcx., Bull. Soc. Min., **11**, 150, 1888. The position here taken brings sillimanite into relation with andalusite; with Dx. the 69° prism is taken as the unit.

GLANCESPAR. Glanzspath *von Dechen*, Geogn. Führer Siebengebirge, 154, 1861; Rath, Pogg., **147**, 272, 1872.

Occurs in small prismatic fragments in the basalt of the Siebengebirge. Form a rhombic prism having an acute angle of 88½°. Cleavage pinacoidal distinct, with pearly luster. H. = 6·5. G. = 3·150. Analysis.—Rath:

$SiO_2$ 36·7 $Al_2O_3$ 57·9 $Fe_2O_3$ 4·4 MgO 0·7 CaO 0·8 = 100·5

Composition deducting impurities like sillimanite. Cf. Vernadsky, Bull. Soc. Min., **12**, 455, 1889.

WESTANITE *C. W. Blomstrand*, Öfv. Ak. Stockh., **25**, 208, 1868.

In radiated crystalline masses, sometimes in prismatic crystals. H. = 2·5. Color brick red. An analysis gave:

$SiO_2$ [42·53] $Al_2O_3$ 51·14 $P_2O_5$ 1·15 $Fe_2O_3$ 1·01 $H_2O$ 4·17 = 100

This composition is near wörthite, a hydrous fibrolite, but it differs from that mineral in inferior hardness. It may be an altered andalusite as suggested by Groth (Tab. Ueb., 106, 1889). B.B. swells up; infusible and turns white. Not acted upon by acids. Associated with pyrophyllite at Westanå, Sweden.

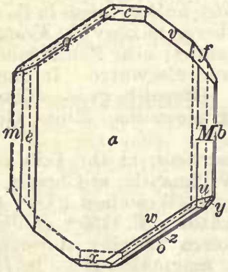
**400. CYANITE.** Talc bleu *Sage*, Descr. Cab. de l'École des Mines, 154, 1784. Sappare *Saussure fils*, J. Phys., 34, 213, 1789. Beril feuilleté *Sage*, J. Phys., 31, 39, 1789. Cyanit (fr. Greiner) *Wern.*, Hoffm., Bergm. J., 377, 393, 1789; *Wern.*, ib., 164, 1790; Kyanite. Disthène *H.*, Tr., 3, 101. Rhætizit (fr. Pfitschthal, or ancient Rhætia) *Wern.*, Hoffm. Min., 2, b, 318, 1815, 4, b, 128, 1817.

Triclinic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·89938 : 1 : 0·70896$; $\alpha = 90° 5\frac{1}{2}'$, $\beta = 101° 2\frac{1}{4}'$, $\gamma = 105° 44\frac{1}{2}'$ Rath[1].

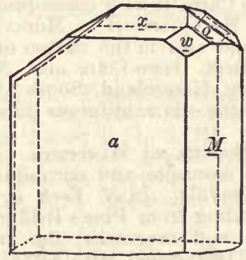
$100 \wedge 010 = 73° 56'$, $100 \wedge 001 = {}^{*}78° 30'$, $010 \wedge 001 = 86° 45'$.

**Forms**[1]:
$a$ $(100, i\text{-}\bar{\imath}, \mathrm{M})$
$b$ $(010, i\text{-}\breve{\imath}, \mathrm{T})$
$c$ $(001, O, \mathrm{P})$
$n$ $(310, i\text{-}\bar{3}')$
$e$ $(210, i\text{-}\bar{2}')$
$m$ $(110, I')$
$Q$ $(120, i\text{-}\breve{2}')$
$M$ $(1\bar{1}0, {}'I)$
$s$ $(1\bar{2}0, {}'i\text{-}\breve{2})$
$h$ $(\bar{2}03, {}_{,}\tfrac{2}{3}\text{-}\bar{\imath}_{,})$
$k$ $(\bar{3}04, {}_{,}\tfrac{3}{4}\text{-}\bar{\imath}_{,})$
$x$ $(\bar{1}01, {}_{,}1\text{-}\bar{\imath}_{,})$
$q$ $(011, 1\text{-}\breve{\imath}')$
$v$ $(0\bar{1}1, {}'1\text{-}\breve{\imath})$
$f$ $(0\bar{2}1, {}'2\text{-}\breve{\imath})$
$d$ $(221, 2')$
$w$ $(\bar{2}11, {}_{,}2\text{-}2)$
$z$ $(\bar{1}22, {}_{,}\tfrac{1}{2})$
$o$ $(\bar{1}11, {}_{,}1)$
$u$ $(\bar{2}21, {}_{,}2)$
$y$ $(\bar{1}21, {}_{,}2\text{-}\breve{2})$
$r$ $(\bar{1}\bar{1}1, 1_{,})$
$g$ $(\bar{3}\bar{1}2, \tfrac{3}{2}\text{-}\bar{3}_{,})$

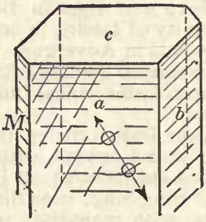
1.



2.



3.

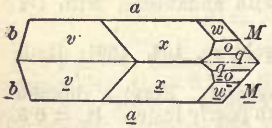


Figs. 1, 2, 4, Greiner, Rath; 1 drawn in inverted position. 3, Bauer.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $ae$ | $= 20° 42'$ | $cv$ | $= {}^{*}36° 58'$ | $cM$ | $= 82° 27'$ | $av$ | $= {}^{*}90° 2'$ |
| $am$ | $= {}^{*}34° 17'$ | $cf$ | $= 57° 33'$ | $cr$ | $= 56° 48$ | $a'r$ | $= 55° 40'$ |
| $aM$ | $= 48° 18'$ | $cd$ | $= 59° 56'$ | $aq$ | $= 71° 37'$ | $by$ | $= 41° 57'$ |
| $mM$ | $= 82° 35'$ | $cm$ | $= {}^{*}80° 28'$ | $a'w$ | $= 44° 9'$ | $bo$ | $= 64° 15'$ |
| $ch$ | $= 30° 59'$ | $co$ | $= 46° 25'$ | $a'o$ | $= 70° 45\frac{1}{2}'$ | $bx$ | $= 98° 26'$ |
| $cx$ | $= 43° 48'$ | $cu$ | $= 67° 44'$ | $a'z$ | $= 89° 31'$ | $b'r$ | $= 52° 6'$ |
| $cq$ | $= 34° 44'$ | | | | | | |

Twins: tw. ax. (1) a normal to *a*, comp.-face *a*, often polysynthetic; (2) the normal to the edge *a*/*b* in *a*; (3) the edge *a*/*c*; (4) a normal to *c*, as penetration-twins, often repeated and as a result of pressure; also staurolite-like cruciform-twins crossing at 60°. Usually in long bladed crystals, rarely terminated. Face *a* often striated ‖ edge *a*/*c* (f. 3). Also coarsely bladed columnar to subfibrous.

4.



Cleavage: *a* very perfect; *b* less perfect; also parting ‖ *c* which is a gliding-plane, parallel to which twinning is produced by pressure[2]. H. = 5–7·25; the least, 4–5, on *a* ‖ $\dot{c}$; 6–7 on *a* ‖ edge *a*/*c*; 7 on *b*. G. = 3·56–3·67; 3·559, white; 3·675, blue; 3·661, Tyrol, Erdmann. Luster vitreous to pearly. Color blue, white; blue along the center of the blades or crystals with white margins; also gray, green, black. Streak uncolored. Translucent to transparent.

Pleochroism distinct in colored varieties. Optically −. Ax. pl. nearly ⊥ *a* and inclined to edge *a*/*b* on *a* about 30° (f. 3), and about 7½ on *b*. Axial angle large, 2V = 82°–83°. Index $\beta_r = 1·720$ Dx.[3] Also Korn[3]:

Pfitschthal $2\mathrm{H}_{a.r} = 99° 18'$ Li $2\mathrm{H}_{a.y} = 98° 55'$ Litchfield $2\mathrm{H}_{a.r} = 100° 50\frac{1}{2}'$ $2\mathrm{H}_{a.y} = 100° 41\frac{1}{2}'$

Comp.—Empirical formula $Al_2SiO_5$ or $Al_2O_3.SiO_2$, like andalusite and sillimanite. Perhaps (Groth) a basic metasilicate $(AlO)_2SiO_3$.

Analyses, 5th Ed., p. 376. A pale green variety from Clip, Arizona, associated with dumortierite, gave Hillebrand (priv. contr.): G. = 3·656, $SiO_2$ 36·30, $Al_2O_3(TiO_2)$ 62·51, $Fe_2O_3$ 0·70, CuO *tr.*, ign. 0·40 = 99·91.

**Pyr., etc.**—Same as for andalusite.

At a high temperature (1320°–1380°) cyanite is transformed into sillimanite; the hardness becomes uniformly 6–7 instead of 5 to 7; the specific gravity falls to 3·15–3·23; the extinction becomes parallel and the optical character +. Cf. Vernadsky, Bull. Soc. Min., **12**, 447, 1889, **13**, 256, 1890.

**Obs.**—Occurs principally in gneiss and mica schist (both the ordinary variety with muscovite and also that with paragonite) often accompanied by garnet and sometimes by staurolite; also in eclogyte. It is often associated with corundum.

Found in transparent crystals at Monte Campione in the St. Gothard region in Switzerland in paragonite schist; on Mt. Greiner, Zillerthal, and in the Pfitschthal (*rhætizite*, a white variety) in Tyrol; also near Admont in Styria; in eclogyte of the Saualpe, Carinthia; Petschau, Bohemia; Heräjoki, Finland; Horrsjöberg in Wermland, Sweden, forming beds enclosing damourite, in quartzyte; on the R. Sanarka, Gov't Orenburg, Russia, in the gold-washings, accompanying euclase and topaz; at Pontivy, France; Villa Rica, Brazil, S. America; in Scotland, at Botriphinie in Banffshire, at Banchory in Aberdeenshire, and near Glen Tilt; in the Shetlands at Hillswickness; in Ireland, at Donegal and Mayo.

In *N. Hamp.*, at Jaffrey, on the Monadnock Mtn. In *Mass.*, at Chesterfield, with garnet in mica schist; at Worthington and Blanford in good specimens; at Westfield and Lancaster. In *Conn.*, at Litchfield and Washington in large rolled masses, with corundum and massive apatite; at Oxford, near Humphreysville, in mica schist. In *Vermont*, at Thetford and Salisbury; at Bellows Falls in short disseminated crystals. In *Penn.*, in fine specimens near Philadelphia, on the Schuylkill road near the Darby bridge; near the Schuylkill, on the Ridge road, back of Robin Hood tavern; at East and West Branford, Chester Co.; at Darby and Haverford, Delaware Co. In *Maryland*, eighteen miles north of Baltimore, at Scott's mill; in *Delaware* near Wilmington. In *Virginia*, at Willis's Mt., Buckingham Co., and two miles north of Chancellorville, Spotsylvania Co. In *N. Carolina*, with rutile, lazulite, etc., at Crowder's Mt., Gaston Co., sometimes black; of fine deep blue color near Bakersville near the summit of Yellow Mt. on the road to Marion Co. (Kunz). In Gaston and Rutherford counties associated with corundum, damourite; also at Swannanoa Gap, Buncombe Co., and elsewhere: in these and similar cases according to Genth derived from the corundum. In British Columbia on the North Thompson River in quartz.

Named from κυανός, *blue.* The name *sappare* arose from a mistake by Saussure, Jr., in reading a label of this mineral on which it was called sapphire; a copy of this label is given in J. Phys., **34**, 213; the specimen thus labelled was from Botriphinie in Scotland, and was sent by the Duke of Gordon to Saussure the father. *Disthene* is from δίς, *twice*, or of two kinds, and σθένος, *strong*, alluding to the unequal hardness and electric properties in two different directions.

**Alt.**—Cyanite occurs altered to talc and steatite.

An analysis of an alteration product from Pregratten gave Böhm, Min. Mitth., **2**, 522, 1880:

| $SiO_2$ | $Al_2O_3$ | FeO | CaO | MgO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 36·62 | 46·39 | 0·90 | 7·35 | 0·58 | 1·93 | 2·75 | 4·51 | = 101·03 |

**Ref.**—[1] Greiner, Zs. Kr., **5**, 17, 1880, also ib., **3**, 1, 87, 1878. See also Bauer on crystals from Monte Campioni, Zs. G. Ges., **30**, 283, 1878, **31**, 244, 1879, **32**, 717, 1880.
[2] *Gliding planes*, Bauer, Zs. G. Ges., **30**, 320, 1878; Mügge, Jb. Min., **2**, 13, 1888. [3] Dx., Min., **1**, 186, 1862; Bauer, l. c.; Korn, Zs. Kr., **7**, 595, 1883. **Axial figures in twin crystals, Kbl., Ber. Ak. München, 1, 272, 1867.**

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## 12. Datolite Group. Monoclinic.

Basic Orthosilicates. $H\overset{II}{R}\overset{III}{R}SiO_5$ or $\overset{II}{R}_3\overset{III}{R}_2(SiO_5)_2$. Oxygen ratio for R : Si = 3 : 2.
$\overset{II}{R}$ = Ca,Be,Fe, chiefly; $\overset{III}{R}$ = Boron, the yttrium (and cerium) metals, etc.

| | | $\grave{a} : \acute{b} : c$ | $\beta$ |
|---|---|---|---|
| 401. | **Datolite**<br>$HCaBSiO_5$ or $Ca(BOH)SiO_4$ | 0·6345 : 1 : 1·2657 | 89° 51′ |
| 402. | **Homilite**<br>$Ca_2FeB_2Si_2O_{10}$ or $Ca_2Fe(BO)_2(SiO_4)_2$ | 0·6249 : 1 : 1·2824 | 89° 21′ |

$2\grave{a} : \bar{b} : 4\grave{c}$ $\beta$

**403. Euclase** $0{\cdot}6474 : 1 : 1{\cdot}3330$ 79° 44′

$HBeAlSiO_5$ or $Be(AlOH)SiO_4$

$\grave{a}$

**404. Gadolinite** $0{\cdot}6273 : 1 : 1{\cdot}3215$ 89° 26½′

$Be_2FeY_2Si_2O_{10}$ or $Be_2Fe(YO)_2(SiO_4)_2$

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**405. Yttrialite** $Y_2O_3,ThO_2$, etc., $SiO_2$ Massive

Silicate of thorium, yttrium earths, etc. Oxygen ratio for Si : R = 4 : 3.

The formulas of the species of the Datolite Group are written as basic orthosilicates in the form suggested by Groth. The crystallographic and chemical relation between datolite and euclase was shown by J. D. Dana in 1854 (Am. J. Sc., **17**, 215, 1854, **49**, 400, 1870, and Min., 4th Ed., p. 204, 5th Ed., pp. 362, 363) and later by Rammelsberg (Zs. G. Ges., **21**, 807, 1869), who also proved the isomorphism of datolite and gadolinite. The latter author shows that the axial ratio and obliquity of euclase may be made to correspond to them, and he calculates: $\grave{a} : \bar{b} : \grave{c} = 0{\cdot}6303 : 1 : 0{\cdot}6318$, $\beta = 88°\ 18'$. The complex character of the symbols resulting from this change shows, however, that the position is an unnatural one.

Yttrialite, associated with the Gadolinite of Texas and like it chiefly a silicate of the rare metals of the yttrium group, is conveniently introduced here, although a more highly acid compound and hence of different formula.

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**401. DATOLITE.** Datolith (fr. Arendal) *Esmark* (undescr.); *Karsten & Klapr.*, Gehlen's J., **6**, 1806, Klapr. Beitr., **4**, 354, 1807; *Karst.*, Tab., 52, 1808. Datholit *Wern.*, 1808. Datholite *Brongn.*, Min., **2**, 397, 1807. Chaux boratée siliceuse *H.*, Tabl., 17, 1809. Esmarkit *Hausm.*, Handb., 862, 1813. Datolite *Aikin*, Min., 1815; Jameson, **2**, 257, 1816. Borate of lime; Borosilicate of lime. Humboldtite *Levy*, Ann. Phil., **5**, 130, 1823.

Botriolit *Hausm.*, v. Moll's Efem., **4**, 393, 1808. Botryolith *Karst.*, Tab., 52, 1808. Chaux boratée siliceuse, var. concretionnée-mammelonnée *H.*, Tabl., 17, 145, 1809. Faser-datolith *Leonh.*, Handb., 590, 1821. Botryolite.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 0{\cdot}63446 : 1 : 1{\cdot}26574$; $\beta = 89°\ 51\tfrac{1}{3}' = 001 \wedge 100$ Dauber[1].

$100 \wedge 110 = 32°\ 23'\ 36''$, $001 \wedge 101 = 63°\ 15'\ 43''$, $001 \wedge 011 = 51°\ 41'\ 22''$.

**Forms**[2]:
$a\ (100,\ i\text{-}\bar{i})$
$b\ (010,\ i\text{-}\grave{i})$
$c\ (001,\ O)$

$\eta\ (410,\ i\text{-}\bar{4})$
$\Delta\ (210,\ i\text{-}\bar{2})$
$e\ (320,\ i\text{-}\bar{\tfrac{3}{2}})$
$m\ (110,\ I)$
$r\ (230,\ i\text{-}\grave{\tfrac{3}{2}})$
$o\ (120,\ i\text{-}\grave{2})$
$l\ (130,\ i\text{-}\grave{3})$

$p\ (106,\ -\tfrac{1}{6}\text{-}\bar{i})$
$u\ (104,\ -\tfrac{1}{4}\text{-}\bar{i})$
$v\ (103,\ -\tfrac{1}{3}\text{-}\bar{i})$
$x\ (102,\ -\tfrac{1}{2}\text{-}\bar{i})$
$f\ (304,\ -\tfrac{3}{4}\text{-}\bar{i})$
$\phi\ (101\ -1\text{-}\bar{i})$
$s\ (302,\ -\tfrac{3}{2}\text{-}\bar{i})$

$\psi\ (201,\ -2\text{-}\bar{i})$
$\mathfrak{a}\ (\bar{1}04,\ \tfrac{1}{4}\text{-}\bar{i})$
$\xi\ (\bar{1}02,\ \tfrac{1}{2}\text{-}\bar{i})$
$\mathfrak{g}\ (\bar{3}04,\ \tfrac{3}{4}\text{-}\bar{i})$
$\Pi\ (\bar{1}01,\ 1\text{-}\bar{i})$
$\Sigma\ (\bar{3}02,\ \tfrac{3}{2}\text{-}\bar{i})$
$z\ (\bar{2}01,\ 2\text{-}\bar{i})$

$\Omega\ (018,\ \tfrac{1}{8}\text{-}\grave{i})$
$\sigma\ (014,\ \tfrac{1}{4}\text{-}\grave{i})$
$t\ (013,\ \tfrac{1}{3}\text{-}\grave{i})$
$g\ (012,\ \tfrac{1}{2}\text{-}\grave{i})$
$h\ (023,\ \tfrac{2}{3}\text{-}\grave{i})$
$m_x\ (011,\ 1\text{-}\grave{i})$
$S\ (021,\ 2\text{-}\bar{i})$

$Z\ (116,\ -\tfrac{1}{6})$
$\mathfrak{f}\ (115,\ -\tfrac{1}{5})$
$W\ (114,\ -\tfrac{1}{4})$
$L\ (113,\ -\tfrac{1}{3})$

$\Lambda\ (112,\ -\tfrac{1}{2})$
$n\ (111,\ -1)$
$\delta\ (221,\ -2)$
$\omega\ (\bar{1}16,\ \tfrac{1}{6})$
$\kappa\ (\bar{1}15,\ \tfrac{1}{5})$
$\mu\ (\bar{1}14,\ \tfrac{1}{4})$
$\lambda\ (\bar{1}13,\ \tfrac{1}{3})$
$\epsilon\ (\bar{1}12,\ \tfrac{1}{2})$
$P\ (\bar{5}59,\ \tfrac{5}{9})$
$\mathfrak{d}\ (\bar{2}23,\ \tfrac{2}{3})$
$\nu\ (\bar{1}11,\ 1)$

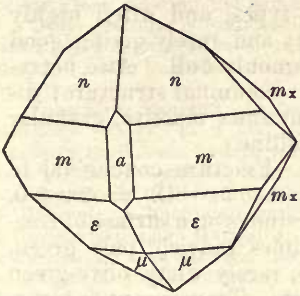
$\Psi\ (414,\ -1\text{-}4)$
$\Gamma\ (314,\ -\tfrac{3}{4}\text{-}\bar{3})$
$q\ (312,\ -\tfrac{3}{2}\text{-}\bar{3})$
$\vartheta\ (212,\ -1\text{-}2)$
$\chi\ (534,\ -\tfrac{5}{4}\text{-}\bar{\tfrac{5}{3}})$
$w\ (324,\ -\tfrac{3}{4}\text{-}\bar{\tfrac{3}{2}})$

$A\ (216,\ -\tfrac{1}{3}\text{-}\bar{2})$
$\mathfrak{w}\ (215,\ -\tfrac{2}{5}\text{-}\bar{2})$
$\mathfrak{b}\ (213,\ -\tfrac{2}{3}\text{-}\bar{2})$
$N\ (322,\ -\tfrac{3}{2}\text{-}\bar{\tfrac{3}{2}})$
$\zeta\ (\bar{6}21,\ 6\text{-}\bar{3})$
$T\ (\bar{2}14,\ \tfrac{1}{2}\text{-}2)$
$\iota\ (\bar{2}12,\ 1\text{-}\bar{2})$

$\mathfrak{j}\ (344,\ -1\text{-}\tfrac{4}{3})$
$\Xi\ (232,\ -\tfrac{3}{2}\text{-}\tfrac{3}{2})$?
$\mathfrak{h}\ (126,\ -\tfrac{1}{3}\text{-}\grave{2})$
$\gamma\ (124,\ -\tfrac{1}{2}\text{-}\grave{2})$
$U\ (123,\ -\tfrac{2}{3}\text{-}\grave{2})$
$Q\ (122,\ -1\text{-}\grave{2})$
$\beta\ (121,\ -2\text{-}\grave{2})$
$R\ (241,\ -4\text{-}\grave{2})$
$D\ (133,\ -1\text{-}\grave{3})$
$y\ (144,\ -1\text{-}\grave{4})$

$\tau\ (\bar{3}{\cdot}4{\cdot}18,\ \tfrac{2}{9}\text{-}\tfrac{4}{3})$?
$\pi\ (\bar{2}31,\ 3\text{-}\grave{\tfrac{3}{2}})$
$C\ (\bar{1}25,\ \tfrac{2}{5}\text{-}\grave{2})$
$\alpha\ (\bar{1}24,\ \tfrac{1}{2}\text{-}\grave{2})$
$i\ (\bar{1}23,\ \tfrac{2}{3}\text{-}\grave{2})$
$B\ (\bar{1}21,\ 2\text{-}\grave{2})$
$E\ (\bar{1}38,\ \tfrac{3}{8}\text{-}\bar{3})$
$F\ (\bar{5}{\cdot}15{\cdot}24,\ \tfrac{5}{8}\text{-}\grave{3})$
$O\ (\bar{2}69,\ \tfrac{2}{3}\text{-}\grave{3})$
$\mathfrak{r}\ (\bar{1}32,\ \tfrac{3}{2}\text{-}\grave{3})$
$H\ (\bar{1}31,\ 3\text{-}\grave{3})$
$J\ (\bar{2}61,\ 6\text{-}\grave{3})$
$\Theta\ (\bar{1}{\cdot}4{\cdot}14,\ \tfrac{2}{7}\text{-}\grave{4})$?
$V\ (\bar{1}41,\ 4\text{-}\grave{4})$
$K\ (\bar{1}58,\ \tfrac{5}{8}\text{-}\grave{5})$
$X\ (\bar{1}64,\ \tfrac{3}{2}\text{-}\grave{6})$
$G\ (\bar{1}{\cdot}9{\cdot}16,\ \tfrac{9}{16}\text{-}\grave{9})$

1.



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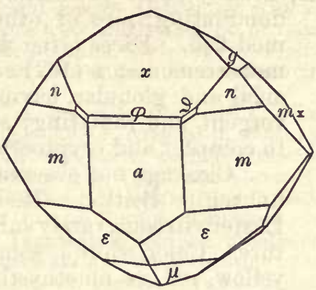

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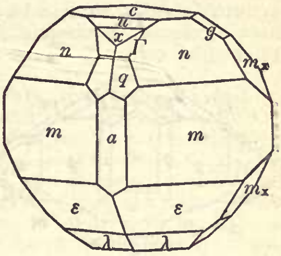

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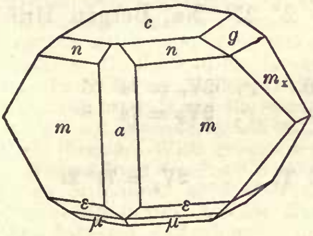

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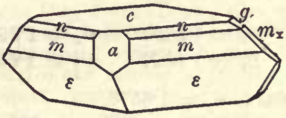

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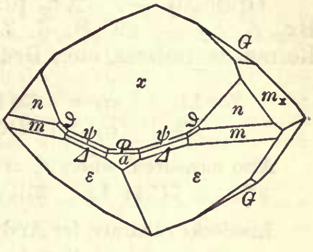

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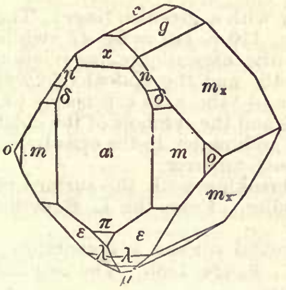

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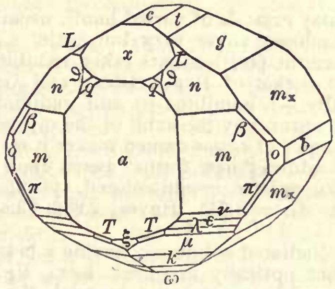

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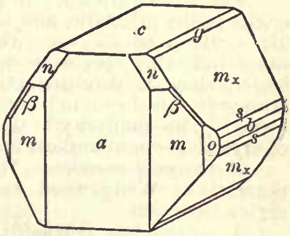


Figs. 1, 2, Bergen Hill. 3, Isle Royale, L. S. 4, Bergen Hill. 5, De Kalb, St. Lawrence Co., N. Y., J. Stanley-Brown. 6, Bergen Hill. 7, Andreasberg. 8, Toggiana. 9, Arendal.

ηη''' = 18° 1½'
ΔΔ''' = 35° 12'
ee''' = 45° 51'
mm''' = 64° 47'
rr' = 92° 50'
oo' = 76° 29'
ll' = 55° 26'

cp = 18° 23'
cu = 26° 29'
cv = 33° 35'
cx = 44° 51'
cf = 56° 9'
cφ = 63° 16'
cs = 71° 23½'
cψ = 75° 48'
ax = 45° 0'
c𝔞 = 26° 32'
cξ = 45° 0'
cΠ = 63° 29½'
cΣ = 71° 39'

cz = 76° 4'
ΩΩ' = 17° 59'
σσ' = 35° 7'
tt' = 45° 45'
gg' = 64° 39½'
hh' = 80° 19'
$m_x m_x'$ = 103° 23'
SS' = 136° 53'

cZ = 21° 29'
cW = 30° 32'
cL = 38° 10½'
cn = 66° 57'
cδ = 77° 56'
cm = 89° 53'
cω = 21° 30½'
cκ = 25° 19'
cμ = 30° 36'
cλ = 38° 16'
cϵ = 49° 49'
cν = 67° 10'

cq = 71° 46'
cϑ = 64° 21'
cT = 46° 22'
cβ = 72° 41'
cπ = 79° 49'

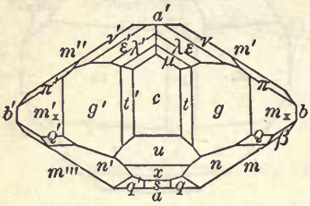
aq = 21° 34'
aϑ = 30° 39'
aγ = 67° 3'
ag = 89° 53'
an = 38° 55'
aQ = 58° 12'
$am_x$ = 89° 55'
aβ = 53° 43½'
a'T = 46° 31'
a'μ = 64° 41'
a'ε = 49° 57'
a'ν = 39° 0'

qq' = 22° 40'
ΨΨ' = 16° 8'

ϑϑ' = 31° 38'
nn' = 59° 4½'
ΞΞ' = 80° 43½'
ββ = 97° 9'
ww' = 31° 35'
γγ' = 59° 0'
ιι' = 31° 42
νν' = 59° 10'
BB' = 97° 16'
HH' = 119° 10'
VV' = 132° 28'
TT' = 25° 17'
ϵϵ' = 48° 19½'
λλ' = 38° 45½'
ii' = 10° 15'
μμ' = 31° 39'
αα' = 59° 6'
yy' = 97° 11'
ππ' = 85° 27'

Crystals varied in habit; usually short prismatic with either $m$ or $m_x$ predominating; also of other types, and often highly modified. Faces often wavy and rarely giving good measurements; $x$ (102) commonly dull. Also botryoidal and globular, having a columnar structure; divergent and radiating; sometimes massive, granular to compact and cryptocrystalline.

10.



Bergen Hill.

Cleavage not observed. Fracture conchoidal to uneven. Brittle. H. = 5–5·5. G. = 2·9–3·0. Luster vitreous, rarely subresinous on a surface of fracture. Color white; sometimes grayish, pale green, yellow, red, or amethystine, rarely dirty olive-green or honey-yellow. Streak white. Transparent to translucent; rarely opaque white.

Optically −. Ax. pl. ‖ $b$. $\mathfrak{a}$ (= $Bx_a$) nearly ⊥ $a$. $Bx_o \wedge \grave{c} = +1°$ Na, $Bx_a \wedge \grave{c} = -89°$ S. d. Zanchetti; $Bx_{o.y} \wedge \grave{c} = +2° 27'$ Na, Bergen Hill. Refractive indices, etc., Brugnatelli[3]:

For Li $\alpha_r = 1{\cdot}6214$ $\beta_r = 1{\cdot}6492$ $\gamma_r = 1{\cdot}6659$ $\therefore$ $2V_r = 74° 26'$
Na $\alpha_y = 1{\cdot}6246$ $\beta_y = 1{\cdot}6527$ $\gamma_y = 1{\cdot}6694$ $\therefore$ $2V_y = 74° 8'$

Also measured, where $n_r = 1{\cdot}6474$, $n_y = 1{\cdot}6576$:
$2H_{a.r} = 74° 44'$ Li $2H_{a.y} = 74° 6'$ Na $2H_{a.gr} = 73° 27'$ Tl $\therefore$ $2V_y = 74° 21'$

Luedecke obtained for Andreasberg:
$Bx_o \wedge \grave{c} = +3° 6'$ Li 3° 8′ Na 3° 12′ Tl; also
$2H_{a.y} = 79° 26'$ $2H_{o.y} = 114° 55'$ $\therefore$ $2V_y = 74° 19'$ and $\beta_y = 1{\cdot}6494$.

**Var.**—1. *Ordinary.* In glassy crystals of varied habit, usually with a greenish tinge. The angles in the prismatic and clinodome zones vary but little, e.g., 110 ∧ $\bar{1}10$ = 64° 47′, while 011 ∧ $01\bar{1}$ = 66° 37′, etc. Hence the position here taken exhibits the crystallographic relation to the following species as well as that of Rammelsberg and Groth, and the optical relations better, since in datolite (optically −), homilite (+), and gadolinite (+) the axis $\mathfrak{c}$ is nearly ‖ $\grave{c}$. Moreover, it is shown to be more natural by the habit of the crystals and the symbols of the chief forms. This similarity in the angles of zones named makes it easy to blunder in the orientation of crystals; several authors have added "new forms" based upon such an error.

2. *Compact massive.* White opaque cream-colored, pink; breaking with the surface of porcelain or Wedgewood ware. G. = 2·911, Hayes; 2·983, Chandler. From the L. Superior region (anal. 12)

3. *Botryoidal; Botryolite.* Radiated columnar, having a botryoidal surface, and containing more water than the crystals, but optically identical, Lcx., Bull., 8, 434, 1885. The original locality of both the crystallized and botryoidal was Arendal, Norway.

**Comp.**—A basic orthosilicate of boron and calcium; empirically $HCaBSiO_5$ or $H_2O.2CaO.B_2O_3.2SiO_2$; this may be written (Groth) $Ca(BOH)SiO_4$ = Silica 37·6, boron trioxide 21·8, lime 35·0, water 5·6 = 100.

**Anal.**—1, 2, Rg., Pogg., **47**, 175, 1839. 3, Lemberg, Zs. G. Ges., **24**, 250, 1872. 4, Preis, ib., **4**, 360, 1880 (after deducting 3·5 $CaCO_3$). 5, Bechi, quoted by Issel, Boll. Com. Geol., **10**, 536, 1879. 6, Molinari, Zs. Kr., **11**, 408, 1886. 7, Liweh, l. c. 8, Brugnatelli, l. c. 9, J. L. Smith, Am. J. Sc., **8**, 435, 1874. 10, Bodewig, Zs. Kr., **8**, 217, 1883. 11, Whitfield, Am. J. Sc., **34**, 285, 1887. 12, Chandler, ib., **28**, 13, 1859. 13, Rg., l. c. Also 5th Ed., p. 382.

| | | G. | $SiO_2$ | $B_2O_3$ | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. | Arendal, *cryst.* | | 37·65 | [21·24] | 35·41 | 5·70 | = 100 |
| 2. | Andreasberg | | 38·48 | [20·31] | 35·64 | 5·57 | = 100 |
| 3. | " *cryst.* | | 36·95 | [21·59] | 35·42 | 6·04 | = 100 |
| 4. | Kuchelbad, Bohemia | 2·894 | 38·40 | 20·89 | 34·62 | 6·09 | = 100 |
| 5. | Casarza, Ital. | 2·898 | 37·61 | 20·84 | 35·52 | [5·88] | $Al_2O_3$ 0·07, MgO 0·08 = 100 |
| 6. | Baveno | | 36·21 | 22·21 | 35·14 | 5·81 | = 99·37 |
| 7. | Serra dei Zanchetti | | 37·20 | [21·74] | 35·29 | 5·77 | = 100 |
| 8. | " " " | 2·997 | 37·89 | [21·23] | 35·04 | 5·84 | = 100 |
| 9. | San Carlos, Cal. | 2·988 | 38·02 | 21·62 | 33·87 | 5·61 | = 99·12 |
| 10. | Bergen Hill, N. J. | | 37·48 | 21·14 | 35·42 | 5·71 | $Fe_2O_3$ 0·12 = 99·87 |
| 11. | " " | | 35·74 | 22·60 | 35·14 | 6·14 | FeO 0·31 = 99·93 |
| 12. | L. Superior, *wh. compact* | 2·983 | 37·41 | [21·40] | 35·11 | 5·73 | $Al_2O_3$,$Fe_2O_3$ 0·35 = 100 |
| 13. | Arendal, *Botryolite* | | 36·08 | 19·34 | 35·22 | 8·63 | = 99·27 |

**Pyr., etc.**—In the closed tube gives off much water. B.B. fuses at 2 with intumescence to a clear glass, coloring the flame bright green. Gelatinizes with hydrochloric acid.

**Obs.**—Datolite is found chiefly as a secondary mineral in veins and cavities in basic eruptive rocks, often associated with calcite, prehnite, and various zeolites; sometimes associated with danburite; also in gneiss, dioryte, and serpentine; in metallic veins; sometimes also in beds of iron ore.

Found in Scotland, in trap, at the Kilpatrick Hills, Glen Farg in Perthshire, and in Salisbury Craigs; in a bed of magnetite at Arendal in Norway, and Utö in Sweden; at Andreasberg in diabase and in veins of silver-ores; at Niederkirchen and Sonthofen in Rhenish Bavaria (the *humboldtite*); at the Seisser Alp, Tyrol, and also at Theiss, near Claussen, in geodes in amygdaloid; in dioryte on the Rosskopf, near Freiburg in Baden; at Kuchelbad near Prague in Bohemia; Schneidemüllerskopf in the Ilmthal, Thuringia; Markirch in Alsace; in granite at Baveno near Lago Maggiore; at Toggiana in Modena, in serpentine; in highly complex crystals in the contact zone between the euphotide and the serpentine of the Serra dei Zanchetti; Fossa della Castellina near Porretta; Casarza in Liguria; Monte Catini in Tuscany, in chalcopyrite, also in cavities and veins in a red gabbro.

In the U. S. not uncommon with the diabase of Connecticut and Massachusetts. Thus at the Rocky Hill quarry, Hartford, Conn.; in the northeast part of Southington, in amygdaloid; also in Berlin, near Kensington; filling small cavities in amygdaloid at Meriden, usually of a deep yellow green, also in crystals; at Middlefield Falls, Conn.; in fine specimens at Roaring Brook, 14 miles from New Haven; at Tariffville in large crystals; Deerfield, Mass. Rare with diopside at De Kalb in St. Lawrence Co., New York; also with the danburite of Russell, but rare. In N. Jersey, at Bergen Hill, in splendid crystals; at Paterson, Passaic Co. In trappean rocks, both crystals and the opaque compact variety, in the Lake Superior region, at the Minnesota, Quincy, Marquette, Ash-bed, and other mines; at the Superior mine near Ontonagon and on Isle Royale. With grossular garnet, vesuvianite at San Carlos, Inyo Co., Cal.

Named from δατεῖσθαι, *to divide*, alluding to the granular structure of a massive variety. Werner introduced an *h* after the first *t* without reason, and most subsequent authors have followed him in this; but not Karsten, nor Leonhard who pronounced it wrong, nor Haidinger, Aikin, Jameson, and others.

Lévy gave the name *humboldtite* to crystals which he found to be *monoclinic*, datolite having been made orthorhombic by Haüy. Wollaston proved their identity with datolite.

**Alt.**—Haytorite is datolite altered to chalcedony, from the Haytor iron-mines in Devonshire, England.

**Ref.**—[1] Andreasberg-Toggiana, Pogg., **103**, 116, 1858; cf. Schröder, ibid., **94**, 235, 1855, **98**, 34, 1856; also Luedecke, Ueber Datolith, Halle, 1889. The form was early regarded as orthorhombic and hemihedral. Some authors make $m_x$ the unit prism, following Dbr., or *g* with Rg., and Groth, but the above position gives the simplest symbols, and also exhibits well the relation to the other species of the group; here $\grave{c} = 4\grave{c}$ Dana, 1868, 1872–4.

[2] Cf. Mlr., Min. 408, 1852; Sdr., l. c.; Dbr., l. c.; Dx., Min., **1**, 167, 1862; E. S. D., Min. Mitth., 1, 1874; Gdt., Index, **1**, 485, 1886, and Luedecke, l. c. Luedecke reviews with great minuteness the results of earlier observers, and adds many original observations with new forms, measurements of angles, and optical constants, etc., based upon the study of crystals from many localities; note, however, the criticism of Gdt. (Zs. Kr., **18**, 280, 1890), who shows that 17 of Luedecke's 30 new forms were probably determined on crystals of anglesite, and are hence to be rejected. The other 13 planes (not all above question, Gdt.) added by Luedecke are as follows: 8·11·0; 504; 0·13·18, 041; 421, 544, 763, 10·9·9; $\bar{1}\bar{0}$·7·14; 148; $\bar{1}$27, $\bar{1}$·2·15, $\bar{1}$32.

The literature of the subject includes the following leading articles: Schröder, Dauber, and other authors already referred to; also E. S. D., Bergen Hill, Am. J. Sc., **4**, 16, 1872; Toggiana, Andreasberg, etc., Min. Mitth., 1, 1874; Bombicci, Fosse della Castellina, Mem. Acc. Bologna, **8**, 311, 1877; also Serra dei Zanchetti, ib., **7**, 100, 1886; Vrba, Kuchelbad, Zs. Kr., **4**, 358, 1880, Theiss, **5**, 425, 1881; Lehmann, Niederkirchen, Zs. Kr., **5**, 529, 1881; Brugnatelli, Serra dei Zanchetti, Zs. Kr., **13**, 150, 1887; Negri, Casarza, Riv. Min., **1**, 45, 1887; Sansoni, Monte Catini, Att. Acc. Torino, **23**, 198, 1888; Franzenau, Seisser Alp, Zs. Kr., **14**, 390, 1889; Luedecke, l. c.

[3] L. c.; cf. earlier Bodewig, Pogg., **158**, 230, 1876, also Dx., Min., **1**, 170, 1862, N. R., 129, 1867. On thermal properties cf. Bodewig and Luedecke. On pyroelectricity, Hankel, Wied. Ann., **6**, 57, 1879.

## 402. HOMILITE. *S. R. Paijkull*, G. För. Förh., 3, 229, 1876.

Monoclinic. Axes: $\grave{a} : \overset{1}{\bar{b}} : \grave{c} = 0{\cdot}6249 : 1 : 1{\cdot}2824$; $\beta = 89° \, 21\frac{1}{2}' = 001 \wedge 100$ Des Cloizeaux[1].

$100 \wedge 110 = {}^*32° \, 0'$, $001 \wedge 101 = 63° \, 30\frac{1}{6}'$, $001 \wedge 011 = 52° \, 3'$.

**Forms**[2]:
*a* (100, $i\text{-}\bar{\imath}$)
*b* (010, $i\text{-}\grave{\imath}$)[3]
*c* (001, *O*)

*m* (110, *I*)
*μ* (120, $i\text{-}\grave{2}$)[3]
*x* (102, $-\frac{1}{2}\text{-}\bar{\imath}$)[3]
*π* (027, $\frac{2}{7}\text{-}\grave{\imath}$)[3]

*e* (013, $\frac{1}{3}\text{-}\grave{\imath}$)[3]
*M* (012, $\frac{1}{2}\text{-}\grave{\imath}$)
*g* (034, $\frac{3}{4}\text{-}\grave{\imath}$)[3] as tw. pl.
*o* (011, $1\text{-}\grave{\imath}$)
*ρ* (098, $\frac{9}{8}\text{-}\grave{\imath}$)[3]

*σ* (021, $2\text{-}\grave{\imath}$)
*Δ* (112, $-\frac{1}{2}$)
*γ* (111, $-1$)
*α* ($\bar{1}$11, 1)

*n* (124, $-\frac{1}{2}\text{-}\grave{2}$)
*Y* (122, $-1\text{-}\grave{2}$)[3]
*τ* (2·5·10, $-\frac{1}{2}\text{-}\frac{5}{2}$)[3]
*v* (1·6·12, $-\frac{1}{2}\text{-}6$)

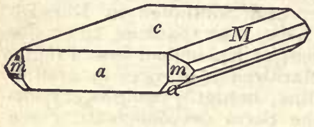
mm‴ = 64° 0′
μμ′ = 77° 20′
cx = 45° 24½′
ax = 43° 57′
MM′ = *65° 20′

gg′ = 87° 46′
oo′ = 104° 6′
σσ′ = 137° 24′
cA = 50° 6′
cγ = 67° 5′

cm = 89° 27′
cα = 68° 1′
AA′ = 47° 58¾′
γγ′ = 58° 26′
αα′ = 58° 52′

aA = 48° 52¼′
aM = 89° 27½′
aγ = 38° 14½′
a′α = 38° 33′
mM = *72° 54′

1. 2. 3.



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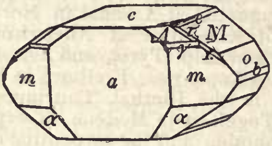

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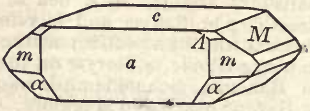

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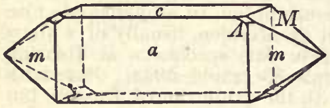
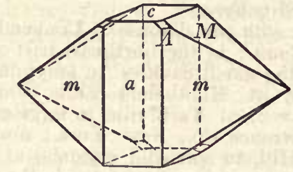
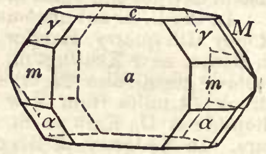






Figs. 1–6, Norway, Bgr.

Twins: tw. pl. (1) *c*, contact-twins with *c* as comp.-face; (2) *a*, similar, but with *a* as comp.-face; these two kinds of twins give nearly the same angles, so that in some cases the second kind could be explained as being twins with *c* as tw. pl. and *a* as comp.-face. Also (3) *g* (034) cruciform-twins with the vertical axes nearly at right angles, since *cc* = 87° 46′. (4) σ (021) somewhat uncertain, observed only on a single specimen where the association may have been accidental. Crystals often tabular ‖ *c*; also with *a* prominent; or octahedral in habit by development of *m* and *M* (012), or *m* and α ($\bar{1}11$).

Cleavage indistinct. Fracture subconchoidal. Brittle. H. = 5. G. = 3·38 Nobel; 3·34 Dmr. Luster resinous to vitreous. Color black, blackish brown. Streak grayish. Opaque or translucent only in thin splinters. Pleochroism distinct: $\mathfrak{c}$ (= $\acute{c}$) deep smoky gray or brownish yellow, $\mathfrak{b}$ (= $\grave{a}$) deep brownish red, $\mathfrak{a}$ (= $\bar{b}$) bluish green. Absorption, $\mathfrak{b} > \mathfrak{a} > \mathfrak{c}$. Optically +. Ax. pl. ⊥ *b*. $\mathfrak{a}$ (= $Bx_o$) nearly ⊥ *a* like datolite; $Bx_a$ almost ‖ $\acute{c}$. Dispersion horizontal, distinct. Also isotropic and amorphous by alteration.

$2H_{a.r}$ = 97° 5′ to 98° 22′, Dx.
$2H_{a.r}$ = 93° 8′ $2H_{o.r}$ = 125° 33′ ∴ $2V_r$ = 79° 59′ $2H_{a.bl}$ = 91° 12′ Bgr.

Des Cloizeaux shows that some crystals of homilite are throughout doubly refracting, others are composed of a green doubly refracting kernel surrounded by a yellowish crust of singly refracting material, while still others are entirely isotropic. Brögger describes a zonal structure in the crystals with varying position of the bisectrix, a few degrees (+ or −) on either side of the axis $\acute{c}$; moreover, sections ‖ *c* show a division into fields of hour-glass form. The zonal structure is in part original, in part a consequence of incipient alteration, which last also explains the variation in the position of the bisectrix, which takes place most rapidly in a direction ‖ *c*. The final result of the alteration is the amorphous material before noted. It is to be noted that the change from a crystalline anisotropic to the amorphous isotropic condition is common in certain of the minerals of the "Brevik" region in Norway (also elsewhere); cf. gadolinite, allanite, etc.

**Comp.**—$(Ca,Fe)_3B_2Si_2O_{10}$ or $(Ca,Fe)_3(BO)_2(SiO_4)_2$. If Ca : Fe = 2 : 1, this is equivalent to $2CaO.FeO.B_2O_3.2SiO_2$ = Silica 32·1, boron trioxide 18·7, iron protoxide 19·3, lime 29·9 = 100.

**Anal.**—1, Paijkull, l. c. 2, Damour, l. c. 3, G. V. Petersson, Öfv. Ak Stockh., **45**, 185, 1888.

| | | $SiO_2$ | $B_2O_3$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | CaO | MgO | $Na_2O$ | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | G. = 3·28 | 31·87 | [18·08] | 1·50 | 2·15 | 16·25 | 27·28 | 0·52 | 1·50[a] | 0·85 = 100 | [=100 |
| 2. | G. = 3·34 | 33·00 | [15·21] | — | — | 19·92[b] | 27·00 | — | 1·01 | 2·30 | $Ce_2O_3$, etc., 2·56 |
| 3. | | 31·83 | [16·51] | 2·72 | 0·88 | 16·74 | 29·54 | — | 0·75 | 0·79 | $Ce_2O_3$ 0·24=100 |

[a] Incl. $K_2O$ 0·41. [b] With MnO 0·74.

**Pyr., etc.**—B.B. homilite fuses very readily to a black glass; reacts for iron and boric acid. Completely decomposed by hydrochloric acid with gelatinization.

**Obs.**—Found on the island Stokö and the neighboring islands, Store-Arö and Övre-Arö in the Langesund fiord, Norway, in veins in augite-syenite, with meliphanite and erdmannite; also titanite, zircon, ægirite, löllingite; further, as accessory associated ~~species,~~ astrophyllite, melanocerite, nordenskiöldine, wöhlerite, hiortdahlite, molybdenite, etc. The largest well developed crystal of homilite found had a length of about 2 inches in the direction of the orthodiagonal axis; another imperfect crystal had a weight of 50 grams. Named from *ὁμιλεῖν, to occur together*, in allusion to its association with meliphanite and erdmannite.

**Alt.**—As noted above, changes to an isotropic and amorphous material, analogous to gadolinite, allanite, etc. See also erdmannite below.

**Ref.**—[1] Ann. Ch. Phys , **12**, 405, 1877, and G. För. Förh., **3**, 385, 1877. Brögger, on the basis of numerous measurements, has calculated the axial ratio: $\grave{a} : \bar{b} : \dot{c} = 0{\cdot}62426 : 1 : 1{\cdot}30126$, $\beta = 89° \ 50'$, for which, however, he does not claim great accuracy. He proposes to accept the following: $a : b : c = 0{\cdot}6245 : 1 : 1{\cdot}2835$, $\beta = 89° \ 38'$, Zs. Kr., **16**, 134, 1890.

[2] Dx., l. c. [3] Bgr., G. För. Förh., **9**, 247, 1887, and l. c.

Brögger argues that the negative side of the homilite crystals may properly correspond to the positive side of gadolinite—in other words, the angle $\beta = 89° \ 21'$ of homilite may correspond to $90° \ 33\frac{1}{2}'$ of gadolinite, and he finds confirmation for this view in the position of the acute bisectrix. Brögger also calls attention to an apparent relation in form, as inferred by him, between homilite and zircon.

ERDMANNITE *Esmark. Berlin*, Pogg., **88**, 162, 1853. Michaelsonite *Dana*, Min. p. 289, 1868. A name originally given to a mineral supposed to be allied to allanite occurring in the "Brevik region" in southern Norway.

As described by Berlin, it occurred on the island Stokö in granular or lamellar masses, embedded in feldspar, not in distinct crystals. G. = 3·01. Luster vitreous. Color dark brown. Translucent in thin splinters. The following incomplete analysis was made by Blomstrand. (This was quoted in 5th Ed., p. 414, as an independent species, and again on p. 288 as a variety of allanite.)

| $SiO_2$ | $Al_2O_3$ | Ce-oxides | $Y_2O_3$ | FeO | MnO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 31·85 | 11·71 | 34·89 | 1·43 | 8·52 | 0·86 | 6·46 | [4·28] = 100 |

An analysis was later (1862) made by Michaelson (also another incomplete by Nobel, ibid.), Öfv. Ak. Stockh., **19**, 512, 1862. The mineral was from Arö, and was supposed to be the same as that investigated by Berlin, and was also referred to allanite. H. = 4·5. G. = 3·44. Michaelson's analysis is as follows:

| $SiO_2$ | $ZrO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Y_2O_3$ | $Ce_2O_3$ | $(La,Di)_2O_3$ | BeO | MgO | CaO | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 29·21 | 5·44 | 2·81 | 6·42 | 1·63 | 9·79 | 15·60 | 4·27 | 0·45 | 14·93 | 2·45 | 5·50 = 98·50 |

Brögger concludes after a study of this, the typical erdmannite, that although a resemblance to allanite is at first noted, this is apparent only, and that the material analyzed, which microscopic examination proves to be heterogenous, consists of a mineral of the melanocerite group (p. 413) appearing in the sections brown and isotropic, intermixed with a doubly refracting mineral, which is probably homilite or a closely allied species.

Also, besides this, there is another mineral, which has been called erdmannite, analyzed by Engström and Damour, below, which is probably a somewhat altered form of a kind of homilite peculiar in containing a considerable amount of the cerium metals, and for which, consequently, Brögger uses the name *Cerhomilite*.

Engstrom's mineral was leek-green in color, with G. = 3·388. Damour's was brown, with H. = 4·5, G. = 3·03. Optically isotropic, amorphous.

Anal.—1, Engström, Inaug. Diss., Upsala, p. 28, 1877. 2, Damour, Ann. Ch. Phys., **12**, 411, 1877.

| | $SiO_2$ | $ZrO_2$ | $ThO_2$ | $B_2O_3$ | $Fe_2O_3$ | $Ce_2O_3$ | $(Di,La)_2O_3$ | $Y_2O_3$ | $Er_2O_3$ | FeO | CaO | BeO | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 25·15 | 2·14 | 9·93 | 8·18 | 3·01 | 9·00 | 8·66 | 1·64 | 0·50 | 3·16 | 18·78 | 3·16 | 1·44[d] | 5·25 = 100 |
| 2. | 28·01 | 3·47 | 0·45[a] | [5·54] | 3·31[b] | 19·28 | 8·09 | — | — | 6·77[c] | 11·00 | — | 1·98 | 12·10 = 100 |

[a] $SnO_2$. [b] $Al_2O_3$. [c] Incl. 1·35 MnO [d] Incl. 1·02 $Na_2O$.

Engström calculates the formula $R_2O_3.SiO_2 + 3RO.SiO_2 + 1\frac{1}{2}H_2O$ and remarks upon its similarity in formula to datolite and gadolinite, a conclusion to which Brögger also arrives in a somewhat different way.

Brögger mentions also that much so-called erdmannite is only zircon usually much altered; cf. Zs. Kr., **16**, 109, 1890, also Krantz, Pogg., **82**, 586, 1851.

**403. EUCLASE.** *Haüy; Delameth.*, J. Phys., **41**, 155, 1792 (without credit to Haüy); T. T., **2**, 254, 1797 (with credit to Haüy); *Haüy*, J. Mines, **5**, 258, 1799, Tr., **2**, 1801. Euklas *Germ.*

Monoclinic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}32369 : 1 : 0{\cdot}33324$; $\beta = 79° \, 44' \, 4'' = 001 \wedge 100$ Schabus[1].

$100 \wedge 110 = 17° \, 40' \, 2''$, $001 \wedge \bar{1}01 = 51° \, 7' \, 48''$, $001 \wedge 011 = 18° \, 9' \, 17''$

**Forms**[2]:

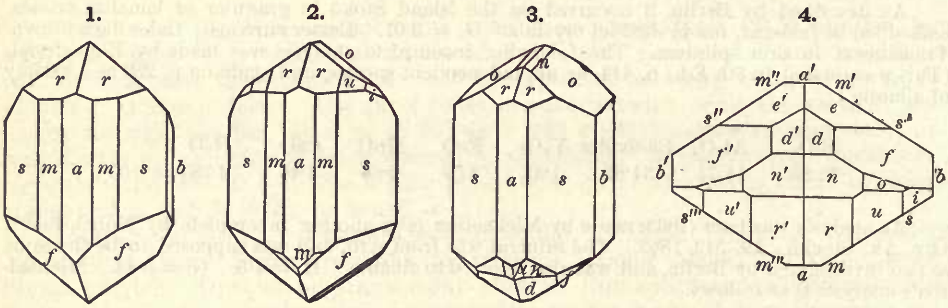
$a \ (100, \ i\text{-}\bar{\imath})$
$b \ (010, \ i\text{-}\grave{\imath})$
$c \ (001, \ O)$ rare
$\vartheta \ (20{\cdot}1{\cdot}0, \ i\text{-}\overline{20})$[3]
$\eta \ (16{\cdot}1{\cdot}0, \ i\text{-}\overline{16})$
$\zeta \ (910, \ i\text{-}\bar{9})$
$\epsilon \ (410, \ i\text{-}\bar{4})$
$\delta \ (320, \ i\text{-}\bar{\tfrac{3}{2}})$
$B \ (430, \ i\text{-}\bar{\tfrac{4}{3}})$
$h \ (650, \ i\text{-}\bar{\tfrac{6}{5}})$

$m \ (110, \ I)$
$Q \ (9{\cdot}10{\cdot}0, \ i\text{-}\grave{\tfrac{10}{9}})$
$\gamma \ (670, \ i\text{-}\grave{\tfrac{7}{6}})$
$l \ (340, \ i\text{-}\grave{\tfrac{4}{3}})$
$\beta \ (230, \ i\text{-}\grave{\tfrac{3}{2}})$[2]
$\alpha \ (590, \ i\text{-}\grave{\tfrac{9}{5}})$
$s \ (120, \ i\text{-}\grave{2})$
$L \ (130, \ i\text{-}\grave{3})$
$z \ (\bar{1}04, \ \tfrac{1}{4}\text{-}\bar{\imath})$
$g \ (\bar{1}02, \ \tfrac{1}{2}\text{-}\bar{\imath})$
$P \ (\bar{1}01, \ 1\text{-}\bar{\imath})$

$n \ (011, \ 1\text{-}\grave{\imath})$
$O \ (0{\cdot}11{\cdot}6, \ \tfrac{11}{6}\text{-}\grave{\imath})$[4]
$o \ (021, \ 2\text{-}\grave{\imath})$
$F \ (0{\cdot}11{\cdot}4, \ \tfrac{11}{4}\text{-}\grave{\imath})$[6]
$q \ (031, \ 3\text{-}\grave{\imath})$
$R \ (041, \ 4\text{-}\grave{\imath})$
$H \ (061, \ 6\text{-}\grave{\imath})$
$r \ (111, \ -1)$
$U \ (332, \ -\tfrac{3}{2})$[4]
$\mathfrak{a} \ (\bar{1}12, \ \tfrac{1}{2})$
$d \ (\bar{1}11, \ 1)$

$\kappa \ (\bar{2}21, \ 2)$[5]
$v \ (323, \ -1\text{-}\bar{\tfrac{3}{2}})$
$\Xi \ (\overline{12}{\cdot}3{\cdot}1, \ 12\text{-}\bar{4})$[4]
$\mu \ (211, \ 2\text{-}\bar{2})$[5]
$A \ (124, \ -\tfrac{1}{2}\text{-}\grave{2})$[4]
$u \ (121, \ -2\text{-}\grave{2})$
$i \ (141, \ -4\text{-}4)$
$\sigma \ (155, \ -1\text{-}\grave{5})$[4]
$\lambda \ (151, \ -5\text{-}\grave{5})$[5]
$e \ (\bar{2}31, \ 3\text{-}\tfrac{3}{2})$
$y \ (\bar{6}{\cdot}10{\cdot}1, \ 10\text{-}\tfrac{5}{3})$?

$\mathfrak{m} \ (\bar{5}93, \ 3\text{-}\tfrac{9}{5})$
$\Theta \ (\bar{1}21, \ 2\text{-}\grave{2})$
$f \ (\bar{1}31, \ 3\text{-}\grave{3})$
$\mathfrak{b} \ (\bar{1}42, \ 2\text{-}\grave{4})$
$D \ (\bar{1}62, \ 3\text{-}\grave{6})$[6]
$\mathfrak{c} \ (\bar{1}52, \ \tfrac{5}{2}\text{-}\grave{5})$
$p \ (\bar{2}{\cdot}13{\cdot}5, \ \tfrac{13}{5}\text{-}\grave{\tfrac{13}{2}})$?
$k \ (\bar{2}{\cdot}13{\cdot}4, \ \tfrac{13}{4}\text{-}\grave{\tfrac{13}{2}})$
$w \ (\bar{1}73, \ \tfrac{7}{3}\text{-}\grave{7})$
$x \ (\bar{1}82, \ 4\text{-}\grave{8})$
$\Psi \ (\bar{1}97, \ \tfrac{9}{7}\text{-}\grave{9})$[4]


1. 2. 3. 4.

Figs. 1, 2, 4, Brazil, Schabus. 3, Alps, Becke.

Hintze (Min., **2**, 186, 1890) quotes the following forms as having been observed by Arzruni on euclase from the Sanárka region in the Ural.

18·1·0, 25·2·0, 23·2·0, 11·1·0, 810, 710, 510, 310, 210, 10·7·0, 530, 540, 870, 980, 20·19·0, 780, 670, 570, 350, 10·19·0, 490, 4·11·0, 170, 3·28·0, 3·35·0; 047, 0·10·7, 0·13·6, 0·13·5, 0·30·11, 0·25·9?, 0·33·1; 24·25·24, 12·13·12, 11·10·11, 454, 13·17·13, 14·25·14, 22·25·22, $\bar{7}57$, $\bar{6}56$, $\overline{29}{\cdot}50{\cdot}29$, $\bar{3}{\cdot}10{\cdot}3$, $\bar{1}71$, $\bar{1}{\cdot}38{\cdot}1$. Also others by Miers: 15·1·0?, 610?, 560, 580, 11·18·0?

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $\epsilon\epsilon'''$ | = 9° 6' | $a'g$ | = 71° 7' | $cm$ | = 80° 13½' | $uu'$ | = 45° 40' |
| $\vartheta\vartheta'''$ | = 23° 58½' | $a'P$ | = 49° 8' | $m'd$ | = 47° 15½' | $ii'$ | = 80° 11½' |
| $hh'''$ | = 29° 44' | $nn'$ | = 36° 18½' | $cd$ | = 52° 31' | $\alpha\alpha'$ | = 17° 55' |
| $mm'''$ | = 35° 20' | $oo'$ | = 66° 31' | $su$ | = 35° 48' | $dd'$ | = 28° 17' |
| $ll'$ | = 133° 59' | $qq'$ | = 89° 3½' | $cu$ | = 45° 33½' | $\Theta\Theta'$ | = 53° 30' |
| $\beta\beta'$ | = 128° 55½' | $RR'$ | = 105° 21' | $c\theta$ | = 55° 55' | $ff'$ | = 74° 11' |
| $ss'$ | = 115° 0' | $cr$ | = 41° 59' | $rr'$ | = 23° 46' | $ee'$ | = 49° 44' |
| $a'z$ | = 85° 24' | $mr$ | = 38° 15' | | | | |

Only in crystals; habit prismatic with faces in zone *ab* vertically striated, and yielding an almost indefinite series of forms (see above).

Cleavage: *b* highly perfect; *a*, *c* rather difficult. Fracture conchoidal. Brittle. H. = 7·5. G. = 3·103 Kk.; 3·051, Sanárka, Erem; 3·089, 3·097 Brazil, Dx. Luster vitreous, somewhat pearly on the cleavage-face. Colorless, pale mountain-green, passing into blue and white. Streak uncolored. Transparent; occasionally subtransparent. Pleochroism distinct.

Optically +. Ax. pl. ∥ *b*. Bx nearly ∥ *P*, Dx. $Bx_a \wedge \dot{c} = +42° \, 16'$ Becke. Indices, Dx.

For Na $\alpha_y=1{\cdot}6520$ $\beta_y=1{\cdot}6553$ $\gamma_y=1{\cdot}6710$ $\therefore$ $2V_y=49°\ 37'$ $2E_y=87°\ 59'$
Measured $2E_r = 88°\ 47'$ $2E_{bl} = 88°\ 7'$ At 176° 2E increased 2° 18′

Electrified by friction.

**Comp.**—$HBeAlSiO_5 = Be(AlOH)SiO_4$ or $H_2O.2BeO.Al_2O_3.2SiO_2$ = Silica 41·3, alumina 35·2, glucina 17·3, water 6·2 = 100.

**Anal.**—Damour, C. R., **40**, 942, 1855. Also Berzelius, Mallet, 5th Ed., p. 380.

| | $SiO_2$ | $Al_2O_3$ | BeO | $H_2O$ | $Fe_2O_3$ | CaO | $SnO_2$ | F | |
|---|---|---|---|---|---|---|---|---|---|
| Brazil | ¼ 41·63 | 34·07 | 16·97 | 6·04 | 1·03 | 0·14 | 0·34 | 0·38 | = 100·60 |

**Pyr., etc.**—In the closed tube, when strongly ignited, gives off water. B.B. in the forceps cracks and whitens, throws out points, and fuses at 5·5 to a white enamel. Not acted upon by acids.

**Obs.**—Occurs in Brazil, in the province of Minas Geraes, mining district of Villa Rica, with topaz in chloritic schist; in the auriferous sands of the Orenburg district, southern Ural, near the river Sanárka, with topaz, corundum, cyanite, etc. One Ural crystal measured 3 in. by ⅜ in. In the Glossglockner region of the Austrian Alps on the Gamsgrube, with pericline, rutile, quartz on mica schist; also from the Möllthal with pericline.

Named by Haüy from εὖ, *easily*, and κλάσις, *fracture*, in allusion to the easy cleavage. Haüy states that his name, Euclase, was published by Daubenton in an early issue of his Tableau meth. de Minéraux; but the particular edition of the Tableau (of which several were issued) the author has not been able to learn. Delamétherie, after publishing, in 1792, the name and description, without crediting either to Haüy, in his *Théorie de la Terre*, in 1797, gives Haüy full credit.

First brought to Europe from S. America by Dombey, in 1785.

**Ref.**—[1] Ber. Ak. Wien, **8**, 507, 1852 (abstr. in Pogg., **88**, 608, 1853), also Denkschr., Ak. Wien, **6**, 57, 1854. [2] Sbs., l. c. Cf. also Kk. Min. Russl., 3, 97, 1858; Dx., Min., **1**, 480, 1862; Kk., ib., **10**, 104, 1889; Gdt., Index, **1**, 583, 1886. [3] Becke, Alps, Min. Mitth., **4**, 147, 1881. [4] Dx., Brazil, Bull. Soc. Min., **5**, 317, 1882. [5] Köchlin, Austr. Alps, Ann. Mus. Wien, **1**, 237, 1886, also doubtful $\omega$ ($\overline{10}\cdot6\cdot5$), 1·41·31; still more so 1·12·0, 1·10·0, 190, 270, 12·1·0, 23·1·0, 494, 131, 643. [6] Erem., Sanarka, Vh. Min. Ges., **24**, 244, 1888, Zs. Kr., **15**, 548, 1889.

**404. GADOLINITE.** Schwarzer Zeolith (fr. Ytterby) *Geyer*, Crell's Ann., 1788. Ytterbit (Silicate of Alumina, ox. Iron, and a new earth) *Gadolin*, Ak. H. Stockh., 1794; *Ekeberg*, ib., 1797 (naming the earth YTTRIA). Gadolinit *Klapr.* (Ak. Berlin, 1800), Beitr., 3, 52, 1802.

Monoclinic. Axes: $\grave{a} : \bar{b} : \grave{c} = 0{\cdot}62726 : 1 : 1{\cdot}32150$; $\beta = {*}89°\ 26\tfrac{1}{2}' = 001 \wedge 100$ Eichstädt[1].

$100 \wedge 110 = 32°\ 5\tfrac{5}{6}'$, $001 \wedge 101 = 64°\ 9\tfrac{1}{6}'$, $001 \wedge 011 = {*}52°\ 53'$.

**Forms**[2]:
$a\ (100,\ i\text{-}\bar{\imath})$
$b\ (010,\ i\text{-}\grave{\imath})$
$c\ (001,\ O)$
$m\ (110,\ I)$
$l\ (120,\ i\text{-}\grave{2})$

$t\ (102,\ -\tfrac{1}{2}\text{-}\bar{\imath})$
$u\ (\bar{1}04,\ \tfrac{1}{4}\text{-}\bar{\imath})$
$v\ (\bar{5}\cdot0\cdot12,\ \tfrac{5}{12}\text{-}\bar{\imath})$
$s\ (\bar{1}02,\ \tfrac{1}{2}\text{-}\bar{\imath})$
$r\ (\bar{1}01,\ 1\text{-}\bar{\imath})$
$e\ (014,\ \tfrac{1}{4}\text{-}\grave{\imath})^3$
$i\ (013,\ \tfrac{1}{3}\text{-}\grave{\imath})^3$

$w\ (012,\ \tfrac{1}{2}\text{-}\grave{\imath})$
$x\ (023,\ \tfrac{2}{3}\text{-}\grave{\imath})^3$
$q\ (011,\ 1\text{-}\grave{\imath})$
$y\ (021,\ 2\text{-}\grave{\imath})$
$\vartheta\ (1\cdot1\cdot10,\ -\tfrac{1}{10})^4$
$\kappa\ (113,\ -\tfrac{1}{3})^4$
$\lambda\ (225,\ -\tfrac{2}{5})^4$

$p\ (111,\ -1)$
$\alpha\ (221,\ -2)$
$\gamma\ (\bar{1}12,\ \tfrac{1}{2})$
$o\ (\bar{1}11,\ 1)$
$\delta\ (\bar{2}21,\ 2)$
$\epsilon\ (212,\ -1\text{-}\bar{2})$
$h\ (321,\ -3\text{-}\tfrac{3}{2})^3$

$\eta\ (\bar{2}12,\ 1\text{-}\bar{2})$
$\zeta\ (232,\ -\tfrac{3}{2}\text{-}\tfrac{3}{2})$
$g\ (231,\ -3\text{-}\tfrac{3}{2})^3$
$z\ (243,\ -\tfrac{4}{3}\text{-}\grave{2})$
$k\ (\bar{1}23,\ \tfrac{2}{3}\text{-}\grave{2})^3$
$\mu\ (\bar{1}22,\ 1\text{-}\grave{2})^4$
$f\ (\bar{1}21,\ 2\text{-}\grave{2})$

Also as given by Eichstädt, but of somewhat uncertain position, $\rho$ (115), $\pi$ ($\bar{1}14$), $\sigma$ ($\bar{2}25$), $\tau$ ($\bar{3}34$): doubtful, 8·10·5. Further Sjögren gives $\beta$ (112), $d$ (121), which are questioned by Eichstädt.

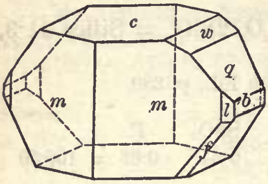
$mm''' = 64°\ 12'$
$mm' = {*}115°\ 48'\ 20''$
$ll' = 77°\ 7'$
$ct = 46°\ 12'$
$cu = 27°\ 54'$
$cs = 46°\ 47'$
$cr = 65°\ 4'$
$ar = 25°\ 29\tfrac{1}{2}'$
$ee' = 36°\ 34'$

$ii' = 47°\ 33'$
$ww' = 66°\ 54\tfrac{1}{2}'$
$qq' = 105°\ 46'$
$yy' = 138°\ 33'$
$c\beta = 50°\ 54'$
$cp = 67°\ 41'$
$c\alpha = 78°\ 11'$
$cm = 89°\ 32'$
$c\pi = 32°\ 0'$

$c\gamma = 51°\ 29'$
$co = 68°\ 30'$
$c\delta = 79°\ 5'$
$c\mu = 59°\ 38\tfrac{1}{2}'$
$cf = 73°\ 50'$
$ap = 38°\ 3\tfrac{1}{2}'$
$po = 103°\ 37\tfrac{1}{2}'$
$a'o = 38°\ 19'$

$\beta\beta' = 48°\ 43'$
$pp' = 58°\ 53\tfrac{1}{2}'$
$\alpha\alpha' = 62°\ 41'$
$\gamma\gamma' = 49°\ 8'$
$oo' = 59°\ 16'$
$\delta\delta' = 62°\ 54'$
$\mu\mu' = 84°\ 52'$
$ff' = 97°\ 22'$

Crystals rough and coarse; commonly prismatic and terminated by *c*; sometimes acutely terminated by certain of the pyramids, as *p* (111), *α* (221), *o* (111), or *δ* ($\bar{2}21$). Twinning lamellæ sometimes observed after ignition, Ytterby, Petersson. Also in masses.



Cleavage none. Fracture conchoidal or splintery. Brittle. H. = 6·5–7. G. = 4·0–4·5; normally 4·36–4·47 of anisotropic; 4·24–4·29 isotropic, Petersson; after heating somewhat increased (see below). Luster vitreous to greasy. Color black, greenish black, also brown; in thin splinters nearly transparent, and usually grass-green to olive-green. Streak greenish gray.

Normally doubly refracting and crystalline in structure, but usually isotropic and amorphous. Pleochroism feeble in green varieties; distinct in brown. Optically +. Double refraction normally strong, but variable. Ax. pl. ∥ *b*. $\mathfrak{a}$ (= $Bx_o$) nearly ⊥ *a* like datolite and homilite; $Bx_{a.y} \wedge \dot{c} = +\ 4°$ Dx. $Bx_a \wedge \dot{c} = +\ 7\frac{1}{2}°$ to 9° in green varieties, 12° to 13° in brown (see below) Eichstädt. Axial angles:

$2H_{a.r} = 106°\ 6'$ $2H_{a.y} = 107°\ 18'$ $2H_{a.bl} = 109°\ 27'$ Dx.

$2H_{a.y} = 105°$ $2H_{o.y} = 118°\ 20'$ $\therefore\ 2V_y = 85°\ 28'$ Eichstädt.

**Var.**—In part crystalline in molecular structure, as well as in form, doubly refracting, with optical characters as noted above; color green in thin splinters. Here belongs the normal gadolinite from Hitterö and from Stora Skedevi in Dalarne, Sweden.

More commonly completely amorphous and isotropic, both in the massive form and also in crystals; also both kinds in the same specimen, and again, as seen in a thin section, with brown spots in an isotropic ground-mass. This change in optical structure is due to alteration involving a molecular rearrangement simply, i.e., by paramorphism, for both varieties have the same composition (anal. 1, 2 Petersson). By heating, the amorphous mineral is transformed into the anisotropic and crystalline, and this is accompanied by strong phosphorescence (evolution of light and heat, see below), at the same time there is an increase in the specific gravity and the green color is changed in the thin section to colorless or reddish, and the mineral no longer gelatinizes with acid. The anisotropic mineral is also changed by heating, for while there is no striking phosphorescence, the specific gravity becomes greater, there is an increase in the strength of the double refraction, the color is paler, and gelatinization no longer takes place (Petersson).[5]

Both the anisotropic and isotropic forms become brown by alteration, involving oxidation of the iron and assumption of water. For the former the brown mineral so formed is pleochroic with a larger angle of extinction; for the latter it is still isotropic.

The following are specific gravity determinations: 1, 2, 3, Ytterby; 4, Hitterö; see also the table of analyses.

| | | 1, H. Rose | 2, Church | 3, Rg. | 4, Rg. |
|---|---|---|---|---|---|
| Before ignition | G. = | 4·097, 4·226 | 4·233 | 4·212 | 4·449 |
| After " | G. = | 4·287, 4·456 | 4·356 | 4·419 | 4·668 |

**Comp.**—$Be_2FeY_2Si_2O_{10}$ or $2BeO.FeO.2Y_2O_3.2SiO_2$; written as a basic orthosilicate (Groth) analogous to datolite, etc., the formula is $Be_2Fe(YO)_2(SiO_4)_2$. Percentage composition: Silica 23·9, yttrium oxides (molec. wght. 260) 51·8, iron protoxide 14·3, glucina 10·0 = 100.

The yttrium earths or "gadolinite-earths" (partly replaced by the oxides of cerium, lanthanum, and didymium) form a complex group which has been much studied both chemically and spectroscopically by many chemists, Marignac, Delafontaine, L. de Boisbaudran, Nilson, Cleve, Crookes, and others. The group contains erbium in considerable amount, and also several new elements (ytterbium, scandium, etc.) of more or less definite character have been separated.

Rammelsberg urges that the determinations of the atomic weight of the yttrium metals in gadolinite vary widely; thus he gives the limits from 97·5 Ytterby, Humpidge, and 100 Ytterby, Rg., to 109 Hitterö Rg., and 126 Colorado, Eakins. See further beyond, after analyses, where it appears that for the majority of cases the atomic weight is about 106 or the molecular weight 260.

Prominent recent articles on the gadolinite earths are the following: Cleve and Höglund, Ak. H. Stockh., Bihang, **1**, No. 8, 1872, **2**, No. 12, 1874. Marignac, Bibl. Univ., **61**, 283, 1878, **64**, 97, 1878, C. R., **87**, 578, 1878. Delafontaine, Bibl. Univ., **51**, 48, 1874, **61**, 273, 1878. Nilson, C. R., **88**, 642, 645, 1879, **91**, 118, 1880. Cleve, Öfv. Ak. Stockh., **36**, No. 7, 3, 1879. Crookes, Proc. Roy. Soc., **40**, 502, 1886.

On the atomic weights of the yttrium metals, see Nordenskiöld, G. För. Förh., **8**, 442, 1886 also Rg., l. c.

**Anal.**—1-9, Petersson, G. För. Förh., **12**, 275 *et seq.*, 1890; also given (except 9) in Öfv. Ak. Stockh., **45**, 179, 1888, but in somewhat different form. 10, 11, Blomstrand, Lunds Univ. Årsskrift, **24** No. 3, 1887-88. 12, Wallin, ibid. 13, 14, Rg., Ber. Ak. Berlin, 549, 1887. 15, 16, Humpidge and Burney, J. Ch. Soc., **35**, 117, 1879. 17, Lindström, G. För. Förh., **2**, 218, 1874. 18, 19, Genth, Am. J. Sc., **38**, 198, 1889 (also of each a second partial anal.). 20, L. G. Eakins, ibid., p. 478, also Bull., **64**, p. 40, U. S. G. Surv. 21, 22, L. G. Eakins, Proc. Col. Soc., **2**. Pt. 1, 32, 1885. 23, 24, Pisani, Dx., Min., **2**, XIII, 1874. For earlier anals. see 5th Ed., p. 294, 295.

| | G. | $SiO_2$ | $ThO_2$ | $Y_2O_3$[a] | $Ce_2O_3$ | $(Di,La)_2O_3$ | $Fe_2O_3$[b] | FeO[c] | BeO | CaO[d] | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Hitterö | 4·509 | 24·28 | 0·39 | 46·51 | 1·21 | 4·26 | 0·84 | 11·35[c] | 9·65 | 0·64 | 0·17 | 0·54 | = 99·84 |
| 2. Ytterby | 4·242 | 24·35 | 0·30 | 45·96 | 1·65 | 3·06 | 2·03[b] | 11·39[c] | 10·17 | 0·30 | 0·17 | 0·52 | = 99·90 |
| 3. " | 4·288 | 23·88 | 0·41 | 45·30 | 3·84 | 2·57 | 0·60 | 12·89 | 9·91 | 0·54[d] | 0·15 | 0·37 | = 100·46 |
| 4. Broddbo | 4·225 | 23·52 | 0·37 | 35·78 | 4·42 | 11·42 | 2·26 | 10·83[c] | 9·89 | 0·03 | 0·49 | 1·40 | = 100·41 |
| 5. G. Kårarfvet | 4·235 | 24·19 | 0·32 | 40·73 | 4·51 | 4·45 | 1·84 | 10·70[c] | 10·13 | 0·09 | 0·20 | 1·46 | = 98·62 |
| 6. N. Kårarfvet | 4·002 | 23·58 | *tr.* | 36·71 | 6·61 | 7·40 | 2·02 | 9·44 | 10·47 | 0·56[d] | 0·35 | 2·38 | = 99·52 |
| 7. Torsåker | 4·24 | 24·55 | 0·75 | 46·08 | 0·52 | 4·13 | 1·01[b] | 12·82[c] | 9·10 | 0·69 | 0·35 | 0·80 | = 100·80 |
| 8. St. Tuna | 4·062 | 24·40 | 0·83 | 38·09 | 2·69 | 7·00 | 4·07[b] | 9·17[c] | 8·87 | 1·87 | 0·22 | 2·38 | = 99·59 |
| 9. Malö | 4·020 | 23·32 | 0·88 | 35·95 | 2·33 | 12·01 | 3·07 | 5·90[c] | 9·30 | 2·02[d] | 0·13 | 3·36 | = 98·27 |
| 10. Hitterö | 4·33 | [g] 23·72 | 0·35 | 45·62 | | 6·67 | — | 12·35[c] | 10·10 | 0·63 | 0·19 | — | PbO 0·05 = 99·68 |
| 11. Ytterby | 4·096 | [g] 23·84 | 0·31 | 47·06 | 0·92 | 3·33 | 0·33[b] | 13·09[c] | 10·55 | 0·42[d] | 0·18 | — | PbO 0·05 = 100·08 |
| 12. " | 4·05 | 23·70 | 0·25 | 44·39 | | 7·21 | — | 13·00 | 10·16 | 0·53 | 0·22 | — | = 99·46 |
| 13. Hitterö | 4·448 | 24·36 | — | 45·51 | | 7·01 | 2·85 | 11·50 | 8·58 | 0·36 | — | 0·50 | = 100·67 |
| 14. Ytterby | 4·212 | 25·35 | — | 38·13 | | 13·55 | 4·07 | 7·47 | 10·03 | 0·57 | — | 1·34 | = 100·51 |
| 15. Hitterö | | 24·24 | — | 41·50[a] | | 9·93 | — | 16·04 | 6·56[e] | 1·02[d] | — | 0·62 | = 99·91 |
| 16. Ytterby | | 25·16 | — | 39·27[a] | | 6·52 | 2·15 | 12·40 | 9·39[e] | 1·11 | — | 2·32 | $P_2O_5$ 1·28 = 99·60 |
| 17. St. Tuna | 4·11 | 23·65 | — | 34·58[a] | 4·80 | 14·40 | 0·14[b] | 8·37[c] | 10·94 | 0·27 | 0·25 | 3·03 | = 100·43 |
| 18. Llano Co.* | 4·201 | 22·87 | *undet.* | 44·35 | 2·65 | 5·22 | 0·28[b] | 13·91[c] | 9·24 | 0·71[d] | 0·35[f] | 0·72[h] | = 100·30 |
| 19. " " | 4·254 | 22·80 | " | 44·45 | 2·66 | 5·01 | 0·31[b] | 13·11 | 9·19 | 0·82[d] | 0·35 | 0·79[h] | insol. 0·93 = 100·42 |
| 20. " " | 4·239 | 23·79 | 0·58 | 41·55 | 2·62 | 5·22 | 0·96 | 12·42 | 11·33 | 0·74 | *tr.* | 1·03 | $P_2O_5$ 0·05 = 100·29 |
| 21. Douglas Co., Col. | 4·56 | 22·13 | 0·89 | 22·24[a] | 11·10 | 21·23 | 3·47[b] | 10·43 | 7·19 | 0·48[d] | 0·46[f] | 0·86 | = 100·48 |
| 22. " " | 4·59 | 21·86 | 0·81 | 28·43[a] | 6·87 | 19·10 | 4·13[b] | 11·47[c] | 5·46 | 0·63 | 0·52[f] | 0·74 | = 100·02 |
| 23. Finbo | 4·083 | 23·25 | — | 42·75 | | 8·65 | 2·82[b] | 12·40 | 8·97 | 1·26[d] | — | 1·03 | = 101·03 |
| 24. Unknown | 4·119 | 23·10 | — | 35·60 | | 15·40 | 3·05[b] | 10·60 | 9·58 | 0·96[d] | — | 1·10 | = 99·39 |

[a] Yttrium earths, Molec. Weight:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 13 | 14 | 26 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 260·7 | 260·8 | 257·5 | 251·6 | 241·08 | 246·9 | 259·6 | 258·4 | 262·2 | 257·5 | 260 | 266 | 248 | 260 | 296 | 294 |

$Er_2O_3$ has been separately determined, as follows: in 15, 10·91 p. c.; in 16, 4·11; in 17, 11·65; in 21, 12·74; in 22, 15·80.

[b] Includes a little $Al_2O_3$ in some cases, viz.: in 2, 0·58 p. c.; 8, 0·79; 11, 0·12; 17, 0·14; 18, 0·28; 19, 0·31; 21, 2·34; 22, 0·54; 23, 2·82; 24, 3·05.

[c] Includes MnO: in 1, 0·19 p. c.; 2, 0·25; 4, 0·09; 5, 0·41; 7, 0·16; 8, 0·32; 9, 0·12; 10, 0·16; 11, 0·12; 17, 0·19; 18, 0·22; 19, 0·18; 22, 0·11.

[d] Includes MgO: in 1, 0·22 p. c.; 3, 0·12; 6, 0·10; 8, 0·06; 9, 0·18; 10, 0·07; 11, 0·07; 15, 0·23; 18, 0·07; 19, 0·11; 21, 0·14; 22, 0·16; 23, 0·33; 24, 0·11.

[e] $Be_2O_3$. [f] Incl. $K_2O$: in 18, 0·15; 19, 0·12; 21, 0·18; 22, 0·20. [g] Incl. $ThO_2$. [h] Ign.

**Pyr., etc.**—The glassy isotropic variety is unchanged in the closed tube, but if heated B.B. the assay gives for a moment a bright light, as if it had taken fire, swells up, cracks open, and becomes grayish green in color without fusing; it has then become anisotropic. The normal anisotropic variety swells into cauliflower-like ramifications and becomes white, rarely glowing (see above, p. 510); the isotropic form, if the alteration has gone too far, also fails to glow. With borax gives an iron reaction. Only slightly acted upon by salt of phosphorus. Decomposed by hydrochloric acid with gelatinization, but not after it has been heated and exhibited the accompanying phosphorescence.

**Obs.**—Occurs principally in pegmatyte veins, often associated with allanite and other minerals containing rare elements, also fluorine compounds. Found at the quarries of Kårarfvet, Broddbo, and Finbo, near Falun in Sweden; also at Ytterby, near Stockholm; chiefly in rounded masses, which are often encircled with a yellow crust, and embedded in coarse-grained granite. At Kårarfvet crystals have been obtained 4 in. long; also in the Torsåker parish, Gestrikland; Karlberg in the Stora Tuna parish, and at St. Skedevi, Dalarne, Sweden. On the island Hitterö in the Flecke fiord, southern Norway, crystals sometimes 4 in. across; on Malö, southeast of Grimstad, Norway. Sparingly in granite veins of the Radauthal in the Harz, associated with allanite (orthite): Schreiberhau in the Riesengebirge, Silesia; Baveno, Italy, in granite; Newcastle, Mourne Mts., Ireland. It is also stated to have been obtained at

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* First announced as from Burnet Co., Texas, but later shown to have come from Llano Co.

Disko in Greenland; in trap near Galway, Ireland; embedded in granite in Ceylon; but these need confirmation.

In Llano Co., Texas, 5 miles south of Bluffton on the west bank of the Colorado River. It occurs in nodular masses and rough crystals, sometimes up to 40 or 60 pounds in weight, but averaging half a pound, and usually with a reddish or yellow altered exterior. It is embedded in a quartzose pegmatyte, and is associated with allanite, yttrialite, nivenite, fergusonite, cyrtolite, gummite, fluorite, molybdenite, magnetite, feldspar, quartz, mica, etc. The crystals are elongated in the direction of the vertical axis (in one case 10 inches long) and are characterized by the presence of the pyramids *p* (111), *o* ($\bar{1}$11) and *α* (221), the basal plane being nearly or quite wanting; cf. Hidden & Mackintosh, Am. J. Sc., **38**, 474, 1889. At Devil's Head Mt., Douglas Co., Colorado.

According to Petersson the only anisotropic gadolinite is that from Hitterö, Norway, and Stora Skedevi, Dalarne, Sweden; that of the other localities noted is isotropic.

Named after the Swedish chemist, J. Gadolin (1760–1852).

**Alt.**—As noted above, the original crystalline anisotropic gadolinite is for the most part changed molecularly to an amorphous isotropic form. This does not necessarily involve a chemical change, which, however, is involved in the change (p. 510) from the green to the brown variety. Further, the mineral is often altered on the exterior to a brownish red color with waxy luster and further to a yellowish or yellowish brown earthy ocher-like or powdery substance.

The altered gadolinite from Llano Co., Texas, has been examined by Genth (Am. J. Sc., **38**, 198, 1889) with the following results: G. = 3·592.

| $SiO_2$ | $Y_2O_3,Ce_2O_3$ | $Fe_2O_3$ | BeO | MnO | CaO | ign. | quartz |
|---|---|---|---|---|---|---|---|
| 22·11 | 39·20 | 14·53 | 6·03 | 0·22 | 5·58 | 9·30 | 1·03 = 98·00. |

E. Goldsmith has given (J. Analyt. Ch., **4**, 22, 1890) the name *metagadolinite* to a similar alteration product, red in color, with G. = 3·494 and for which he obtained:

$SiO_2$ 18·15 $Ce_3O_4$ 20·66 $Fe_2O_3$ 26·03 YO 21·85 CaO 3·64 MgO 0·21 $H_2O$ 9·76 = 100·30

**Ref.**—[1] Hitterö, Ak. H. Stockh., Bih., **10** (2), No. 18, 1885; the form was first proved to be monoclinic by Dx., Ann. Ch. Phys., **18**, 305, 1869, Min., **2**, xi, 1874. Some early authors made it monoclinic, others orthorhombic. Dx. also early called attention to the isotropic and anisotropic varieties. [2] See Dx., l. c., and Min., **2**, p. xi, 1874. Cf. also Waage, Jb. Min., 696, 1867; Rath, Radauthal, Pogg., 144, 576, 1871; Gdt., Index, **1**, 65, 1887. [3] H. Sj., Öfv. Ak. Stockh., **39**, No. 7, 47, 1882. [4] Eichstädt, l. c. [5] G. För. Förh., **12**, 275–347, 1890.

### 405. YTTRIALITE. *W. E. Hidden* and *J. B. Mackintosh*, Am. J. Sc., **38**, 477, 1889.

Massive. Amorphous.

No cleavage. Fracture conchoidal and splintery. Brittle. H. = 5–5·5. G. = 4·575. Luster vitreous to greasy. Color on the fresh fracture olive-green, tending to drab; this changes on the exterior by alteration to orange-yellow. Translucent, made partially opaque by the presence of minute ragged lines penetrating the mass in all directions.

**Comp.**—A silicate of thorium and the yttrium metals chiefly; oxygen ratio of silicon to bases = 4 : 3, hence equivalent to $R_2O_3.2SiO_2$.

**Anal.**—

| $SiO_2$ | $ThO_2$ | $Y_2O_3$[a] | $Ce_2O_3$ | $(La,Di)_2O_3$ | $UO_3$ | $Al_2O_3$ | FeO | CaO | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|
| 29·17 | 12·00 | 46·50 | 1·86 | 2·94[b] | 0·83 | 0·55 | 3·66[c] | 0·60 | 0·79 | PbO 0·85 = 99·75 |

[a] Yttrium earths including:
A, 22·67 p. c., at. wght. 110·3; B, 5·30, at. wght. 110·53; C, 4·50, at. wght. 114·9; D, 14·03, at. wght. 120.

[b] At. weight 162. [c] Incl. 0·77 MnO.

**Pyr.**—Decrepitates violently in the Bunsen burner; falls to powder when strongly ignited, becoming snuff-brown, infusible and insoluble. Before heating the mineral is soluble in hydrochloric acid.

**Obs.**—Occurs associated with and often implanted upon the gadolinite of Llano Co., Texas (see above). It is sometimes in masses of considerable size (up to 10 pounds); these are orange-yellow on the surface by alteration; this serves to distinguish it from the similar masses of gadolinite associated with it, which are brick-red on the surface. A white crystalline mineral, perhaps tengerite, is observed in the cracks.

Named in allusion to the composition from *yttrium* and *λίθος*, *stone*, the yttrium earths being the chief bases.

Yttrium Silicate *Damour*, L'Institut, 78, 1853. H. = 5–6; scratches glass. G. = 4·391. Color brown. Probably a silicate of yttrium, but composition not determined. B.B. whitens, but infusible. Not soluble in salt of phosphorus. Sulphuric acid heated to 300° C. decomposes it, leaving a siliceous residue.

From the diamond sands of Bahia, Brazil.

## 13. Epidote Group. Orthorhombic and Monoclinic.

Basic Orthosilicates, $H\overset{II}{R}_2\overset{III}{R}_3Si_3O_{13}$ or $\overset{II}{R}_2(\overset{III}{R}OH)\overset{III}{R}_2(SiO_4)_3$,
$\overset{II}{R} = Ca,\overset{II}{Fe}$; $\overset{III}{R} = Al,\overset{III}{Fe},\overset{III}{Mn},Ce$, etc.

### α. *Orthorhombic Section.*

| | | | $\breve{a} : \bar{b} : \acute{c}$ |
|---|---|---|---|
| **406.** | **Zoisite** | $Ca_2(AlOH)Al_2(SiO_4)_3$ | 0·6196 : 1 : 0·3429 |

### β. *Monoclinic Section.*

| | | | $\grave{a} : \bar{b} : \acute{c}$ | $\beta$ |
|---|---|---|---|---|
| **407.** | **Epidote** | $\begin{cases} mCa_2(AlOH)Al_2(SiO_4)_3 \\ nCa_2(FeOH)Fe_2(SiO_4)_3 \end{cases}$ | 1·5787 : 1 : 1·8036 | 64° 37′ |
| **408.** | **Piedmontite** | $Ca_2(AlOH)(Al,Mn)_2(SiO_4)_3$ | 1·6100 : 1 : 1·8326 | 64° 39′ |
| **409.** | **Allanite** | $(Ca,Fe)_2(AlOH)(Al,Ce,Fe)_2(SiO_4)_3$ | 1·5509 : 1 : 1·7691 | 64° 59′ |

Although Zoisite and Epidote belong to different crystalline systems, they are near each other in angle as well as composition, and are to be regarded as essentially isomorphous, similarly to the monoclinic and triclinic feldspars; see further p. 517.

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**406. ZOISITE.** Saualpit (fr. the Saualpe in Carinthia) *v. Zois*, and *Carinthian Mineralogists*, before 1806, *Klapr.*, Beitr., **4**, 179, 1807. Zoisite (fr. Carinthia) *Wern.*, 1805. Var. of Epidote *H.*, J. Mines, **19**, 365, 1806, *Bernhardi*, Moll's Efem., **3**, 24, 1807. Illuderit *Leonh.*, Syst. Tab., p. IV, 1806. Lime-Epidote. Zoisite, sp. distinct from Epidote, *Brooke*, Ann Phil., **5**, 382, 1823. Thulite *Brooke*, Cryst., 494, 1823. Unionite *Silliman*, Am. J. Sc. **8**, 384, 1849.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c}$ = 0·61963 : 1 : 0·34295 Tschermak and Sipöcz[1].
100 ∧ 110 = 31° 47′, 001 ∧ 101 = 28° 57$\frac{5}{6}$′, 001 ∧ 011 = 18° 55$\frac{5}{6}$′.

**Forms**[2]:
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)
*k* (310, *i*-3̄)
*q* (210, *i*-2̄)
*n* (530, *i*-$\frac{5}{3}$)
*m* (110, *I*)
*r* (120, *i*-2̆)
*t* (130, *i*-3̆)
*l* (140, *i*-4̆)
*d* (101, 1-ī)
*f* (011, 1-ĭ)
*u* (021, 2-ĭ)
*x* (041, 4-ĭ)
*e* (061, 6-ĭ)
*o* (111, 1)
*v* (121, 2-2̆)
*p* (131, 3-3̆)
*z* (161, 6-6̆)?

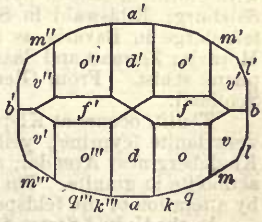
On the relation in form of zoisite to epidote, see under epidote, p. 517.

*kk‴* = 23° 20′
*qq‴* = 34° 26′
*mm‴* = 63° 34′
*rr′* = 77° 48′
*tt′* = 56° 33′
*ll′* = 43° 57′
*dd′* = 57° 56′
*ff′* = 37° 52′
*uu′* = 68° 54′
*xx′* = 107° 49′
*ee′* = 128° 10′
*oo′* = 55° 16′
*oo″* = 66° 8′
*oo‴* = 33° 24′
*vv′* = 49° 4′
*pp′* = 42° 11′
*vv‴* = 61° 56′
*pp‴* = 83° 59′

Crystals prismatic, deeply striated or furrowed vertically, and seldom distinctly terminated. A want of symmetry in the development of the pyramidal planes common. Also massive; columnar to compact.

Cleavage: *b* very perfect. Fracture uneven to subconchoidal. Brittle. H. = 6–6·5. G. = 3·25–3·37. Luster vitreous; on the cleavage face, *b*, pearly. Color grayish white, gray, yellowish brown, greenish gray, apple-green; also peach-blossom-red to rose-red. Streak uncolored. Transparent to subtranslucent.

Pleochroism strong in pink varieties, see below. Optically +. Ax. pl. usually ∥ *b*; also ∥ *c*. Bx ⊥ *a*. Dispersion strong, $\rho < v$; also $\rho > v$. Axial angle variable even in the same crystal, also increasing rapidly with rise of temperature.



Tennessee.

| | | | | |
|---|---|---|---|---|
| Bavaria | $2E_r$ = 42° to 44° | $2E_{gr}$ = 50° to 52° | $2E_{bl}$ = 65° to 70° | $\beta_r$ = 1·70 Dx.[3] |
| U. S. | 2E = 94° 59′ at 21½° C. | 100° 12′ at 95½° | 104° 38′ at 146½° | 107° 28′ at 195°·8 Dx. |
| Carinthia | $\alpha$ = 1·696 | $\beta$ = 1·696 | $\gamma$ = 1·702 Lévy-Lcx. | |

The variation in optical characters is probably to be explained (Tschermak) by the existence of twinning lamellæ with (031) as tw. pl. ($c \wedge 031 = 45° 49'$), hence having the axis $\breve{a}$ in common but the $\bar{b}$ axes inclined about 90° to each other; the lamellæ, however, have *m* or *l* (140) as face of contact. Another system of tw. lamellæ with (905) as tw. pl. may also be present.

**Var.**—1. *Ordinary.* Colors gray to white and brown; also green. Usually in indistinct prismatic or columnar forms; also in fibrous aggregates. For zoisite of Rauris, G. = 3·226 Breith.; Saualpe. 3·345 Id.; Moravia, 3·336 Id.; Faltigl, 3·381 Id.; Titiribi, 3·381 Id. *Unionite* is a very pure zoisite, anal. 4.

2. *Rose-red,* or *Thulite.* G. = 3·124; fragile; pleochroism strong: 𝔠 (= $\breve{a}$) yellow, 𝔟 (= $\bar{b}$) deep rose, 𝔞 (= $\dot{c}$) light rose, Lcx.[3]

3. *Compact, massive.* Includes the essential part of most saussurite, which has arisen from the alteration of feldspar. See p. 515.

**Comp.**—$HCa_2Al_3Si_3O_{13}$ or $4CaO.3Al_2O_3.6SiO_2.H_2O$ = Silica 39·7, alumina 33·7, lime 24·6, water 2·0 = 100. The alumina is sometimes replaced by iron, thus graduating toward epidote, which has the same general formula.

**Anal.**—1, 2, Sipöcz, Ber. Ak. Wien, **82** (1), 141, 1880. 3, Koenig, Proc. Ac. Philad., 83, 1878. 4, Brush, Am. J. Sc., **26**, 69, 1858. 5, Luedecke, Zs. G. Ges., **28**, 258, 1876. 6–11, Rg., Pogg., **100**, 133, 1857, and Min. Ch., 591, 1875. 12, Heddle, Min. Mag., **5**, 11, 1882. 13, Gmelin, quoted by Hermann, J. pr. Ch., **43**, 84, 1848. 14, Pisani, C. R., **62**, 100, 1866. Also Cullakenee, Clay Co., N. C., Koenig and Genth, Am. Phil. Soc., **13**, 374, 1873; California, Becker, Mon. **13**, p. 79, U. S. G. Surv. Further 5th Ed., p. 291.

| | G. | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | CaO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Ducktown | 3·367 | $\frac{2}{2}$ | 39·61 | 32·89 | 0·91 | 0·71 | 24·50 | 0·14 | 2·12 | = 100·88 |
| 2. Pregratten | 3·338 | $\frac{3}{3}$ | 39·75 | 31·45 | 0·85 | 1·83 | 24·05 | 0·13 | 2·61 | = 100·67 |
| 3. Leiperville, Pa. | 3·642 | | 40·70 | 33·30 | 2·40 | 0·70 | 19·70 | 0·15 | 2·40 | MnO 0·43 = [99·78 |
| 4. Unionville, Pa., *Unionite* | 3·299 | | 40·61 | 33·44 | 0·49 | — | 24·13 | *tr.* | 2·22 | = 100·89 |
| 5. Syra | | $\frac{2}{2}$ | 42·85 | 32·60 | *tr.* | — | 21·37 | 0·21 | 2·55 | = 99·58 |
| 6. Saualpe | 3·353 | | 40·64 | 28·39 | 3·89 | — | 24·26 | 0·57 | 2·09 | = 99·84 |
| 7. Goshen, Mass. | 3·341 | | 40·06 | 30·67 | 2·45 | — | 23·91 | 0·49 | 2·25 | = 99·83 |
| 8. Gefrees | 3·361 | | 40·32 | 29·77 | 2·77 | — | 24·35 | 0·24 | 2·08 | = 99·53 |
| 9. Sterzing | 3·352 | | 40·00 | 30·34 | 2·06 | — | 24·15 | 0·23 | 2·04 | = 98·82 |
| 10. Fuschthal | 3·251 | | 41·92 | 27·09 | 2·94 | — | 22·73 | 1·21 | 3·67 | = 99·56 |
| 11. Saasthal | 3·280 | | 42·35 | 28·30 | 3·08 | — | 21·60 | 0·56 | 3·18 | $K_2O$ 0·91 = [99·98 |
| 12. Glen Urquhart | 3·014 | | 39·60 | 31·08 | — | 2·07 | 23·34 | *tr.* | 2·41 | MnO 0·08, [$Na_2O$ 1·06, $K_2O$ 0·56 = 100·20 |
| 13. Tellemark, *Thulite* | | | 42·81 | 31·14 | 2·29 | — | 18·73 | 1·63 | 0·64 | $Na_2O$ 1·89 = [99·13 |
| 14. Traversella, *compact* | 3·02 | | 41·79 | 31·00 | — | 1·95 | 19·68 | 2·43 | 3·70 | = 100·55 |

**Pyr., etc.**—B.B. swells up and fuses at 3–3·5 to a white blebby mass. Not decomposed by acids; when previously ignited gelatinizes with hydrochloric acid. Gives off water when strongly ignited.

**Obs.**—Occurs chiefly in crystalline schists, especially those characterized by the presence of some one of the amphiboles (actinolite, smaragdite, glaucophane, etc.); thus in amphibolyte, glaucophane schist, eclogyte; also less often in granite.

The original zoisite is that of the eclogyte of the Saualpe in Carinthia (*saualpite*); occurs also with biotite in beds of pyrrhotite at Lamprechtsberg, Carinthia. Other localities are: Rauris in Salzburg; Eibiswald in Styria; Sterzing, Pregratten, Passeyr, Pfitschthal in Tyrol; the Fichtelgebirge in Bavaria, as at Gefrees and Weissenstein; the Saxon Erzgebirge; Marschendorf in Moravia; Zermatt and Saasthal in Switzerland; the island of Syra, one of the Cyclades, in glaucophane schist. From Glen Urquhart, Grantown, Inverness-shire; Loch Garve, Ross shire, in Scotland.

*Thulite* occurs at Kleppan in the parish of Souland in Tellemarken, Norway, with bluish vesuvianite (cyprine), yellowish white garnet, epidote, and fluorite; also at the iron mine of Klodeberg near Arendal; and at Traversella in Piedmont, forming small veins with talc and actinolite in granite. The red color of the *porfido rosso antico* is in part due to thulite produced by alteration of the feldspar (Rosenbusch).

In the United States, found in *Vermont*, at Willsborough, in columnar masses; at Montpelier, bluish gray along with calcite, in mica schist. In *Mass.*, at Chester, in mica schist; at Goshen, Chesterfield, Hinsdale, Heath, Leyden, Williamsburg, Windsor. In *Conn.*, at Milford. In *Penn.*, in W. Bradford and W. Goshen, Chester Co.; in Kennet township and E. Marlboro; Leiperville, Delaware Co.; at Unionville, white (*unionite*) with corundum and euphyllite. In

*N. Carolina*, at the Cullakenee mine in Clay Co., with corundum; also rose-red crystals at the Flat Rock mine, Mitchell Co. In *Tenn.*, at the Ducktown copper mines. In *California*, abundant in the metamorphic rocks, often intimately associated, as at Sulphur Bank, with glaucophane (Becker, l. c.).

This species was instituted by Werner in 1805, first united to epidote by Haüy and Bernhardi independently in 1806, and separated again from epidote on crystallographic grounds by Brooke in 1823. Des Cloizeaux has confirmed Brooke's conclusion by optical examinations, and further has shown that the crystallization is orthometric, instead of clinometric. Thulite is referred to the species by Des Cloizeaux, together with the calcium-epidote from most of the localities mentioned in connection with the analyses.

*Zoisite* was so named after Baron von Zois, from whom Werner received his first specimens; and *Thulite* after Thule, an ancient name of Norway.

**Ref.**—[1] Ducktown, Tenn., Ber. Ak. Wien, **82** (1), 141, 1880; cf. Bgr., Zs. Kr., **3**, 471, 1879; Lewis, ib., **7**, 183, 1882. [2] Cf. Mlr., Min., 306, 1852; Dx., Ann. Mines, **16**, 219, 1859, Min., **1**, 238, 1862; also [1] above. [3] Optical characters: Dx., l. c. and N. R., 106, 1867, Min. 2, p. xxx, 1874; Lcx., Bull. Soc. Min., **9**, 77, 1886; Lévy-Lcx., Min. Roches, 183, 1888.

SAUSSURITE. Jade (fr. near L. Geneva) *H. B. de Saussure*, Voy. Alpes, **1**, § 112, 1780. Bitterstein, Schweizerische Jade, *Höpfner*, Mag. Helvet., **1**, 291, Bergm. J., 448, 1788. Nephrite pt. *Wern.* Lehmanite *Delameth.*, T. T., **2**, 354. Jade tenace, Jade de Saussure, *H.*, Tr , **4**, 1801. Saussurite *T. de Saussure*, J. Mines, **19**, 205, 1806. Var. of Zoisite *T. S. Hunt*, Am. J. Sc., **25**, 437, 1858, **27**, 336, 1859.

A tough compact mineral substance with splintery fracture; H. = 6·5–7; G. = 3·0–3·4; color varying from white or nearly so to gray, greenish gray, bluish green; translucent to nearly opaque. For the most part derived from the alteration of a feldspar by a process of "saussuritization," and rarely, if ever, a homogeneous mineral.

In composition it often approaches zoisite, as shown by Hunt (l. c.), of which it has been regarded as a soda-bearing variety. It has been proved by Cathrein and others[1], however, that while zoisite is often a prominent constituent, there is usually present a plagioclase feldspar, often near albite and probably of secondary origin; also rarely orthoclase in varying amount, and garnet, with tremolite, chlorite, etc., as accessories. In many cases the saussurite is of so fine-grained texture that it is only with difficulty resolved by the microscope.

The place of the zoisite is sometimes taken by epidote, when sufficient iron for the latter mineral is present. Further some so-called saussurite contains no zoisite, the name having been given, for example, to some compact labradorite; also to some substances which have proved to have the composition of garnet. Cf. Michael, Jb. Min., **1**, 39, 1888. Cathrein also describes the change of garnet to saussurite, Zs. Kr., **10**, 444, 1885. Roepper has described a calcium-potash pseudomorph after anorthite from Franklin, N. J., with G. = 3·06–3·10, Am. J. Sc., **16**, 364, 1878.

The original saussurite was from the vicinity of Lake Geneva. G. = 3·261 de Saussure; 3·365–3·385. Hunt; H. = 6·5–7; color pale bluish green, greenish gray, to white or nearly so; very tough. Not attacked by acids. It was named after the elder H. B. de Saussure (1740–1799) by his son, Th. de Saussure (1767–1845). Hütlin and Pfaffius have described a saussurite which occurs with serpentine in the Schwarzwald. It forms with smaragdite the euphotide of the Alps, a rock which, as a result of glacier action, is widely distributed in boulders over the valley of the Rhone, and the country about Lake Geneva; the boulders, as ascertained by Prof. Guyot, were derived from the chain of the Saasgrat, through the valley of the Saas, and are distributed to a distance of 150 miles from this place of origin. Also present in saussurite-gabbro and related rocks of Corsica, Piedmont, the Fichtelgebirge, Scandinavia, the Lizard; in the greenstones of the Lake Superior region (G. H. Williams, Bull. **62**, U. S. G. Surv.).

The following are typical analyses.

Anal.—1, 2, Boulanger, Ann. Mines, **8**, 159, 1835. 3, 4, T. S. Hunt, Am. J. Sc., **27**, 345, 1859. 5, Finkenscher, J. pr. Ch., **89**, 456. 1863. 6, Hütlin & Pfaffius, Vh. Ges. Freib., **2**, 1861. 7, Hudleston, quoted by Bonney, Min. Mag., **2**, 6, 1878. 8, Delesse, Bull. Soc. G., **6**, 547, 1849. 9, Id., Ann. Mines, **17**, 116, 1850. 10, Damour, C. R., **63**, 1044, 1866. 11, Rath, Pogg., **95**, 555, 1855. 12, Chandler, Inaug. Diss., Gött., 1856, and JB. Ch., 858, 1856. 13, 14, Heddle, Min. Mag., **2**, 29, 1878. 15, Id., ibid., **5**, 6, 1882. 16, Hjortdahl, Nyt Mag., **23**, 228, 1877. 17, Fellenberg, Vh. Schw. Ges., Interlaken, 1870. 18, 19, F. W. Clarke, Proc. U. S. Mus., **11**, 128, 1888. 20, Id., Am. J. Sc., **28**, 21, 1884. 21, Michael, Jb. Min., **1**, 38, 1888. 22–24, Cathrein, Zs. Kr., **7**, 234 *et seq.*, 1882.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | CaO | MgO | $Na_2O$ | $K_2O$ | ign. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Mt. Genèvre | | 44·6 | 30·4 | — | — | 15·5 | 2·5 | 7·5 | — | — =100·5 |
| 2. Orezza, Corsica | 3·18 | 43·6 | 32·0 | — | — | 21·0 | 2·4 | — | 1·6 | — =100·6 |
| 3. L. Geneva, *bl. wh.* | 3·365 | 43·59 | 27·72 | 2·61 | — | 19·71 | 2·98 | 3·08 | — | 0·35=100·04 |
| 4. " | 3·385 | 48·10 | 25·34 | 3·30 | — | 12·60 | 6·76[a] | 3·55 | — | 0·66=100·31 |
| 5. " | | 45·34 | 30·28 | — | 1·37 | 13·87 | 3·88 | 4·23 | — | 0·71= 99·68 |
| 6. Schwarzwald | | 42·64 | 31·00 | — | 2·40 | 8·21 | 5·73 | 3·50 | | 3·83= 97·31 |
| 7. Mt. Colon | | 45·70 | 23·00 | 0·50 | | 19·30 | 4·75 | [1·95] | | 4·80=100 |
| 8. Mt Genèvre | | 49·73 | 29·65 | — | 0·85 | 11·18 | 0·56 | 4·04 | 0·24 | 3·75=100 |
| 9. Durance | | 56·12 | 17·40 | 7·79 | — | 8·74 | 3·41 | 3·72 | 0·24 | 1·93= 99·35 |
| 10. Neuchâtel | | 50·69 | 25·65 | 2·50 | — | 10·61 | 5·76 | 4·64 | — | 0·30=100·15 |

[a] The specimen analyzed contained some talc.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | CaO | MgO | $Na_2O$ | $K_2O$ | ign. |
|---|---|---|---|---|---|---|---|---|---|---|
| 11. Neurode | 2·991 | 50·84 | 26·00 | 2·73 | — | 14·95 | 0·22 | 4·68 | 0·61 | 1·21=101·24 |
| 12. Zopten | | 51·76 | 26·82 | 1·77 | — | 12·96 | 0·35 | 4·61 | 0·62 | 0·68= 99·57 |
| 13. Unst | 2·95 | 52·21 | 29·64 | 0·48 | — | 12·43 | 0·26 | 4·00 | 0·44 | 0·11= 99·57 |
| 14. " | 2·954 | 53·14 | 29·99 | 0·25 | — | 12·29 | 0·21 | 3·86 | 0·47 | 0·21=100·42 |
| 15. Ayrshire | 3·088 | 39·92 | 27·51 | 1·92 | — | 17·13 | 1·66 | 4·63 | 1·40 | 6·12=100·29 |
| 16. Bergen | 3·19 | 42·91 | 31·98 | 0·19 | — | 20·94 | 0·81 | 2·31 | 0·18 | — = 99·32 |
| 17. Bieler L. | 3·407 | 48·86 | 29·27 | — | 1·67 | 11·74 | — | 5·43 | 3·58 | 0·50=101·05 |
| 18. Swiss L. Dwellings | 3·403 | 46·90 | 29·76 | 2·52 | | 11·77 | 5·80 | 3·21 | *tr.* | 0·30=100·26 |
| 19. Saasthal, *mass.* | | 48·29 | 27·65 | 1·45 | | 12·95 | 5·36 | 3·57 | *tr.* | 0·54= 99·81 |
| 20. Shasta Co., Cal. | 3·148 | 42·79 | 29·43 | — | 3·65 | 18·13 | 1·40 | 2·51 | — | 2·42=100·33 |
| 21. Wojaleite | | 38·15 | 32·63 | 2·92 | — | 25·10 | 0·40 | *tr.* | — | 2·41=101·61 |
| 22. Wildschönau | 2·659 | 65·23 | 21·22 | 0·80 | — | 1·80 | 0·61 | 10·24 | 0·61 | — =100·41 |
| 23. " | 2·988 | 50·49 | 25·27 | 3·36 | — | 11·07 | 2·70 | 4·93 | 1·30 | 2·11=101·23 |
| 24. " | 3·011 | 48·30 | 29·98 | 0·65 | — | 12·36 | 1·31 | 4·49 | 1·57 | 2·33=100·99 |

**Ref.**—[1] Cathrein, Zs. Kr., **7**, 234–249, 1882. Traube, Inaug. Diss., Greifswald, 1884. G. H. Williams, Bull. **62**, U. S. G. Surv., 1891.

**407. EPIDOTE.** Schorl vert du Dauphiné *de Lisle*, Crist., **2**, 401, 1783. Strahlstein pt. *Wern.*, 1788–1800. Thallite (fr. Dauphiné) *Delameth.*, Sciagr., **2**, 401, 1792, T. T., **2**, 319, 1796; *H.*, J. Mines, **5**, 270, 1799. Delphinite (ib.) *Saussure*, Voy. Alpes, § 1918, 1796 (= Oisanite pt.). Akanticone (fr. Arendal) *d'Andrada*, J. Phys., **51**, 240, 1800, Scherer's J., **4**, 1800; = Arendalite *Karst.* (and Lectures of Blumenbach, earlier), Tab., 34, 74, 1800. Skorza *Wallachian Min.*, Karst., Tab., 28, 72, 1800, Klapr., Beitr., **3**, 282, 1802. Epidote *H.*, Tr., **3**, 1801. Pistazit *Wern.*, 1803, Ludw. Min., Wern., **2**, 209, 1804. Withamite (fr. Glencoe) *Brewst.*, Ed. J. Sc., **2**, 218, 1825. Puschkinit *Wagner*, Bull. Soc. Moscow, 1841. Achmatit *Herm.*, Vh. Min. Ges., 202, 1845–46. Escherit (fr. St. Gothard) *Scheerer*, Pogg., **95**, 507, 1855. Beustit *Breith.*, B. H. Ztg., **24**, 364, 1865.

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c}$ = 1·57874 : 1 : 1·80362; $\beta$ = *64° 36′ 50″ = 001 ∧ 100 N. von Koksharov, Jr.[1]

100 ∧ 110 = 54° 59′ 54″, 001 ∧ 101 = 34° 42′ 52″, 001 ∧ 011 = 58° 27′ 45″.

**Forms**, pt.[2]:
$a\ (100,\ i\text{-}\bar{\imath},\ \mathrm{T})$
$b\ (010,\ i\text{-}\grave{\imath},\ \mathrm{P})$
$c\ (001,\ O,\ \mathrm{M})$
$u\ (210,\ i\text{-}\bar{2})$
$t\ (320,\ i\text{-}\bar{\tfrac{3}{2}})$
$m\ (110,\ I,\ \mathrm{z})$
$\eta\ (120,\ i\text{-}\grave{2})$
$\nabla\ (150,\ i\text{-}\grave{5})$
$\Omega\ (105,\ -\tfrac{1}{5}\text{-}\bar{\imath})$

$\mathfrak{m}\ (102,\ -\tfrac{1}{2}\text{-}\bar{\imath})$
$e\ (101,\ -1\text{-}\bar{\imath})$
$h\ (201,\ -2\text{-}\bar{\imath})$
$g\ (301,\ -3\text{-}\bar{\imath})$
$\omega\ (\bar{1}04,\ \tfrac{1}{4}\text{-}\bar{\imath})$
$\sigma\ (\bar{1}03,\ \tfrac{1}{3}\text{-}\bar{\imath})$
$i\ (\bar{1}02,\ \tfrac{1}{2}\text{-}\bar{\imath})$
$s\ (\bar{2}03,\ \tfrac{2}{3}\text{-}\bar{\imath})$
$N\ (\bar{3}04,\ \tfrac{3}{4}\text{-}\bar{\imath})$
$r\ (\bar{1}01,\ 1\text{-}\bar{\imath})$
$\beta\ (\bar{4}03,\ \tfrac{4}{3}\text{-}\bar{\imath})$

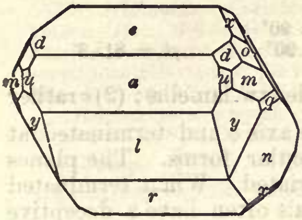
$\kappa\ (\bar{3}02,\ \tfrac{3}{2}\text{-}\bar{\imath})$
$l\ (\bar{2}01,\ 2\text{-}\bar{\imath})$
$f\ (\bar{3}01,\ 3\text{-}\bar{\imath})$
$p\ (016,\ \tfrac{1}{6}\text{-}\grave{\imath})$
$\Sigma\ (015,\ \tfrac{1}{5}\text{-}\grave{\imath})$
$\gamma\ (013,\ \tfrac{1}{3}\text{-}\grave{\imath})$
$k\ (012,\ \tfrac{1}{2}\text{-}\grave{\imath})$
$o\ (011,\ 1\text{-}\grave{\imath})$
$\mu\ (116,\ -\tfrac{1}{6})$
$\epsilon\ (113,\ -\tfrac{1}{3})$

$v\ (112,\ -\tfrac{1}{2})$
$d\ (111,\ -1)$
$\rho\ (\bar{1}13,\ \tfrac{1}{3})$
$x\ (\bar{1}12,\ \tfrac{1}{2})$
$n\ (\bar{1}11,\ 1)$
$q\ (\bar{2}21,\ 2)$
$\chi\ (611,\ -6\text{-}\bar{6})$
$w\ (211,\ -2\text{-}\bar{2})$
$R\ (\bar{4}11,\ 4\text{-}\bar{4})$
$V\ (\bar{6}23,\ 2\text{-}\bar{3})$
$C\ (\bar{3}11,\ 3\text{-}\bar{3})$

$H\ (\bar{7}32,\ \tfrac{7}{2}\text{-}\bar{\tfrac{7}{3}})$
$\nu\ (\bar{2}12,\ 1\text{-}\bar{2})$
$y\ (\bar{2}11,\ 2\text{-}\bar{2})$
$B\ (\bar{2}33,\ 1\text{-}\grave{\tfrac{3}{2}})$
$Z\ (\bar{2}32,\ \tfrac{3}{2}\text{-}\grave{\tfrac{3}{2}})$
$\Phi\ (\bar{3}53,\ \tfrac{5}{3}\text{-}\grave{\tfrac{5}{3}})$
$\alpha\ (\bar{1}22,\ 1\text{-}\grave{2})$
$\phi\ (\bar{1}21,\ 2\text{-}\grave{2})$
$\Delta\ (\bar{1}31,\ 3\text{-}\grave{3})$
$\delta\ (\bar{1}41,\ 4\text{-}\grave{4})$
$E\ (\bar{1}51,\ 5\text{-}\grave{5})$

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $uu'''$ | = 70° 59′ | $cr$ | = 63° 42′ | $cq$ | = 89° 42′ | $\epsilon\epsilon$ | = 48° 14½′ |
| $tt'''$ | = 87° 7′ | $a'r$ | = 51° 41′ | $c\nu$ | = 68° 47½′ | $vv'$ | = 62° 19′ |
| $mm'''$ | = 109° 56′ | $c\beta$ | = 75° 51′ | $cB$ | = 69° 9′ | $dd'$ | = 83° 55′ |
| $\eta\eta'$ | = 38° 38′ | $c\kappa$ | = 80° 16½′ | $c\phi$ | = 81° 31′ | $\rho\rho'$ | = 61° 57½′ |
| $\nabla\nabla'$ | = 15° 58′ | $cl$ | = 89° 26′ | $aw$ | = 34° 28′ | $nn'$ | = 109° 31′ |
| $c\Omega$ | = 10° 39′ | $cf$ | = 98° 37′ | $ad$ | = 49° 52′ | $bn$ | = *35° 14′ 40″ |
| $c\mathfrak{m}$ | = 22° 31′ | $\gamma\gamma'$ | = 57° 1′ | $ao$ | = 77° 2½′ | $nn'''$ | = 70° 29′ |
| $ce$ | = 34° 43′ | $kk'$ | = 78° 20½′ | $a'\alpha$ | = 85° 37½′ | $\nu\nu'$ | = 70° 34′ |
| $ae$ | = 29° 54′ | $oo'$ | = 116° 55½′ | $a'B$ | = 79° 52′ | $\phi\phi'$ | = 141° 5′ |
| $ch$ | = 46° 12′ | $c\epsilon$ | = 28° 56′ | $a'n$ | = 69° 2′ | $\delta\delta'$ | = 159° 58′ |
| $cg$ | = 51° 26′ | $cv$ | = 37° 46′ | $a'y$ | = 45° 6½′ | $EE'$ | = 163° 55′ |
| $c\omega$ | = 16° 23′ | $cd$ | = 52° 19′ | $a'C$ | = 31° 51′ | $qq'$ | = 115° 18′ |
| $c\sigma$ | = 22° 21′ | $cm$ | = 75° 45′ | $a'\phi$ | = 78° 5′ | $yy'$ | = 76° 34′ |
| $ci$ | = 34° 21′ | $c\rho$ | = 37° 32 | $a'\delta$ | = 83° 48½′ | $CC'$ | = 54° 59′ |
| $cs$ | = 45° 37′ | $cx$ | = 51° 56′ | $a'E$ | = 85° 1½′ | $BB'$ | = 118° 51′ |
| $cN$ | = 50° 44½′ | $cn$ | = *75° 11′ | | | $\alpha\alpha'$ | = 121° 23′ |

1.



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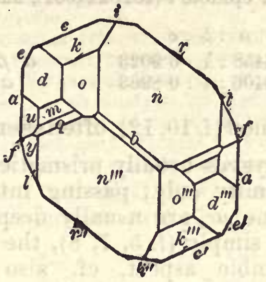

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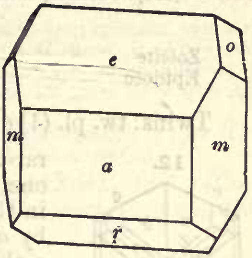

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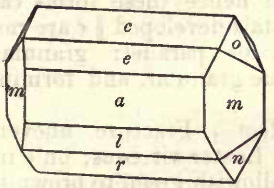

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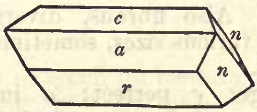

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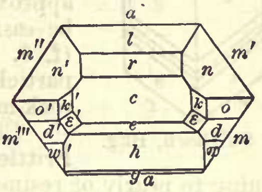

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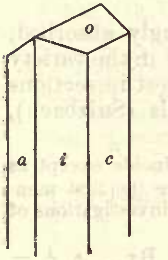

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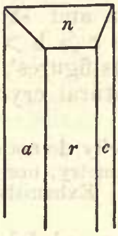

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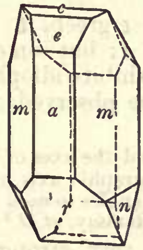

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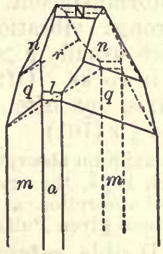

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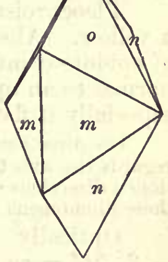


Figs. 1, Arendal, Haid. 2, Sulzbach, Bkg., projection on *b* (010). 3, Ural, Kk. 4, Achmatovsk, Kk. 6, Achmatovsk, after Kk., projection on plane ⊥ *ċ*. 5, 7, 8, common forms; 7, 8, with axis ⊥ *b* erect. 9, Elba, Artini. 10, Colorado, Bodewig. 11, *Bucklandite*, Achmatovsk, Kk.

The species zoisite and epidote, similar in composition, are also closely related in form and hence to be regarded as isomorphous though belonging to different crystalline systems. Thus, as suggested by Tschermak and others (cf. 5th Ed., p. 292), the corresponding planes may be regarded as:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Zoisite | *b* (010) | *c* (001) | *m* (110) | *u* (021) | *m'''* (110) | *o* (111) | *o'''* (1$\bar{1}$1) |
| Epidote | *a* (100) | *b* (010) | *c* (001) | *m* (110) | *r* (101) | *o* (011) | *n* ($\bar{1}$11) |

| Zoisite | | | Epidote (cf. f. 4) | | |
|---|---|---|---|---|---|
| *mm'''* | (110 ∧ 1$\bar{1}$0) | = 63° 34′ | *cr* | (001 ∧ $\bar{1}$01) | = 63° 42′ |
| *oo'''* | (111 ∧ 1$\bar{1}$1) | = 33° 24′ | *on* | (011 ∧ $\bar{1}$11) | = 33° 55½′ |
| *uu'* | (021 ∧ 0$\bar{2}$1) | = 68° 54′ | *mm'* | (110 ∧ $\bar{1}$10) | = 70° 4′ |
| *mo* | (110 ∧ 111) | = 56° 56′ | { *co* | (001 ∧ 011) | = 58° 28′ |
| | | | { *rn* | ($\bar{1}$01 ∧ $\bar{1}$11) | = 54° 45′ |
| *oo''* | (111 ∧ $\bar{1}$11) | = 66° 8′ | { *oo'''* | (011 ∧ 10$\bar{1}$) | = 63° 4½′ |
| | | | { *nn'''* | ($\bar{1}$11 ∧ 11$\bar{1}$) | = 70° 29′ |

Brögger, however, prefers to regard the planes in the prismatic zone as corresponding thus:

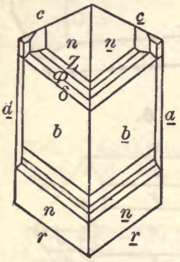
| | | | | | |
|---|---|---|---|---|---|
| Zoisite | 100 | 120 | 130 | 140 | 210 |
| Epidote | 102 | 102 $\bar{3}$02 | 101 $\bar{2}$01 | 302 $\bar{5}$02 | $\bar{1}$04 $\bar{3}$04 |

Further by exchanging, for zoisite, the axes *c* and *b* and *b* and *a*, also by making the dome (021) = (110): further, taking for epidote *i* ($\bar{1}02$) as (001), and *r* ($\bar{1}01$) as (101), he calculates:

| | $a' : b' : c'$ | | |
|---|---|---|---|
| Zoisite | 1·4458 : 1 : 0·9023 | $\alpha'\ \beta'\ \gamma' = 90°$ | |
| Epidote | 1·4406 : 1 : 0·8903 | $\alpha'\ \gamma' = 90°$ | $\beta' = 81°\ 3'$ |

Twins: tw. pl. (1) *a* common (f. 10, 12), often as embedded tw. lamellæ; (2) *c* rather rare. Crystals usually prismatic ∥ the axis $\overset{|}{b}$ and terminated at one extremity only; passing into acicular forms. The planes in the zone, *ac*, are usually deeply striated. When terminated by *n* or *o* simply (f. 5, 7, 8), the crystals often have a deceptive orthorhombic aspect, cf. also f. 4. The terminal angles *mm'* ($110 \wedge \bar{1}10 = 70°\ 4'$) and *nn'''* ($\bar{1}11 \wedge \bar{1}1\bar{1} = 70°\ 29'$) approximate closely to each other and hence these forms can be easily confounded. Prismatic crystals developed ∥ $\acute{c}$ are rare (f. 9, 10). Also fibrous, divergent, or parallel; granular, particles of various sizes, sometimes fine granular, and forming rock-masses.

12.



12, Sulzbach, Bkg.

Cleavage: *c* perfect; *a* imperfect. Fracture uneven. Brittle. H. = 6–7. G. = 3·25–3·5. Luster vitreous; on *c* inclining to pearly or resinous. Color pistachio-green or yellowish green to brownish green, greenish black, and black; sometimes clear red and yellow; also gray and grayish white, rarely colorless. Streak uncolored, grayish. Transparent to opaque: generally subtranslucent.

Pleochroism strong: vibrations ∥ $\mathfrak{c}$ green, $\mathfrak{b}$ brown and strongly absorbed, $\mathfrak{a}$ yellow. Absorption usually $\mathfrak{b} > \mathfrak{c} > \mathfrak{a}$; but sometimes $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$ in the variety of epidote common in rocks. Often exhibits idiophanous figures[4], best in sections normal to an optic axis, but often to be observed in natural crystals (Sulzbach), especially if flattened ∥ *r* ($\bar{1}01$).

The directions of maximum absorption and the axes of elasticity do not coincide except as regards the axis $\mathfrak{b}$ which is ∥ $\overset{|}{b}$, the crystallographic axis of symmetry; nor are the first mentioned directions (axes of absorption) at right angles to each other. Exhaustive investigations of these phenomena have been given Pulfrich. Ramsay, *et al.*[4]

Optically −. Double refraction very strong. Ax. pl. ∥ *b*. $Bx_{a.r} \wedge \acute{c} = -2°\ 56' = \mathfrak{c}a$. $Bx_{a.gr} \wedge \acute{c} = -2°\ 26'$ Klein. Hence $\mathfrak{c} \perp a$ (100) nearly. Dispersion inclined, strongly marked; of the axes feeble, $\rho > v$. One optic axis nearly ⊥ *r* (101), the other slightly inclined to *c* (001). Axial angles, Klein[3]:

| | | | |
|---|---|---|---|
| | $2H_{a.r} = 91°\ 26'$ | $2H_{a.y} = 91°\ 20'$ | $2H_{a.gr} = 91°\ 12'$ |
| | $2H_{o.r} = 144°\ 56'$ | $2H_{o.y} = 145°\ 38'$ | $2H_{o.gr} = 146°\ 36'$ |
| ∴ | $2V_{a.r} = 73°\ 48'$ | $2V_y = 73°\ 39'$ | $2V_{gr} = 73°\ 26'$ |
| Also | $\beta_r = 1·75405$ | $\beta_y = 1·75702$ | $\beta_{gr} = 1·76213$ |
| | $\alpha_r = 1·76766$ | $\gamma_r = 1·73053$ | |

**Var.**—Epidote has ordinarily a peculiar yellowish green (pistachio) color, seldom found in other minerals. But this color passes into dark and light shades—black on one side, and brown on the other; red, yellow, and colorless varieties also occur.

Var. 1. *Ordinary.* Color green of some shade, as described, the pistachio tint rarely absent. (*a*) In crystals. (*b*) Fibrous. (*c*) Granular massive. (*d*) *Scorza* is epidote sand, of the usual green color, with quartz from the gold washings of the river Aranyos, near Muska in Transylvania. The Arendal epidote (*Arendalite*) is mostly in dark green crystals: that of Dauphiné (*Thallite, Delphinite, Oisanite*) in yellowish green crystals, sometimes transparent; found near Bourg d'Oisans. *Puschkinite* includes crystals from the auriferous sands of Ekaterinburg, Ural; G. = 3·066; named after Pushkin, a Russian senator. *Achmatite* is ordinary epidote, in crystals, from Achmatovsk, Ural. *Escherite* is a brownish yellow, somewhat greenish epidote, from St. Gothard. A variety from Garda, Hoste Is., Terra del Fuego, has been described which is colorless and resembles zoisite (anal. 17).

2. The so-called *Bucklandite* from Achmatovsk, described by Hermann, is black with a tinge of green, and differs from ordinary epidote in having the crystals nearly symmetrical (f. 11), and not, like other epidote, lengthened in the direction of the orthodiagonal. G. = 3·51. Hermann's *Bagrationite*, from Achmatovsk, appears to be essentially the same mineral, agreeing with it

in angles, according to Hermann (Bull. Soc. Nat. Moscow, **35**, 248, 1862), and having G. = 3·46, while the original bagrationite of Koksharov is a variety of allanite (p. 523). It differs from bucklandite in containing a little cerium.

3. *Withamite.* Carmine-red to straw-yellow; strongly pleochroic; deep crimson and straw-yellow; H. = 6–6·5; G. = 3·137; in small radiated groups. From Glencoe, in Argyleshire, Scotland. Named after Dr. Henry Witham of Glencoe. It is stated to contain manganese, and sometimes referred to piedmontite, but an analysis by Heddle (anal. 15) gives only 0·14 MnO, Min. Mag., **5**, 15, 1882. Cf. Lcx., Bull. Soc. Min., **9**, 75, 1886.

*Beustite* is a grayish white to ash-gray mineral. From near Predazzo in the Tyrol. G. = 2·859–2·877, Breith. Its identity with epidote has not certainly been proved.

**Comp.**—$HCa_2(Al,Fe)_3Si_3O_{13}$ or $H_2O.4CaO.3(Al,Fe)_2O_3.6SiO_2$, the ratio of aluminium to iron varies commonly from 6 : 1 to 3 : 2. Percentage composition:

| Al : Fe | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|
| 1 : 0 | 39·67 | 33·71 | — | 24·64 | 1·98 | = | 100 |
| 5 : 1 | 38·44 | 27·23 | 8·53 | 23·88 | 1·92 | = | 100 |
| 4 : 1 | 38·20 | 25·98 | 10·18 | 23·73 | 1·91 | = | 100 |
| 3 : 1 | 37·87 | 24·13 | 12·60 | 23·51 | 1·89 | = | 100 |
| 2 : 1 | 37·29 | 21·13 | 16·55 | 23·16 | 1·87 | = | 100 |
| 0 : 1 | 33·30 | — | 44·35 | 20·68 | 1·67 | = | 100 |

Most early analysts failed to recognize the presence of the water, and when found it was usually referred to alteration. The correct formula was first established by Tschermak, who (Min., 1883) makes it a basic orthosilicate containing (CaOH), while Groth assumes the presence of (AlOH).

**Anal.**—1, Ludwig, Min. Mitth., 189, 1872. 2, Id., Zs. Kr., **6**, 180, 1881. 3, Drasche, Jb. Min., 120, 1872. 4, Rg., Zs. G. Ges., **24**, 649, 1872. 5, Lasp., Zs. Kr., **3**, 561, 1879. 6, Mauthner, Min. Mitth., 259, 1872. 7, Doelter, Min. Mitth., 175, 1875. 8, 9, Lasp., l. c., p. 562. 10, Luedecke, Zs. G. Ges., **28**, 262, 876. 11, Renard, Bull. Ac. Belg., **50**, 170, 1880. 12, Schlemmer, Min. Mitth., 258, 1872. 13, Nanke, Jb. Min., **2**, 81, 1880. 14, Heddle, Min. Mag., **2**, 34, 1878. 15, Id., ibid., **5**, 15, 1882. 16, A. G. Dana, Am. J. Sc., **29**, 455, 1885. 17, Wiik, Finsk. Vet.-Soc. Förh., **27**, 1885. 18, Lcx., Bull. Soc. Min., **10**, 150, 1887. 19, Genth, Bull. **74**, p. 40, U. S. G. Surv.

For earlier analyses see 5th Ed., p. 283; also cf. Ludwig, who selects those among them which deserve confidence.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| 1. Untersulzbach | | $\frac{3}{3}$ 37·83 | 22·63 | 14·02 | 0·93 | *tr.* | 23·27 | *tr.* | 2·05 = 100·73 |
| 2. " | 3·466 | $\frac{2}{2}$ 37·83 | 23·43 | 13·31 | 0·48 | *tr.* | 23·47 | *tr.* | 2·06 = 100·58 |
| 3. " | 3·5 | 38·37 | 22·09 | 13·77 | 0·88 | *tr.* | 17·94 | 4·08 | 2·11 $Na_2O$ *tr.* [= 99·24 |
| 4. " | | 37·11 | 21·90 | 16·00 | | | 23·19 | — | 2·03 = 100·23 |
| 5. " | | 36·57 | 24·14 | 12·29 | 0·71 | 0·06 | 23·33 | — | 1·99 insol. 1·13 [= 100·22 |
| 6. " | | 38·60 | 23·08 | 12·34 | 0·95 | | 24·17 | — | 1·88 = 101·02 |
| 7. Allochetthal | 3·452 | 37·70 | 24·61 | 14·23 | 0·45 | | 20·99 | — | 2·23 = 100·21 |
| 8. Zillerthal | | 38·46 | 28·59 | 5·76 | 0·53 | | 24·60 | — | 1·92 insol. 0·42 [= 100·28 |
| 9. Bourg d'Oisans | | 36·49 | 22·45 | 14·27 | 0·61 | 0·03 | 23·52 | — | 1·91 insol. 0·68 [= 99·96 |
| 10. Syra | | 38·15 | 25·30 | 9·30 | | | 25·10 | 0·24 | 1·80 = 99·89 |
| 11. Quenast | 3·421 | $\frac{2}{2}$ 38·26 | 24·75 | 11·07 | 0·56 | *tr.* | 23·63 | *tr.* | 2·26 = 100·53 |
| 12. Zöptau, *blk. green* | | 38·51 | 18·88 | 17·25 | | | 23·32 | — | 2·98 = 100·94 |
| 13. " *light green* | | 39·18 | 26·52 | 8·21 | | | 23·89 | — | 2·20 = 100 |
| 14. Unst Is. | | 38·75 | 26·99 | 7·90 | 1·81 | 0·50 | 20·38 | 0·79 | 2·38 Alk. 0·46 [= 99·96 |
| 15. Glencoe, *Withamite, straw yw.* | | 43·23 | 23·09 | 6·68 | 1·13 | 0·14 | 20·00 | 0·88 | 2·40 Alk. 2·15[a] [insol. 0·35 = 99·70 |
| 16. Rowe, Mass. | | $\frac{2}{2}$ 38·20 | 24·62 | 12·20 | — | 0·57 | 21·59 | 0·13 | 2·16 Alk. 0·37 [= 100·19 |
| 17. Pargas | 3·3 | 37·92 | 27·90 | 9·10 | — | — | 22·81 | — | 2·02 = 99·75 |
| 18. Is. Garda, *colorless* | 3·21 | 37·95 | 30·38 | | 7·83 | | 20·34 | 0·93 | 2·64 = 100·07 |
| 19. Macon Co., N. C. | 3·269 | 36·95 | 25·82 | 9·97 | 1·34 | 0·56 | 21·86 | 0·56 | 3·02 = 100·08 |

[a] Incl. $Na_2O$ 0·94, $K_2O$ 0·96, $Li_2O$ 0·25.

**Pyr., etc.**—In the closed tube gives water on strong ignition. B.B. fuses with intumescence at 3–3·5 to a dark brown or black mass which is generally magnetic. Reacts for iron and sometimes for manganese with the fluxes. Partially decomposed by hydrochloric acid, but when previously ignited, gelatinizes with acid. Decomposed on fusion with alkaline carbonates. G. of Arendal epidote changes on ignition, from 3·409 to 2·984.

**Obs.**—Epidote is common in many crystalline rocks, as syenite, gneiss, mica schist, hornblendic schist, serpentine, and especially those that contain the ferriferous varieties of amphibole. It often accompanies beds of magnetite or hematite in such rocks. It is sometimes found in geodes in trap; and also in sandstone adjoining trap dikes as a result of contact metamorphism. It also occurs at times in nodules in different quartz-rocks or altered sandstones. It is a constituent of much so-called saussurite formed from plagioclase feldspar (p. 515). It is associated often with quartz, pyroxene, feldspar, axinite, chlorite, etc.

It sometimes forms with quartz an epidote rock, called *epidosyte*. A similar rock exists at Melbourne in Canada. A gneissoid rock consisting of flesh-colored orthoclase, quartz, and epidote from the Unaka Mts. (N. C. and Tenn.) has been called unakyte.

Beautiful crystallizations come from Bourg d'Oisans, Dauphiné; the Ala valley and Traversella, in Piedmont; Elba; Zermatt in the Valais; near Guttannen in the Haslithal; at Kaverdiras and Baduz in the valley of Tavetsch (the latter sometimes referred to zoisite, but optically epidote, Dx.); Monzoni in the Fassathal, Zillerthal in Tyrol, sometimes in rose-red and greenish crystals of small size, resembling *thulite;* the Saualpe in Carinthia. The Knappenwand in the Untersulzbachthal, Pinzgau, has since 1866 furnished large quantities of crystals beautiful in size, complexity of form, luster and transparency; they occur in crevices in an epidotic schist associated with asbestus, adularia, fine crystals of apatite, also titanite, scheelite; also well crystallized from the Krimler-Achenthal, near Kriml; the Habachthal and Hollersbach in Tyrol; Striegau, Silesia; Zöptau, Moravia; Arendal in Norway; Nordmark, Wermland, Sweden; the Achmatovsk mine near Zlatoust, Ural; from the Ilmen Mts.; Ekaterinburg. In Brazil with the green tourmaline of Minas Geraes.

In N. America, occurs in *N. Hamp.*, at Franconia, crystallized and granular. with magnetite; Warren with quartz and pyrite. In *Mass.*, at Hadlyme and Chester, in crystals in gneiss; at Athol, in syenitic gneiss, in fine crystals, 2 m. S.W. of the center of the town; Newbury. in limestone; at Somerville with prehnite; at Nahant, poor, in trap; at Rowe, at the pyrite mine with gahnite. In *Rhode Island*, at Cumberland, in a kind of trap. In *Conn.*, at Haddam, in large splendid crystals; on Hosmer Mt., ½ mile S.W. of Willimantic. In *N. York*, 2 m. S.E. of Amity, in quartz; 2 m. S. of Carmel, Putnam Co., with hornblende and garnet; 2 m. S. of Coffee's, Monroe, Orange Co.; 6 m. W. of Warwick, pale yellowish green, with titanite and pyroxene; on New York island on the East river, near 38th St. In *N. Jersey*, at Franklin, massive; at Roseville in Byram township, Sussex Co., in good crystals. In *Penn.*, at E. Bradford; on John Balderson's farm, Kennett township, Chester Co. In *Maryland*, at Webb's mine, Cumberland. In *N. Carolina*, from the gold-washings of Rutherford Co.; fine crystals at Hampton's, Yancey Co.; White's mill, Gaston Co.; Franklin, Macon Co.; in crystals and crystalline masses in quartz at White Plains, Alexander Co. In *Michigan*, in the Lake Superior region, at many of the mines; at the Norwich mine, beautifully radiated with quartz and native copper. In *Colorado*, in the Pike's Peak region (fig. 10); also in calcite at the Calumet mine, Calumet, Chaffee Co. In *Canada*, at St. Joseph, Beauce Co., Quebec, in a concretionary argillaceous rock.

*Epidote* is one of Haüy's crystallographic names, derived from the Greek ἐπίδοσις, *increase*, and translated by him, "qui à reçu un accroissement," the base of the prism (rhomboidal prism) having one side longer than the other. In its introduction Haüy set aside three older names. Thallite (from θαλλός, color of young twigs, alluding to the green color) was rejected because it was based on a varying character, color; *Delphinite* and *Arendalite*, because derived from localities. But the name *Epidote* is now so involved in geological as well as mineralogical literature that the law of priority cannot well do the justice demanded of it. Werner's name *Pistacite*, from πιστάκια, *the pistachio-nut* (referring to the color), was not proposed as early as thallite or epidote.

**Alt.**—Epidote is less liable to alteration than most of the silicates, partly because the iron it contains is mostly, when not wholly, in the state of sesquioxide.

**Artif.**—Epidote has not, as yet, been found among the crystallizations of furnace slags, or formed in the laboratory of the chemist, although it has been a frequent result of the action of heat and steam on ferruginous sandstones accompanying the ejection of doleryte and other eruptive rocks.

**Ref.**—[1] Vh. Min. Ges., **15**, 31, 1880, and Min. Russl., **8**, 44; from measurements of crystals from Untersulzbach; the agreement of measured and calculated angles shows that these elements are probably more precise than those of Koksharov, Sr., (Min. Russl., **3**, 268, 1858,) generally accepted hitherto, viz., 1·58073 : 1 : 1·80574, $\beta = 64° 36'$. The position here taken is that of Marignac and now adopted by most authors; with Mohs and Naumann (also Dana, earlier Eds.) $a$ (T) = $\bar{1}01$, $c$ (M) = 100, $z$ = $\bar{1}11$, $l$ = 001, etc.

[2] See Bkg. (Zs. Kr., **2**, 321, 1878) for a list of planes with early authorities, etc.; he enumerates 220 planes, including 147 determined by him, but many are doubtful, especially those (about 100 in number) in the striated orthodome zone. Cf. also Gdt., Index, **1**, 557, 1886, and recently Flink, Artini (see below), and Hintze, Min., **2**, 210 *et seq.*, 1890. The list here given includes all the common planes and some others.

For important memoirs on epidote see: Haid., Ed. Phil. J., **10**, 305, 1824; Lévy, Min. Heuland, **2**, 115, 1837; Mgc., Bibl. Univ., Suppl., **4**, 148, 1847; Hbg., Min. Not., **1**, 23–25, 1856, **2**, 10, 1858; Kk., l. c.; Zeph., Ber. Ak. Wien, **34**, 480, 1859, **45**, 381, 1862; Dx., Min., **1**, 243, 1862; Rath, Pogg., **115**, 472, 1862, Erg., **6** 368, 1873; Schrauf, Ber. Ak. Wien, **64** (1), 159, 1871; Brz., Min. Mitth., 49, 1871; Klein, Jb. Min., 113, 1872; Bkg., l. c., Bgr. Zs. Kr., **16**, 91, 1890.

Recent papers are by: Flink, Ak. H. Stockh., Bihang, **12** (2), p. 2, 46, 52, 1886; Artini, Mem. Acc. Linc., **4**, 380, 1887; Gränzer, Min. Mitth., **9**, 361, 1887; Brugnatelli, Zs. Kr., **17**, 529, 1890.

[3] Optical constants, Dx., Min., **1**, 218, 219, 1862, N. R., 131, 1867; Klein, Untersulzbach, Jb. Min., p. 1, 1874; also Artini, l. c., *et al.*

[4] Absorption phenomena, Bertin, ref. under iolite, p. 421; Klein, l. c.; Laspeyres, Zs. Kr., **4**, 444, 1880; Pulfrich, Zs. Kr., **6**, 142, 158, 1881; Ramsay, ib., **13**, 97, 1887. Absorption spectra, Becquerel, C. R, **108**, 282, 891, 1889.

PICROEPIDOTE *Damour* and *Des Cloizeaux*, Bull. Soc. Min., **6**, 23, 1883. In white or slightly yellowish translucent crystals, having the habit (prismatic ‖ $\bar{b}$) and approximately the angles of epidote; also similar optically. Scratches glass; B.B. infusible. Contains essentially silica, alumina, magnesia, and traces of lime; presumably a *magnesium-epidote*. Observed with diopside, pyrite, calcite in the lapis lazuli from Lake Baikal, Siberia.

**408. PIEDMONTITE.** Röd Magnesia (fr. Piedmont) *Cronst.*, Min., 106, 1758. Manganèse rouge (id.) *Napione*, Mem. Acc. Turin, **4**, 1790. Manganèse oxydé violet silicifère (id.) *H.*, Tr., **4**, 1801. Epidote manganésifère (id.) *L. Cordier*, J. Mines, **13**, 135, 1803; *H.*, Tabl., 1809. Piemontischer Braunstein *Wern.*, Hoffm. Min., **4**, *a*, 152, 1817. Manganepidot *Germ.* Piemontit *Kenng.*, Min., 75, 1853.

Monoclinic. Axes $\grave{a} : \bar{b} : \dot{c} = 1{\cdot}6100 : 1 : 1{\cdot}8326$; $\beta = {}^*64° 39' = 001 \wedge 100$ Laspeyres[1].

$100 \wedge 100 = 55° 30'$, $001 \wedge \bar{1}01 = 63° 30\frac{1}{2}'$, $001 \wedge 011 = 58° 52\frac{1}{2}'$.

**Forms**[1]: *a* (100, *i*-$\bar{i}$), *b* (010, *i*-$\breve{i}$), *c* (001, *O*), *m* (110, *I*); *e* (101, – 1-$\bar{i}$), *i* ($\bar{1}$02, $\frac{1}{2}$-$\bar{i}$), *r* ($\bar{1}$01, 1-$\bar{i}$); *n* ($\bar{1}$11, 1).

Angles: *mm‴* = 111° 0′, *ci* = 34° 13′, *cx* = 63° 30½′, *a′i* = 81° 8′, *cn* = 75° 16′, *a′n* = 69° 22½′, *nn′* = 110° 29′.

Twins: tw. pl. *a*, often polysynthetic; also *c* very rare. Crystals prismatic ‖ $\bar{b}$ like ordinary epidote, but distinct forms rare and faces usually dull. Also massive.

Cleavage: *c* perfect; *a* less so. Fracture uneven. Fragile. H. = 6·5. G. = 3·404 Breith. Luster vitreous; slightly pearly on other faces. Color reddish brown and reddish black; in very thin splinters columbine-red. Streak reddish. Opaque to subtranslucent.

Pleochroism strong: $\mathfrak{c}$ red, $\mathfrak{b}$ amethyst to pink, $\mathfrak{a}$ orange to citron-yellow. Absorption $\mathfrak{a} > \mathfrak{b} > \mathfrak{c}$. Optically +. Ax. pl. ‖ *b*. $Bx_{a.r} \wedge \dot{c} = +82° 34'$, $Bx_{a.y} = 83° 19'$, or $Bx_{o.r} \wedge \dot{c} = -7° 26'$, $Bx_{o.y} = -6° 41'$; hence $\mathfrak{c}$, as in epidote, nearly ⊥ *a*, Lasp.[2], St. Marcel. For Japanese piedmontite, extinction-angle $= \mathfrak{a} \wedge \dot{c} = Bx_o \wedge \dot{c} = -3°$ Kotō. Dispersion inclined, strong. Axial angles, Dx.:

$$2H_a = 82°\text{–}90° \qquad 2H_o = 121°\text{–}126°$$

**Comp.**—$HCa_2(Al,Mn,Fe)_3Si_3O_{13}$ or $H_2O.4CaO.3R_2O_3.6SiO_2$. If Al : Mn : Fe = 3 : 2 : 1, the percentage composition is: Silica 33·6, alumina 14·3, iron sesquioxide 14·9, manganese sesquioxide 14·7, lime 20·9, water 1·7 = 100.

**Anal.**—1, Rammelsberg, Min. Ch., 595, 1875, also Lasp., l. c. Most earlier analyses (5th Ed., p. 285) neglect the water. 2, Takayama, J. Coll. Sc., Japan, **1**, 303, 1887. 3, Igelström, Öfv. Ak. Stockh., **24**, 11, 1867. 4, Flink, Ak. H. Stockh., Bihang, **13** (2), No. 7, 52, 1888; also Svensson and Tamm, quoted by Flink.

| | | $SiO_2$ | $Al_2O_3$ | $Mn_2O_3$ | $Fe_2O_3$ | CaO | MgO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 1. St. Marcel | G. = 3·518 | 38·64 | 15·03 | 15·00 | 8·38 | 22·19 | — | 1·78 = 101·02 |
| 2. Japan | | 36·16 | 22·52 | 6·43 | 9·33 | 22·05 | 0·40 | 3·20 $Na_2O$ 0·44 = 100·53 |
| 3. Jakobsberg | | ⅔ 33·81 | 18·58 | 4·85[a] | 12·57 | 26·46 | 3·04 | —[b] = 99·31 |
| 4. " | | 36·44 | 24·65 | 4·52 | 12·44 | 19·52 | — | 3·19 = 100·76 |

[a] MnO. [b] Ignition, separately determined, 0·94.

**Pyr., etc.**—B.B. fuses with intumescence at 3 to a black lustrous glass. Gives strong reactions for manganese with the fluxes, and also for iron. Not decomposed by acids, but when previously ignited gelatinizes with hydrochloric acid. Decomposed on fusion with alkaline carbonates.

**Obs.**—Occurs at St. Marcel, in the valley of Aosta, in Piedmont, in braunite with quartz, greenovite, violan, and tremolite. Common in the crystalline schists of Japan at numerous points, with quartz in piedmontite-schist, also as an accessory in glaucophane-schist, and in general in the chlorite-sericite gneiss of the Archæan. It sometimes occurs as a nucleus surrounded by ordinary epidote. Also in the mica schists of the Ile de Groix, Brittany, and in England.

A manganesian epidote (anal. 3, 4) occurs in crystalline limestone at Jakobsberg, Nordmark, Sweden[1].

**Ref.**—[1] Zs. Kr., **4**, 435, 1880. Flink observed on the manganepidote (anal. 4) of Jakobsberg (cf. epidote) *a* (100), *c* (001), *m* (110), *η* (120), **m** (102), *i* ($\bar{1}02$), *r* ($\bar{1}01$), *o* (011), *n* ($\bar{1}11$) with $\grave{a} : \bar{b} : \acute{c} = 1{\cdot}5807 : 1 : 1{\cdot}8057$, $\beta = 64° 36'$. Optically —. $\mathfrak{a} \wedge \acute{c} = Bx_{a.r} \wedge \acute{c} = -4° 34'$, $Bx_{a.y} \wedge \acute{c} = -5° 20'$, $2H_{a.r} = 86° 52'$, $2H_{o.r} = 89° 26'$, $\therefore 2V_r = 88° 40\frac{1}{3}'$. In composition and optical characters it lies between ordinary epidote and piedmontite.

[2] Absorption phenomena, etc., cf. Lasp., l. c.; Dx., Bull. Soc. Min., **6**, 25, 1883.

**409. ALLANITE,** or ORTHITE. Crystallized Gadolinite? (fr. Greenland) *T. Allan*, Tr. R. Soc. Edinb., **6**, 345 (read Nov. 1808) = Allanite *Thomson*, ib., 371 (read Nov. 1810); Phil. Mag., **36**, 278, 1811. Cerin (fr. Riddarhyttan) *Hisinger*, Afh., **4**, 327, 1815. Orthit (fr. Finbo) *Berz.*, Afh., **5**, 32, 1818. Pyrorthit (fr. Kårarfvet) *Berz.*, Afh., **5**, 52, 1818. Bucklandit (fr. Arendal), *Levy*, Ann. Phil., **7**, 134, 1824. Tautolit (fr. L. Laach) *Breith.*, Schw. J., **50**, 321, 1826. Uralorthit *Herm.*, J. pr. Ch., **23**, 273, 1841. Bagrationit (fr. Achmatovsk) *Kk.*, Russisches Berg. J., **1**, 434, 1847; Pogg., **73**, 182, 1848 [not Bagrationite *Herm.*, = Epidote]. Xanthorthit (fr. Erikberg) *Herm.*, J. pr. Ch., **43**, 112, 1848.

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c} = 1{\cdot}55090 : 1 : 1{\cdot}76908$; $\beta = {}^*64° 59' = 001 \wedge 100$ Rath[1].

$100 \wedge 110 = {}^*54° 34'$, $001 \wedge 101 = 63° 24'$, $001 \wedge 011 = 58° 2\frac{2}{3}'$.

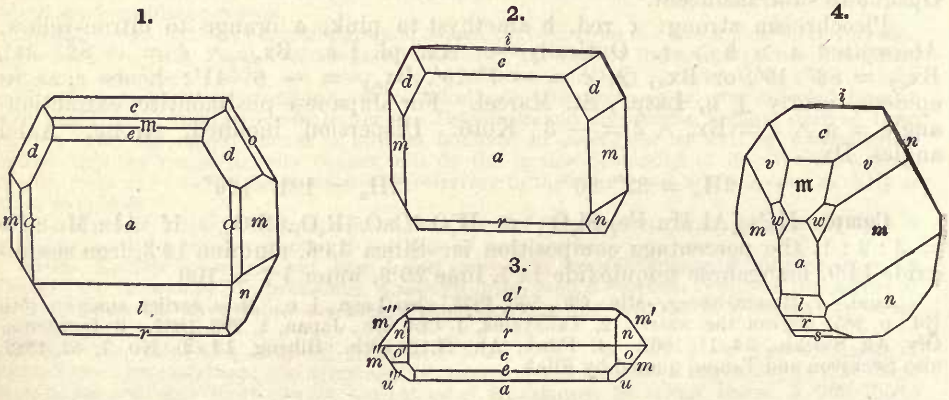
**Forms**[2]:
*a* (100, *i*-$\bar{i}$, T)
*c* (001, *O*, M)
*π* ($10{\cdot}1{\cdot}0$, *i*-$\bar{10}$)[7]
*p* (610, *i*-$\bar{6}$)[5]
*u* (210, *i*-$\bar{2}$)

*m* (110, *I*, z)
**m** (102, $-\frac{1}{2}$-$\bar{i}$)
*e* (101, $-$ 1-$\bar{i}$)[3]
*h* (201, $-$ 2-$\bar{i}$)[5]
*σ* ($\bar{1}03$, $\frac{1}{3}$-$\bar{i}$)
*i* ($\bar{1}02$, $\frac{1}{2}$-$\bar{i}$)

*s* ($\bar{2}03$, $\frac{2}{3}$-$\bar{i}$)
*r* ($\bar{1}01$, 1-$\bar{i}$)
*l* ($\bar{2}01$, 2-$\bar{i}$)
*g* ($\bar{7}03$, $\frac{7}{3}$-$\bar{i}$)[7]
*f* ($\bar{3}01$, 3-$\bar{i}$)[4]
*λ* ($\bar{5}01$, 5-$\bar{i}$)[7]

*k* (012, $\frac{1}{2}$-$\grave{i}$)
*o* (011, 1-$\grave{i}$)
*V* (115, $-\frac{1}{5}$)[6]
*v* (112, $-\frac{1}{2}$)
*d* (111, $-$ 1)
*x* ($\bar{1}12$, $\frac{1}{2}$)

*n* ($\bar{1}11$, 1)
*q* ($\bar{2}21$, 2)
*w* (211, $-$ 2-$\bar{2}$)
*y* ($\bar{2}11$, 2-$\bar{2}$)[3]
*ρ* ($\bar{1}24$, $\frac{1}{2}$-$\grave{2}$)[6]



Figs. 1, Moriah, N. Y., $\frac{1}{3}$ nat. size. 2, *Uralorthite*, Ilmen Mts., Kk. 3, *Bucklandite*, Laacher See, Rath. 4, *Bagrationite*, Kk.

*uu'''* = 70° 11½′
*mm'''* = 109° 8′
*c***m** = 22° 36½′
*ce* = 34° 53′
*ch* = 46° 27½′
*cσ* = 22° 19′
*ci* = 34° 15½′
*cs* = 45° 27′
*cr* = 63° 24′

*a'r* = *51° 37′
*cl* = 89° 1′
*cf* = 98° 12′
*kk'* = 77° 26′
*oo'* = 116° 5′
*cv* = 37° 32′
*cd* = 52° 9′
*cm* = 75° 48½′
*cx* = 51° 29½′

*cn* = 74° 49′
*cq* = 89° 28′
*av* = 50° 37′
*ad* = 49° 40′
*ao* = 76° 45½′
*a'x* = 83° 3′
*a'n* = 68° 42′
*a'q* = 60° 51′
*aw* = 34° 15′

*do* = 27° 5½′
*dn* = 61° 38′
*vv'* = 61° 36′
*dd'* = 83° 9′
*xx'* = 82° 15′
*nn'* = 108° 24½′
*qq'* = 114° 22′
*ww'* = 58° 41′
*yy'* = 75° 34½′

Twins: tw. pl. *a*; also *c* rare. Crystals often flat tabular ‖ *a*; also long and slender to acicular prismatic by elongation ‖ axis $\acute{b}$ Also massive and in embedded angular or rounded grains.

Cleavage: *a* and *c* in traces; also *m* sometimes observed. Fracture uneven or subconchoidal. Brittle. H. = 5·5–6. G. = 3·5–4·2 Luster submetallic, pitchy, or resinous—occasionally vitreous. Color pitch-brown to black, either brownish, greenish, grayish, or yellowish. Streak gray, sometimes slightly greenish or brownish. Subtranslucent to opaque.

In part normally anisotropic and biaxial with strong pleochroism: $\mathfrak{c}$ brownish yellow, $\mathfrak{b}$ reddish brown, $\mathfrak{a}$ greenish brown. Optically —. Double refraction weak and variable. Ax. pl. ‖ *b*. $Bx_a \wedge \acute{c} = 32\frac{1}{2}°$ approx. $\beta = 1·682$ Lcx.

According to Brögger, optically —. Ax. pl. ⊥ *b* and inclined to $\acute{c}$ — $37\frac{1}{2}°$. Sognsvand. Also for other occurrences, Arendal, Hitterö extinction-angle 34°–37°, 40°–41°. Also isotropic and amorphous by alteration analogous to gadolinite[8] and homilite.

**Var.**—This species, while closely like epidote in crystallization, varies much in the results of analyses, and also in external appearance. The more prominent ways of variation are the following: (1) The crystals are sometimes broad tabular, and sometimes very long acicular. (2) The crystals, when well-formed, often manifest no double refraction, as Des Cloizeaux observed, and as has been more closely studied by Brögger. (3) The amount of water present varies from 2 p. c. to 17 p. c., and the hardness and specific gravity correspondingly, the kinds containing the most water being lowest; and, in some, G. not exceeding 2·53. (4) There is also much diversity in pyrognostic and other chemical characters, as explained beyond.

The varieties that have been distinguished are as follows:

1. *Allanite.* In tabular crystals or plates, the crystals sometimes 8 to 10 in. long, 5 to 6 wide, and an inch or so thick. Color black or brownish black. G. = 3·50–3·95. Named after T. Allan, the discoverer of the mineral, and found among specimens from East Greenland, brought to Scotland by Giesecke early in the century. *Cerine* is the same thing, named by Hisinger, having H. = 6; G. = 3·77–3·8; luster weak, greasy; and being subtranslucent in thin splinters.

*Bucklandite* is anhydrous allanite in small black crystals from a magnetite mine near Arendal, Norway. It was referred here by v. Rath on the ground of the angles and physical characters (Pogg., **113**, 281, 1861). That of the Laacher See is also shown to have the angles of allanite by Rath (l. c.); the angles are those cited above as the angles of the species. *Tautolite Breith.* is also from the trachyte of the Laacher See and is probably the same species.

2. *Uralorthite* is allanite in large prismatic crystals from the Ilmen Mts., near Miask. H. = 6; G. = 3·41–3·60 Herm.; 3·647 Rg. It is pitch-black, gives a gray powder, and is nearly anhydrous.

3. *Bagrationite.* Occurs, according to Koksharov, in black crystals, which are nearly symmetrical like the bucklandite of Achmatovsk, and not lengthened, like uralorthite, in the direction of the orthodiagonal. Angles the same with those of uralorthite. H. = 6·5. G. = 3·84 Kk. Streak dark brown. B.B. intumesces and forms a black, shining, magnetic pearl. In powder not attacked by hot hydrochloric acid or by boiling nitric acid. Named after the discoverer, P. R. Bagration. From Achmatovsk, Ural. Hermann has described and analyzed what he calls *bagrationite*, from Achmatovsk, which he states has the angles of the bucklandite *of Achmatovsk*, and which, therefore, is true epidote (q.v.). The analyses by Hermann sustain this reference.

4. *Orthite* included, in its original use, the slender or acicular prismatic crystals, often a foot long, containing some water. But these graduate into massive forms, and some orthites are anhydrous, or as nearly so as much of the allanite. The name is from ὀρθός, *straight*. The tendency to alteration and hydration may be due to the slenderness of the crystals, and the consequent great exposure to the action of moisture and the atmosphere. Luster vitreous to greasy. Some authors use orthite as the comprehensive name of the species.

5. *Xanthorthite*, of Hermann, is yellowish and contains much water, and is apparently an altered variety: G. = 2·78–2·9. Named from ξανθος, *yellow*, and *orthite*.

6. *Pyrorthite* of Berzelius is an impure altered orthite-like mineral, in long prisms of rather loose texture, containing as its principal impurity some carbonaceous material (over 30 p. c.), and showing this in its burning before the blowpipe. Named from πῦρ, *fire*, and *orthite*. From Kårarfvet, near Falun, Sweden.

**Comp.**—Like epidote $H\overset{II}{R}\overset{III}{R}_3Si_3O_{13}$ or $H_2O.4RO.3R_2O_3.6SiO_2$ with $\overset{II}{R}$ = Ca and Fe, and $\overset{III}{R}$ = Al,Fe, the cerium metals Ce,Di,La, and in smaller amount those of the yttrium group. Some varieties contain considerable water, but probably by alteration.

On the composition of allanite, see Rg., Zs. G. Ges., **24**, 60, 1872.

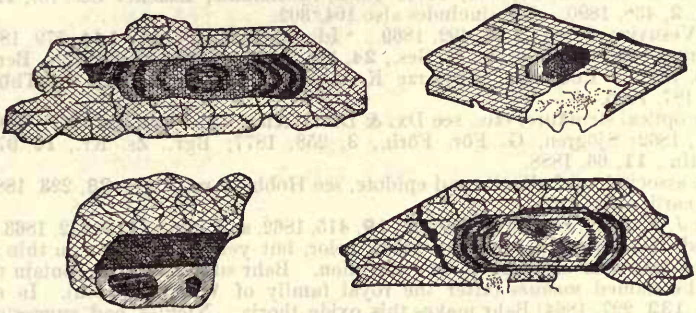
| | G. | $SiO_2$ | $ThO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Ce_2O_3$ | $Di_2O_3$ | $La_2O_3$ | $Y_2O_3$ | $Er_2O_2$ | FeO | MnO | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Hitterö | 3·52 | 31·63 | 0·87 | 13·21 | 8·39 | 8·67 | 5·60 | 5·46 | 0·87 | 0·52 | 7·86 | 1·66 | 10·48 | 0·08 | 0·28 | — | 3·49 | = 99·07 |
| 2. Ural | 3·67 | 30·81 | — | 16·25 | 6·29 | 10·13 | 3·43 | 6·35 | 1·24 | — | 8·14 | 2·25 | 10·43 | 0·13 | 0·53 | — | 2·79 | = 98·77 |
| 3. Chester County | 3·48 | 31·56 | 0·31 | 16·77 | 5·74 | 18·15 | 2·71 | | 1·65 | — | 9·08 | 1·15 | 9·35 | — | 0·37 | — | 2·25 | = 99·09 |
| 4. Slättåkra | 3·38 | 29·31 | 0·18 | 12·79 | 6·63 | 10·49 | 5·33 | 6·37 | 1·52 | — | 8·85 | 1·48 | 7·38 | 1·63 | 0·64 | — | 6·64 | = 99·24 |
| 5. Ytterby | 3·39 | 32·07 | *tr.* | 16·52 | 2·53 | 5·90 | 7·57 | 5·16 | 2·74 | 2·00 | 11·89 | 2·34 | 6·75 | 0·45 | 0·29 | — | 3·23 | = 99·44 |
| 6. Kragerö | 3·57 | 32·85 | — | 19·28 | 4·07 | 9·24 | 5·58 | 4·85 | — | — | 8·08 | 0·51 | 11·09 | 0·14 | 0·27 | — | 3·72 | = 99·68 |
| 7. Alvö | 3·39 | 30·54 | 2·49 | 13·67 | 6·76 | 8·08 | 3·95 | 8·10 | 1·92 | — | 10·42 | 2·09 | 7·09 | 0·40 | 0·18 | 0·28 | 4·44 | = 100·42 |
| 8. Egedes Minde | 3·32 | 33·29 | 1·17 | 19·35 | 3·31 | 9·26 | 6·97 | 1·04 | — | — | 10·67 | — | 11·04 | 0·40 | 1·27 | 0·38 | 1·54 | = 99·68 |
| 9. Näskilen | 3·33 | 32·01 | 1·14 | 17·54 | 5·20 | 6·21 | 10·78 | 0·24 | 1·38 | 1·53 | 9·92 | 0·47 | 12·03 | — | 0·15 | — | 1·79 | = 100·39 |
| 10. Blakstadbro | 3·28 | 32·08 | — | 17·65 | 4·94 | 9·40 | 7·09 | 3·15 | 1·49 | — | 7·21 | — | 10·90 | 0·11 | 0·79 | — | 6·44 | = 101·25 |
| 11. Stockholm | 3·22 | 30·05 | 1·06 | 17·19 | 3·67 | 10·57 | 5·97 | 6·17 | 0·78 | — | 8·67 | 0·94 | 9·57 | 0·10 | 0·27 | — | 5·53 | = 100·54 |
| 12. Ytterby | 2·92 | 33·48 | *tr.* | 18·06 | 5·10 | 3·75 | 3·76 | 4·01 | 2·77 | 0·78 | 6·42 | — | 10·99 | — | 0·35 | — | 9·72 | = 99·19 |
| 13. Karlberg | 3·07 | 30·89 | — | 22·17 | 5·47 | 4·35 | 2·88 | 6·67 | 2·08 | — | 5·13 | — | 4·97 | — | 0·58 | 0·66 | 14·63 | = 100·48 |
| 14. Tunaberg | | 34·52 | 3·48 | 18·79 | 3·11 | 1·34 | 9·77 | — | — | — | 7·08 | 1·56 | 16·21 | 0·17 | 0·12 | — | 3·15 | = 99·30 |
| 15. Bastnäs, *A* | 4·15 | 30·99 | — | 9·10 | 8·71 | 11·35 | 16·08 | — | — | — | 12·69 | — | 9·08 | 1·36 | — | — | 0·33 | = 99·69 |
| 16. " *B* | 4·15 | 31·12 | — | 8·73 | 9·02 | 12·90 | 14·46 | — | — | — | 12·29 | — | 9·74 | 1·12 | — | — | 0·48 | = 99·86 |
| 17. Kragerö | 3·54 | 31·72 | *undet.* | 17·80 | 2·52 | 19·43 | | — | — | — | 9·37 | — | 13·17 | 0·74 | 0·25 | 0·04 | 3·30 | = 98·34 |
| 18. Hitterö | 3·503 | 32·08 | 0·95 | 13·91 | 8·37 | 7·47 | 12·30 | — | 1·11 | — | 7·85 | 1·21 | 10·47 | 0·49 | 0·54 | — | 2·74 | = 99·49 |
| 19. Näskilen | 3·47 | 32·32 | — | 14·76 | 5·95 | 6·35 | 14·91 | — | 1·86 | — | 10·81 | 0·95 | 10·55 | 0·23 | 0·23 | 0·60 | 1·64 | = 101·17 |
| 20. Buö | 3·465 | 33·22 | *undet.* | 14·08 | 6·14 | 20·97 | | — | — | — | 6·99 | 0·48 | 11·15 | 0·13 | — | 0·56 | 5·93 | = 99·65 |
| 21. Körsbärshagen | 3·37 | 31·86 | 1·51 | 14·88 | 2·47 | 7·64 | 10·84 | — | 1·88 | — | 13·09 | 2·02 | 9·76 | 0·09 | 0·24 | — | 3·90 | = 100·18 |
| 22. Greenland | 3·37 | 32·97 | 0·33 | 16·10 | 4·65 | 9·66 | 10·65 | — | — | — | 9·52 | 0·90 | 12·40 | 0·16 | 0·17 | — | 1·96 | = 99·47 |
| 23 Ytterby | 3·041 | 33·03 | 1·12 | 17·63 | 5·26 | 2·84 | 7·68 | — | 2·92 | — | 7·01 | 0·64 | 12·78 | 0·11 | 0·40 | — | 9·37 | = 100·79 |
| 24 " | 3·33 | 31·44 | 1·63 | 17·12 | 3·97 | 5·61 | 12·78 | — | 4·20 | — | 12·02 | 2·17 | 7·30 | 0·32 | 0·23 | — | 2·15 | = 100·94 |
| 25. Kartagobacke | 2·406 | 30·77 | *undet.* | 15·24 | 3·06 | 12·54 | 8·31 | — | 1·93 | — | 11·70 | 0·31 | 9·38 | 0·38 | 0·69 | — | 4·60 | = 98·91 |
| 26. Eriksberg | 2·74 | 31·54 | 1·34 | 13·84 | 3·65 | 6·59 | 11·42 | — | 1·28 | — | 1·21 | 1·14 | 3·34 | 0·94 | 0·36 | 0·14 | 21·11 | $CO_2$ 1·49 = 99·39 |
| 27. " | 2·872 | 32·02 | 1·50 | 15·80 | 2·17 | 6·55 | 10·17 | — | 1·36 | — | 5·45 | 0·44 | 6·99 | 1·84 | 0·28 | 0·38 | 12·25 | $CO_2$ 2·93 = 100·13 |
| 28. Arendal | 2·98 | 28·64 | — | 15·66 | 21·16 | | 13·51 | | — | — | 1·80 | — | 1·40 | 0·31 | *tr.* | 3·02 | 14·61 | = 100·11 |
| 29. *Bucklandite* | 3·983 | 31·83 | — | 13·66 | ? | | 20·89 | | — | — | 18·35 | — | 11·46 | 2·70 | — | — | — | = 98·89 |
| 30. *Uralorthite* | 3·647 | 34·08 | — | 16·86 | 7·35 | | 21·38 | | — | — | 7·90 | 0·13[a] | 9·28 | 0·95 | — | — | 1·32 | = 99·25 |
| 31. *Bagrationite* | 3·46 | 38·88 | — | 20·19 | 9·82 | | 3·60 | | — | — | — | — | 17·37 | 1·98 | — | — | 1·60 | = 97·26 |
| 32. Bedford Co., Va. | 4·32 | 26·70 | — | 6·34 | 3·21 | 33·76 | 16·34 | 1·03 | — | 0·52[b] | 4·76 | *tr.* | 2·80 | 0·54 | 0·55 | 0·49 | 1·99 | = 99·03 |
| 33. Amelia Co., Va. | 3·323 | 32·35 | — | 16·42 | 4·49 | 11·14 | 6·91 | 3·47 | — | — | 10·48 | 1·12 | 11·47 | — | 0·46 | | 2·31 | = 100·62 |
| 34. Nelson Co., Va. | 3·59 | 30·04 | — | 16·10 | 5·06 | 11·61 | 5·39 | 4·11 | — | — | 9·89 | *tr.* | 13·02 | 1·11 | 0·02 | 0·28 | 2·56 | $SnO_2$ 0·17 = 99·36 |
| 35. Balsam Gap, N. C. | 3·400 | 32·79 | — | 18·16 | 1·64 | 6·07 | 14·40 | — | 1·84 | — | 10·08 | 1·23 | 10·95 | 0·15 | 0·12 | 0·33 | 1·89 | = 99·65 |
| 36 Alex. Co., N. C. | 3·005 | 32·05 | — | 22·93 | 11·04 | — | 14·81 | — | 0·85 | — | — | 1·99 | 9·43 | 1·28 | 0·20 | 0·54 | 3·64 | = 98·76 |
| 37. Statesville, N. C. | 3·63 | 31·68 | — | 17·38 | 7·05 | — | 18·99[c] | — | 1·12 | | 10·11 | 1·03 | 10·79 | 0·54 | *tr.* | 0·21 | 1·46 | = 100·31 |
| 38. India | 3·546 | 31·67 | 0·33 | 12·20 | 4·42 | — | 23·98 | — | 0·36 | — | 10·89 | 2·52 | 9·39 | 2·08 | — | — | 2·25 | = 100·07 |
| 39. " | 3·491 | 32·04 | — | 14·02 | 7·17 | — | — | — | 0·33 | — | 7·52 | 0·37 | 13·37 | 1·47 | — | — | 2·63 | = 100·16 |
| 40. Douglas Co., Col. | 3·52 | 31·13 | 0·21 | 11·44 | 6·24 | 12·50 | 10·98 | | — | 0·27[b] | 13·59 | 0·61 | 9·44 | 0·16 | *tr.* | 0·56 | 2·78 | = 99·91 |

[a] CuO.     [b] BeO.     [c] Mostly $Di_2O_3$, 5 p. c. $Ce_2O_3$.

**Anal.**—1–13, Engström, Akad. Afhandling, Upsala, 1877. 14–27, Cleve, quoted by Engström. 28, Paijkull, Akad. Afhandl., Upsala, 1875, p. 17. 29, Rath, Pogg., **119**, 269, 1863. 30, Rg., Min. Ch., 746, 1860. 31, Hermann, J. pr. Ch., **88**, 199, 1863. 32, Page, Chem. News, **46**, 195, 1882. 33, Dunnington, Am. Ch. J., **4**, 139, 1882; also Koenig, Proc. Ac. Philad., 103, 1882. 34, Memminger, ib., **7**, 177, 1885. 35, F. A. Genth, Min. N. C., ~~45, 1881.~~ 36, Id., Am. Phil. Soc., **20**, 402, 1882. 37, H. F. Keller, Am. Phil. Soc., **24**, 42, 1887. 38, 39, Genth, Am. J. Sc., **40**, 118, 1890. 40, Eakins, Proc. Colorado Sc. Soc., **2**, 32, 1885. Also 5th Ed., pp. 287, 288.—For analyses see the preceding page.

**Pyr., etc.**—Some varieties give much water in the closed tube and all kinds yield a small amount on strong ignition. B.B. fuses easily and swells up (F. = 2·5) to a dark, blebby, magnetic glass. With the fluxes reacts for iron. Most varieties gelatinize with hydrochloric acid, but if previously ignited are not decomposed by acid.

**Obs.**—Occurs in albitic and common feldspathic granite, gneiss, syenite, zircon-syenite, porphyry. Also in white limestone, and often in mines of magnetic iron. Rather common as an accessory constituent in many rocks, as in andesyte, dioryte, dacyte, rhyolyte, tonalyte of Mt. Adamello (Rath), the scapolite rocks of Ödegaarden, Norway (Lcx.), etc. Cf. Iddings and Cross, Am. J. Sc., **30**, 108, 1885; Lcx., Bull. Soc. Min., **12**, 210, 1889. Sometimes inclosed as a nucleus in crystals of the isomorphous species, epidote; as at Sillböle, Finland and other points (Nordenskiöld, F. J. Wiik, Min-Saml. Helsingfors, fig. 7, 1887, Lcx., l. c., *et al.;* similarly at Ilchester, Md., Hobbs[9]).



Allanite enclosed within epidote, Ilchester, Md., Hobbs[9].

*Allanite* occurs in Greenland, in granite; at Criffel, in Scotland, in small crystals; at Jotun Fjeld in Norway, in a kind of porphyry, and at Snarum, in albite, along with rutile and apatite; at the Plauensche Grund, near Dresden; in granite at the Schwarze Krux near Schmiedefeld and elsewhere in the Thüringer Wald; in the granite of Striegau, Silesia. At Vesuvius in ejected masses with sanidine, sodalite, nephelite, hornblende, etc. Similarly in trachytic ejected masses at the Laacher See (*bucklandite*) with sanidine, mica, hornblende, etc. In granular limestone at Auerbach on the Bergstrasse, but rare. *Cerine* occurs at the Bastnäs mine, in Westmanland, Sweden, with cerite, hornblende and chalcopyrite.

*Orthite* occurs in acicular crystals sometimes a foot long at Finbo near Falun in Sweden; at Ytterby and Skeppsholm near Stockholm, in black vitreous masses disseminated through gneiss; also at Kragerö, Hitterö, and Fille Fjeld in Norway; at Sillböle; also at Stansvik, parish of Helsinge, in Finland, forming the nucleus of epidote crystals; *uralorthite* occurs with small crystals of zircon in flesh-red feldspar at Miask in the Ural; *bagrationite* at the Achmatovsk mine near Zlatoust.

In *Mass.*, at the Bolton quarry; at S. Royalston, in boulders; in Athol, on the road to Westminster, in gneiss; at Swampscot, near Marblehead. In *Conn.*, at Allen's vein, at the gneiss quarries, Haddam. In *N. York,* near West Point, in tabular cryst.; Moriah, Essex Co., with magnetite and apatite, some cryst. 8–10 in. long, 6–8 broad, and 1–2 thick; at Monroe, Orange Co. In *N. Jersey,* at Franklin with feldspar and magnetite. In *Penn.*, at S. Mountain, near Bethlehem, in large crystals; at E. Bradford in Chester Co. (called orthite, G. = 3·5); at Easton, Northampton Co.(?); Pricetown, near Reading, Berks Co., abundant. In *Virginia,* in large masses in Amherst Co.; also in Bedford, Nelson, and Amelia counties. In *N. Carolina,* in crystals at the hiddenite mine in Alexander Co., with emerald, etc.; also in Mitchell Co., at the Wiseman mica mine; at Balsam Gap, Buncombe Co.; massive in large quantities near Bethany Church, Iredell Co.; also Democrat P. O., Madison Co.; at Brindletown, and at the zircon mines in Henderson Co. At the Devil's Head Mt., Douglas Co., Colorado. As an accessory rock constituent it has been identified in many localities (cf. above). In *Canada,* at Bay St. Paul, Charlevoix Co., Quebec; in a rock composed of labradorite and hypersthene from Lake St. John, Chicoutimi Co., Quebec; at Hollow lake, head-waters of the S. Muskoka, Ontario.

**Alt.**—The hydrous varieties of allanite or orthite (see several of the analyses given on p. 524, also *vasite* below) are properly altered forms of the species. They often contain carbon dioxide. It is probable that the carbonates of lanthanum and of cerium proceed at times from the alteration of allanite.

The alteration product of the allanite of Amherst Co., Va., which forms an earthy pulverulent crust about the original mineral (anal. 1, J. A. Cabul, Ch. News, **30**, 141, 1872), has been analyzed by J. R. Santos (ibid., **38**, 95, 1878), anal. 2, 3:

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | $Ce_2O_3$ | $(La,Di)_2O_3$ | $Yr_2O_3$ | CaO | MgO | BeO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Amherst Co., Va., *Allanite* | 3·83 | 31·23 | 16·45 | 3·49 | 13·67 | 11·24 | 9·90 | 1·65 | 8·69 | 0·22 | 0·24 | 2·28 | = 99·06 |
| 2. Crust, inner, *blk.rd.* | | 8·05 | 16·83 | 37·14 | — | 7·13 | — | — | — | — | 0·94 | 29·55 | = 99·64 |
| 3. " outer, *white* | | 21·37 | 20·66 | 12·24 | — | 21·90 | — | — | — | — | 1·95 | 21·37 | = 99·49 |

**Ref.**—[1] Laacher See, Pogg., **113**, 281, 1861. [2] See Kk., Min. Russl., **3**, 344, 1858, **4**, 37, 1862; also earlier Haid., Min. Mohs, **3**, 68, 1825, Pogg., **5**, 157, 1825; Rose, Reis. Ural, **1**, 432, 1837; Credner, Pogg., **79**, 144, 1850; A. E. Nordenskiöld, Laurinkari, ib., **101**, 635, 1857; *cerine*, Öfv. Ak. Stockh., **27**, 551, 1870; Rath, *bucklandite*, Laacher See, ib., **113**, 281, 1861; Gdt., Index, **2**, 438, 1890. Gdt. includes also 104, 302.

[3] Rath, Vesuvius, Pogg., **138**, 492, 1869. [4] Id., Radauthal, ibid., **144**, 579, 1871. [5] Bauer, Schwarze Krux, Schmiedefeld, Zs. G. Ges., **24**, 385, 1872. [6] Rath, Auerbach, Ber. nied. Ges., p. 25, Jan. 3, 1881. [7] Luedecke, Schwarze Krux, and other localities in the Thüringer Wald, Zs. Kr., **10**, 187, 1885.

[8] On the optical structure, etc., see Dx. & Dmr., Ann. Ch. Phys., **59**, 357, 1860; Dx., Min., **1**, 259 *et seq.*, 1862; Sjögren, G. För. Förh., **3**, 258, 1877; Bgr., Zs. Kr., **16**, 97, 1890; Lcx., Bull. Soc. Min., **11**, 66, 1888.

[9] On the association of allanite and epidote, see Hobbs, Am. J. Sc., **38**, 223, 1889, who gives in detail the earlier literature.

WASITE *J. F. Bahr*, Öfv. Ak. Stockh., **19**, 415, 1862, and Pogg., **119**, 572, 1863. Vasite. A much altered allanite, of a brownish black color, but yellowish brown in thin splinters and powder; with traces of cleavage in one direction. Bahr supposed it to contain the oxide of a new metal he named *wasium* (after the royal family of Wasa, Sweden). In a later paper (Lieb. Ann., **132**, 227, 1864) Bahr makes this oxide thoria. Nicklès had suggested previously that it might be impure cerium. From Rönsholm, an island near Stockholm. Analyses by Engström are (ref., p. 525) as follows:

| | $SiO_2$ | $ThO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Y_2O_3$ | $Er_2O_3$ | $Ce_2O_3$ | $Di_2O_3$ | $La_2O_3$ | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Blk.-brown* | 32·75 | 0·98 | 11·45 | 17·21 | 3·77 | 2·22 | 3·64 | 3·46 | 4·64 | 7·95 | 11·95 | = 100·02 |
| *Red* | 38·40 | 0·94 | 15·65 | 19·97 | 3·52 | 1·93 | 4·19 | 4·42 | 3·50 | 3·60 | 13·97 | = 101·09 |

MUROMONTITE *Kerndt*, J. pr. Ch., **43**, 228, 1848. In grains. H. = 7. G. = 4·263. Luster vitreous or slightly greasy. Color black or greenish black. Apparently related to allanite, but containing much of the yttrium metals, also beryllium and but little aluminium or cerium. Analysis—Kerndt:

| $SiO_2$ | $Al_2O_3$ | $Y_2O_3$[a] | $Ce_2O_3$ | $La_2O_3$ | BeO | FeO | MnO | CaO | MgO | $Na_2O$ | $K_2O$ | $H_2O$&loss | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31·09 | 2·23 | 37·14 | 5·54 | 3·54 | 5·52 | 11·23 | 0·91 | 0·71 | 0·42 | 0·65 | 0·17 | 0·85 | = 100 |

[a] Yttrium earths.

From Mauersberg, near Marienberg, in the Saxon Erzgebirge. Named from a Latin rendering of Mauersberg.

BODENITE *Breith.*, Pogg., **62**, 273, 1844, *Kersten*, ib., **63**, 135, *Kerndt.*, J. pr. Ch., **43**, 219, 1848. Related to muromontite in composition, and in containing more yttrium than cerium, but has a larger percentage of alumina and lime, and no glucina, and is hydrous. Composition according to Kerndt:

| $SiO_2$ | $Al_2O_3$ | $Y_2O_3$[a] | $Ce_2O_3$ | $La_2O_3$ | FeO | MnO | CaO | MgO | $Na_2O_3$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26·12 | 10·34 | 17·43 | 10·46 | 7·57 | 12·05 | 1·62 | 6·32 | 2·34 | 0·84 | 1·21 | 3·02 | loss 0·68 = 100 |

[a] Yttrium earths.

From Boden, near Marienberg, with muromontite.

## 14. Axinite Group. Triclinic.

**410. AXINITE.** Espéce de Schorl (fr. Oisans) *Schreiber*, 1781, de Lisle's Crist., **2**, 353, 1783. Schorl violet, Schorl transparent lenticulaire (fr. Oisans), *de Lisle*, ib., and J. Phys., **26**, 66, 1785. Thumerstein (fr. Thum) *Wern.*, Bergm. J., 54, 261, 1788. Glasschörl *Blumenb.*, Nat., 1791. Schorl violet, Yanolite, *Delameth.*, Sciagr., **1**, 287, 1792. Axinite *H.*, J. Mines, **5**, 264, 1799, Tr., **3**, 1801. Thumite.

Triclinic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}49211 : 1 : 0{\cdot}47970$; $\alpha = 82° 54' 13''$, $\beta = 91° 51' 43''$, $\gamma = 131° 32' 19''$ Rath[1].

$100 \wedge 010 = 48° 21' 8''$, $100 \wedge 001 = 93° 48' 56''$, $010 \wedge 001 = 97° 50' 8''$.

**Forms**[2]:
*a* (100, $i$-$\bar{i}$, l)$^3$
*b* (010, $i$-$\breve{i}$, v)$^4$
*c* (001, $O$, m)$^2$
*β* (510, $i$-$\bar{5}'$)$^6$
*H* (310, $i$-$\bar{3}'$)$^{3,5}$
*α* (210, $i$-$'\bar{2}$)$^7$
*K* (11·7·0, $i$-$\bar{\frac{11}{7}}'$)$^{3,5}$
*m* (110, $I'$, u)$^2$
*h* (3$\bar{1}$0, $'i$-$\bar{3}$)$^7$

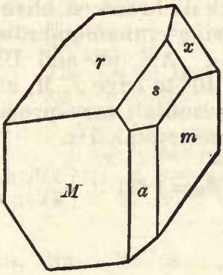
*M* (1$\bar{1}$0, $'I$, P)$^2$
*w* (1$\bar{3}$0, $'i$-$\breve{3}$)$^4$
*s* (201, $'2$-$\bar{i}'$)$^2$
*g* (023, $\frac{2}{3}$-$\breve{i}'$)$^7$
*f* (011, 1-$\breve{i}'$)$^6$
*y* (021, 2-$\breve{i}'$)$^4$
*X* (0$\bar{2}$1, $'2$-$\breve{i}$)$^7$
*μ* (0$\bar{4}$1, $'4$-$\breve{i}$)$^9$
*W* (312, $\frac{3}{2}$-$\bar{3}'$)$^{12}$

*x* (111, 1$'$)$^2$
*ν* (131, 3-$\breve{3}'$)$^{11}$
*e* ($\bar{1}$11, $,1$)$^3$
*σ* ($\bar{2}$41, $,4$-$\breve{2}$)$^8$
*ρ* ($\bar{3}$71, $,7$-$\frac{7}{3}$)$^8$
*ψ* ($\bar{1}$33, $,1$-$\breve{3}$)$^8$
*o* ($\bar{1}$32, $,\frac{3}{2}$-$\breve{3}$)$^2$
*Y* ($\bar{1}$31, $,3$-$\breve{3}$)$^4$
*ζ* ($\bar{1}$55, $,1$-$\breve{5}$)$^7$?

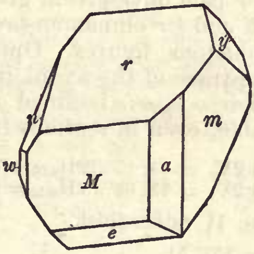
*q* ($\bar{1}$51, $,5$-$\breve{5}$)$^4$
*V* ($\bar{1}\bar{1}$2, $\frac{1}{2},$)$^{8,12}$
*i* (3$\bar{1}$1, $'3$-$\bar{3}$)$^9$
*z* (1$\bar{1}$2, $'\frac{1}{2}$)$^2$
*L* (4$\bar{4}$5, $'\frac{4}{5}$)$^3$
*B* (5$\bar{5}$6, $'\frac{5}{6}$)$^9$
*r* (1$\bar{1}$1, $'1$)$^2$
*π* (2$\bar{2}$1, $'2$)$^8$
*φ* (3$\bar{3}$1, $'3$)$^9$

*τ* (8·$\bar{1}\bar{0}$·3, $'\frac{10}{8}$-$\frac{5}{4}$)$^8$
*ξ* (6$\bar{8}$3, $'\frac{8}{3}$-$\frac{4}{3}$)$^8$
*ϵ* (3$\bar{5}$2, $'\frac{5}{2}$-$\frac{5}{3}$)$^{10}$
*d* (2$\bar{4}$1, $'4$-$\breve{2}$)$^7$
*δ* (1$\bar{3}$2, $'\frac{3}{2}$-$\breve{3}$)$^7$
*n* (1$\bar{3}$1, $'3$-$\breve{3}$)$^3$
*k* (2$\bar{6}$1, $'6$-$\breve{3}$)$^7$
*t* (3$\bar{7}$1, $'7$-$\frac{7}{3}$)$^7$
*θ* (1$\bar{7}$2, $'\frac{7}{2}$-$\breve{7}$)$^7$?

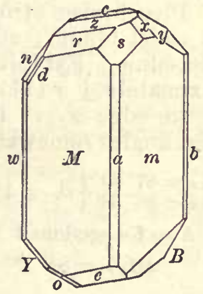
1.



2.



3.



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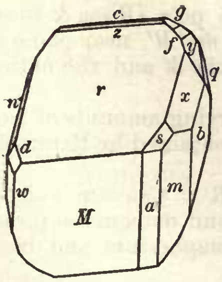

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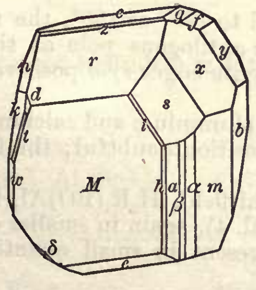

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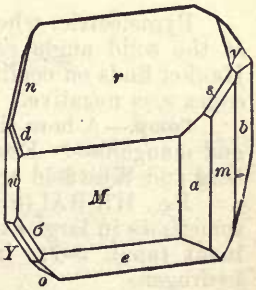


Figs. 1, Bourg d'Oisans. 2, Poloma, Schrauf. 3, Bethlehem, Penn., Frazier. 4, Botallack, Rath. 5, Bourg d'Oisans, Rath. 6, Poloma, Schrauf.

*aH* = 6° 21′
*aα* = 9° 2′
*am* = 15° 34′
*bm* = 32° 47′
*ah* = 7° 54′
*aM* = 28° 55′
*mM* = 44° 29′
*aw* = 89° 23′

*cs* = 72° 12′
*as* = 21° 37′
*cg* = 24° 11′
*cf* = 34° 49′

*cy* = 56° 58′
*cX* = 47° 13′
*cμ* = 62° 0′

*cx* = 65° 1½′
*cm* = 95° 34½′
*mx* = *30° 33′
*ce* = 44° 45′
*cz* = 27° 19′
*cr* = 44° 40½′
*cπ* = 63° 8½′
*cM* = 89° 55½′

*Mr* = 45° 15′

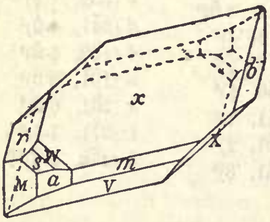
*rz* = 18° 21′
*re* = 89° 25½′
*bx* = 45° 53′
*b′r* = 93° 21′
*xr* = 40° 46′
*M′e* = 45° 19½′
*Mi* = 24° 34′
*Ms* = 33° 18′
*Mx* = 49° 25′
*My* = 79° 12′
*MY* = 115° 24′
*sy* = 45° 54′

*sx* = *16° 7′
*xy* = 29° 47′
*iy* = 54° 38′
*ms* = *27° 57′
*mr* = 64° 22′
*mX* = 132° 46′
*rs* = 36° 25′
*my* = 49° 40′
*mo* = *85° 38′
*ox* = *61° 51′
*ho* = 97° 42′
*so* = 76° 43′

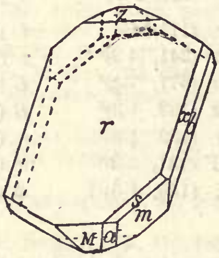
Crystals usually broad and acute-edged, but varied in habit; usually with *M* (1$\bar{1}$0) and *r* (1$\bar{1}$1) prominent, rarely *x* (111); also rarely prismatic ‖ $\dot{c}$ (f. 3). Faces in zone *maM*, also *Msx*, often striated ‖ their respective intersection-edges; also *r* usually striated ‖ edge *r*/*M*. Also massive, lamellar, lamellæ often curved; sometimes granular.

Cleavage: *b* distinct; also *c*, *w*; *r* interrupted; *M*, *y* in traces (Dx.). Fracture conchoidal. Brittle. H. = 6·5–7. G. = 3·271 Haid.; 3·294 but after fusion 2·812 Rg. Luster highly glassy. Color clove-brown, plum-blue, and pearl-gray; also honey-yellow, greenish yellow. Streak uncolored. Transparent to subtranslucent.

7.



8.



7, Franklin, N. J., Pfd. 8, Guadalcazar, Id.

Pleochroism strong: ⊥ *r* pale olive-green, giving with dichroscope olive-green and violet-blue; ⊥ edge *r*/*M* and ‖ *r* cinnamon-brown, giving cinnamon-brown and violet-blue. Exhibits idiophanous figures. Optically –. Ax. pl. and $Bx_a$ approximately ⊥ *x* (111). The trace of the ax. pl. inclined 40° to edge *x*/*M*, and 24° 40′ to edge *x*/*r*. Dispersion $\rho < v$; inclined and horizontal, very prominent. Axial angles somewhat variable, even in sections from same crystal, Dx.

$$\left.\begin{matrix} 2H_{a.r} = 87^\circ\ 30' \\ 2H_{a.r} = 86^\circ\ 33' \end{matrix}\right\} \beta_r = 1{\cdot}678 \ \therefore \left\{\begin{matrix} 2V_r = 74^\circ\ 17' \\ 2V_r = 73^\circ\ 32' \end{matrix}\right. \quad \left.\begin{matrix} 2H_{a.bl} = 87^\circ\ 47' \\ 2H_{a.bl} = 86^\circ\ 43' \end{matrix}\right\} \beta_{bl} = 1{\cdot}691 \ \therefore \left\{\begin{matrix} 2V_{bl} = 74^\circ\ 39' \\ 2V_{bl} = 73^\circ\ 49' \end{matrix}\right.$$

Also for sections I, very thin; II, rather thick.

I. $2H_{a.r} = 84^\circ\ 7'$ $2E_r = 157^\circ\ 51$ II. $2H_{a.r} = 82^\circ\ 15'$ $2E_r = 148^\circ\ 53'$

| Indices | α | β | γ | | 2V | 2E |
|---|---|---|---|---|---|---|
| Red | 1·6720 | 1·6779 | 1·6810 | ∴ | 71° 38′ | 158° 13′ |
| Blue | 1·6850 | 1·6918 | 1·6954 | ∴ | 71° 49′ | 165° 38′ |

Pyroelectric, when heated to 120° or 130°, the analogous pole (Riess & Rose) at the solid angle *rxM′*; the antilogous pole at the angle *mr′M′* near plane *n*. Hankel finds on cooling the acute edges *r*/*m* positive; the faces *M* and the obtuse edges *r*/*m* negative.

**Comp.**—A boro-silicate of aluminium and calcium with varying amounts of iron and manganese. Exact composition doubtful; the formulas obtained by Rammelsberg and Whitfield are:

Rg., $HR_3BAl_2(SiO_4)_4$; Whitfield, $H_2R_4(BO)Al_3(SiO_4)_6$. R = Calcium chiefly, sometimes in large excess (anal. 4), again in smaller amount and manganese prominent (anal. 5–7); iron is present in small quantity, also magnesium and basic hydrogen.

**Anal.**—1, Rg., Zs G. Ges., **21**, 689, 1869. 2, 3, Whitfield, Am. J. Sc., **34**, 286, 1887. 4, Baumert, quoted by Luedecke, Zs. Nat. Halle, **42**, 1, 1889. 5–7, F. A. Genth, Am. J. Sc., **41**, 394, 396, 1891.

| | G. | $SiO_2$ | $B_2O_3$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Bourg d'Oisans | | 43·46 | 5·61 | 16·33 | 2·80 | 6·78 | 2·62 | 20·19 | 1·73 | 1·45 | $K_2O$ 0·11 = 101·08 |
| 2. " " | | 41·53 | 4·62 | 17·90 | 3·90 | 4·02 | 3·79 | 21·66 | 0·74 | 2·16 | = 100·32 |
| 3. Cornwall | | 42·10 | 4·64 | 17·40 | 3.06 | 5·84 | 4·63 | 20·53 | 0·66 | 1·80 | = 100·66 |
| 4. Radauthal | | 40·76 | 4·76 | 12·47 | 2·17 | 3·60 | 2·84 | 30·21 | 2·00 | 1·22 | = 100·03 |
| 5. Franklin, *cryst.* | 3·358 | 42·77 | 5·10 | 16·73 | 1·03 | 1·60[a] | 13·69 | 18·25 | 0·23 | 0·76 | = 100·16 |
| 6. " *lam.* | 3·306 | 42·47 | 5·05 | 16·85 | 1·16 | 1·73[b] | 13·14 | 18·35 | 0·26 | 0·40 | = 99·41 |
| 7. Guadalcazar | 3·299 | 42·85 | 5·17 | 16·96 | 5·00 | 0·19[c] | 9·59 | 18·49 | 0·87 | 0·75 | = 99·87 |

[a] ZnO, including 0·12 CuO. [b] ZnO, including 0·09 PbO, 0·11 CuO. [c] CuO.

**Pyr., etc.**—B.B. fuses readily with intumescence, imparts a pale green color to the O.F., and fuses at 2 to a dark green to black glass; with borax in O.F. gives an amethystine bead (manganese), which in R.F. becomes yellow (iron). Fused with a mixture of bisulphate of potash and fluor on the platinum loop colors the flame green (boric acid). Not decomposed by acids, but when previously ignited, gelatinizes with hydrochloric acid.

**Obs.**—Axinite occurs in implanted glassy clove-brown crystals, at St. Cristophe, near Bourg d'Oisans in Dauphiné, with albite, prehnite, and quartz. In the Harz at Andreasberg, Treseburg, also in the Radauthal; in granite at Striegau, Silesia; on Mt. Monzoni, in Tyrol, with brown garnet and calcite forming a vein in diabase; Piz Valatscha, the northern spur of Mt. Skopi south of Dissentis in Eastern Switzerland; Poloma, Hungary; Baveno, Italy; Elba; at the silver mines of Kongsberg, Norway, in small crystals; with hornblende or magnetic iron in Nordmark, Sweden; L. Onega, Russia, and near Miask in the Ural; in Cornwall, of a dark color, at the Botallack mine near St. Just, where it also occurs massive, forming a peculiar kind of rock with garnet and tourmaline; at Trewellard, at Carn Silver near Lamorran creek, and at Boscawen Cliffs in St. Burien; in Devonshire, at Brent Tor, 4 m. north of Tavistock; at Thum near Ehrenfriedersdorf in Saxony. It occurs with gray cobalt near Coquimbo, Chili, at the mine La Buitro. At Guadalcazar, Mexico, in minute brownish or greenish crystals embedded in feldspar, which is in part changed to kaolinite.

In the U. S., at Phippsburg, Maine, with yellow garnet and vesuvianite; at Wales, Maine; at Cold Spring, N. Y.; Franklin Furnace, N. J., in honey-yellow crystals and laminated forms with rhodonite, polyadelphite, barite; at Bethlehem, Pa., with amphibole. Rare in Northumberland Co., Nova Scotia, on McKay's brook, a branch of N.E. Mirimichi river.

Named from *ἀξίνη, an axe*, in allusion to the form of the crystals. The name *yanolite* is of earlier date; but it means *violet-stone*, and violet is not a characteristic color of the mineral.

**Alt.**—Crystals altered to chlorite occur on Dartmoor in Devonshire, England.

**Ref.**—[1] Pogg., **128**, 20, 227, 1866 (Rath's axes calculated for Naumann's position are entirely wrong). The position taken is that of Naumann; see Frazier (Am. J. Sc., **24**, 442, 1882) for a table giving the symbols of the planes in the positions of Neumann and Miller, Rath, Des Cloizeaux, Schrauf, and Frazier; the last two chosen to show relation to titanite and datolite respectively. See also Gdt., Index, **1**, 271, 1886, who gives transformation-equations; Solly, Min. Mag., **6**, 203, 1886; Hintze, Min., **2**, 487, 1891.

[2] Haüy, Min., **2**, 559, 1822. [3] Phillips, Min., p. 43, 1823, identified by Dx. (l. c.). [4] Neumann, Pogg., **4**, 63, 1825. [5] Dx., Min., **1**, p. 515, 1862. [6] Mgc., credited by Dx. [7] Rath, l. c.; he adds two doubtful planes $\eta$ and $\lambda$. [8] Schrauf, Ber. Ak. Wien, **62** (2), 712, 1870; **65** (1), 241, 1872; Atlas, xxv, 1870. [9] Hbg., Min. Not., **5**, 28, 1863, **11**, 30, 1873. [10] Websky, Min. Mitth., 1, 1872. [11] Schmidt, Zs. Kr., **6**, 98, 1882. [12] Pfd., Franklin Furnace, N. J., Am. J. Sc., **41**, 394, 1891.

On *pyro-electricity*, Riess & Rose, Pogg., **59**, 375, 1843; Hankel, Wied. Ann., **6**, 57, 1879. *Heat expansion*, Beckenkamp, Zs. Kr., **5**, 451, 1881.

## Orthosilicates not included in foregoing Groups.

| | | | | $\breve{a} : \bar{b} : \acute{c}$ |
|---|---|---|---|---|
| **411.** | **Prehnite** | $H_2Ca_2Al_2(SiO_4)_3$ | Orthorhombic | 0·8401 : 1 : 0·5549 |
| **412.** | **Harstigite** | $H_7(Ca,Mn)_{12}Al_3(SiO_4)_{10}$ | Orthorhombic | 0·7148 : 1 : 1·0150 |

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**413.** **Cuspidine** $Ca_2Si(O,F_2)_4$? Monoclinic

$\grave{a} : \dot{\bar{b}} : \acute{c} = 0·7243 : 1 : 1·9342; \quad \beta = 89° 22'$

**411. PREHNITE.** Chrysolite *Sage,* Min., 1, 232, 1777. Chrysolite du Cap (a kind of Schorl) *de Lisle,* 2, 275, 1783. Zeolithe verdâtre *v. Born,* Cat. de Raab, 1, 203, 1790. Prehnit *Wern.,* Bergm. J., 1, 110, 1790; anal. by *Klapr.,* Schrift Ges. nat. Berlin, 8, 217, 1788. Koupholite (fr. Barèges), *Picot de la Peyrouse, Delameth.,* T. T., 2, 547, 1797. Ædelite (Edelite) *Walmstedt,* Brz. JB., 5, 217, 1825. Jacksonite *Whitney,* J. Nat. H. Soc. Boston, 5, 487, 1847.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}84009 : 1 : 0{\cdot}55494$ Streng[1].
$100 \wedge 110 = {}^*40° \, 2'$, $001 \wedge 101 = 33° \, 26\frac{5}{6}'$, $001 \wedge 011 = 29° \, 1\frac{2}{3}'$.

**Forms**[2]:
*a* (100, *i*-$\bar{i}$)
*b* (010, *i*-$\breve{i}$)
*c* (001, *O*)
*m* (110, *I*)
*p* (130, *i*-$\breve{3}$)[3]
*v* (304, $\frac{3}{4}$-$\bar{i}$)
*n* (302, $\frac{3}{2}$-$\bar{i}$)
*o* (061, 6-$\breve{i}$)
*r* (221, 2)
*s* (661, 6)
*q* (261, 6-$\breve{3}$)[3]

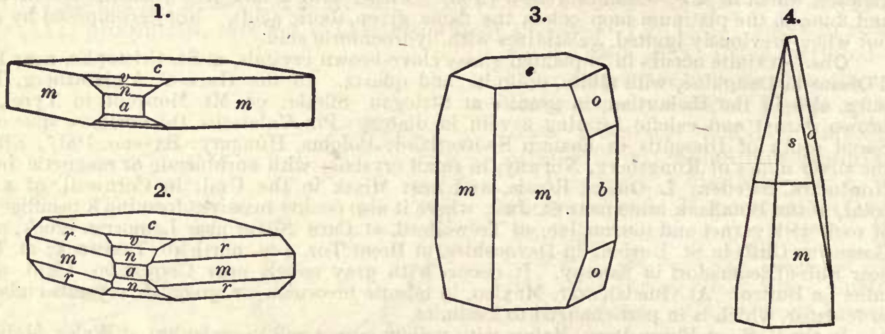


Fig. 1, Harzburg, Streng. 2, Farmington, Dx. 3, Ratschinges, Tyrol, Haid.
4, Jordansmühl, Beutell.

*mm‴* = 80° 4′
*pp′* = 43° 17′
*vv′* = 52° 42′
*nn′* = 89° 28′
*oo′* = 146° 34′
*oo‴* = *33° 26′
*cr* = 59° 54′
*cs* = 79° 4′
*rr′* = 82° 58′
*rr‴* = 67° 38′
*ss′* = 97° 29′
*ss″* = 78° 20′

Distinct individual crystals rare; usually tabular ‖ *c;* sometimes prismatic; again acute pyramidal. Faces *c* striated ‖ edge *a/c; b* rough and uneven; *m* smooth and brilliant, also striated ‖ edge *m/c.* Commonly in groups of tabular crystals, united by *c* making broken forms, often barrel-shaped. Reniform, globular, and stalactitic with a crystalline surface. Structure imperfectly columnar or lamellar, strongly coherent; also compact granular or impalpable.

Cleavage: *c* distinct. Fracture uneven. Brittle. H. = 6–6·5. G. = 2·80–2·95. Luster vitreous; *c* weak pearly. Color light green, oil-green, passing into white and gray; often fading on exposure. Subtransparent to translucent. Streak uncolored. Pyroelectric, with polarity central, the analogous poles at the center of the base and the antilogous at the extremities of the brachydiagonal[4].

Optically +. Double refraction strong. Ax. pl. usually ‖ *b,* dispersion $\rho > v$ or $\rho < v$, weak; sometimes (Farmington) ‖ *a,* dispersion strong $\rho > v$. Bx ⊥ *c.* Index $\beta_y = 1{\cdot}626$. Axial angles variable, Dx.:

| | | | |
|---|---|---|---|
| Dauphiné | $2H_r = 74° \, 29'$ to $76° \, 7'$ | ∴ | $2E_r = 124° \, 54'$ to $129° \, 9'$ |
| " | $2H_r = 75° \, 22'$ to $75° \, 52'$ | ∴ | $2E_r = 127° \, 9'$ to $128° \, 28'$ |
| Pyrenees | $2H_r = 73° \, 43'$ to $74° \, 42'$ | ∴ | $2E_r = 122° \, 59'$ to $125° \, 27'$ |

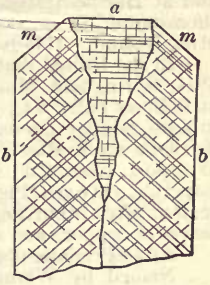
Also for homogeneous crystals, Beutell:

$2H_{a\cdot r} = 77° \, 41'$ $2H_{a\cdot y} = 77° \, 44'$ $2H_{a\cdot bl} = 77° \, 53'$ ∴ $2E_y = 135° \, 26'$ $2V_y = 69° \, 22'$

Ratschinges $\alpha_y = 1{\cdot}616$ $\beta_y = 1{\cdot}626$ $\gamma_r = 1{\cdot}649$ Lévy-Lcx.

The grouping in the common aggregated forms is often highly complex with consequent wide variation in the optical characters (cf. Dx., Mld., Emerson, Beutell)[5]; crossed dispersion, otherwise characteristic of the monoclinic system is often observed. For example, a section ∥ *c* (f. 5) of a variety from Farmington was divided (Mld.) into two parts: (1) a central wedge-shaped portion with lamellæ chiefly ∥ *a*, also ⊥ *a*, with parallel extinction; optically +; ax. pl. usually ∥ *a*, also ⊥ *a*; angle variable but usually small and becoming 0°. (2) Also lateral sectors (see fig.) with lamellæ chiefly ∥ *m* and less prominent nearly ⊥ *m* (110 and $1\bar{1}0$), the angle included being 82°–83°; these lamellæ show no definite extinction; the axial figure is distorted, crossed dispersion is visible; ax. pl. inclined about 48° to the normal to *a* for red and about 58° for blue.

5.



The peculiarities of the wedge-shaped portion are explained by the presence of two systems of thin layers superimposed normal respectively to the + and − bisectrix; in the lateral sectors there is an intergrowth of systems of lamellæ having a common base but whose axes of elasticity are inclined 60° to each other, thus producing rotatory polarization, analogous to that produced by mica laminæ crossed at angles of 60°.

**Var.**—Usual in firm and hard incrusting masses, externally globular or mammillary, the surface made up often of grouped crystals more or less imperfect, but sometimes smooth.

*Coupholite* is in cavernous masses, made of small, thin, fragile laminæ or scales; the original was from the peak of Ereslids, near Barèges, in the Pyrenees; also reported from the Col du Bonhomme, at the foot of Mt. Blanc. Named from κοῦφος, *tender*. *Edelite*, or *Ædelite*, is prehnite from Ædelfors, Sweden. *Jacksonite*, or "*anhydrous prehnite*," of Whitney is ordinary prehnite, from Keweenaw Pt. and Isle Royale; it contains 4 to 5 p. c. water (Jackson and Brush); that examined by Whitney may have been from a specimen previously calcined with associated ores.

**Comp.**—An acid orthosilicate, $H_2Ca_2Al_2Si_3O_{12}$ = Silica 43·7, alumina 24·8, lime 27·1, water 4·4 = 100.

Prehnite is sometimes classed with the zeolites, with which it is often associated; the water here, however, has been shown to go off only at a red heat (Rg.), and hence plays a different part. Doelter (Jb. Min., **2**, 137, 1890) calls attention to a similarity in composition to friedelite, p. 465.

**Anal.**—1, Rg., Zs. G. Ges., **20**, 79, 1868. 2–5, Corsi, Boll. Com. Geol., 54, 1878; cf. also 155, 1879. 6, Schubert, Inaug. Diss. Brieg, 1880. 7, Beutell, Jb. Min., **1**, 89, 1887, also Traube, ib. 8, Schalch, Jb. Min., Beil., **4**, 182, 1886. 9, Hersch, Inaug. Diss., p. 27, Zürich, 1887. 10, Young, Ch. News, **27**, 56, 1873. 11, P. T. Cleve. Ak. H. Stockh., **9**, No. 12, 1871. 12, Darapsky. Jb. Min., **1**, 66, 1888. 13, Genth, Am. Phil. Soc., **20**, 401, 1882. 14, Harrington, Geol. Canada, 1868.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. Ratschinges, Tyrol | | 43·40 | 24·53 | — | 27·37 | 4·48 = 99·78 |
| 2. Impruneta, Tuscany | 2·91 | 42·35 | 24·67 | 0·92 | 25·77 | 4·81 MgO 0·45 = 98·97 |
| 3. Figline " | 2·93 | 42·36 | 24·14 | 1·10 | 26·87 | 4·85 MgO 0·30 = 99·62 |
| 4. Monte Catini " | | 42·86 | 24·20 | 0·99 | 27·03 | 4·96 = 100·04 |
| 5. Elba | | 44·03 | 23·20 | 2·05 | 26·24 | 4·90 = 100·42 |
| 6. Jordansmühl | | 44·12 | 26·00 | 0·61 | 25·26 | 4·91 = 100·90 |
| 7. Striegau | | 43·12 | 25·62 | *tr.* | 26·69 | 4·92 = 100·35 |
| 8. Globenstein | | 43·57 | 24·76 | *tr.* | 26·80 | 4·59 = 99·72 |
| 9. Harzburg | 2·907 | 43·23 | 23·41 | 1·68 | 27·41 | 4·42 = 100·15 |
| 10. Bowling | 2·885 | 43·41 | 24·77 | — | 27·13 | 4·20 $Na_2O$ 0·27 = 99·78 |
| 11. Tortola | 2·98 | 44·06 | 22·94 | 1·98 | 26·62 | 4·44 = 100·04 |
| 12. Rodaito, Chili | | 43·57 | 24·27 | 4·44 | 21·74 | 5·28 $Na_2O$ 0·96 = 100·26 |
| 13. Cornwall, Penn. | 3·042 | 42·40 | 20·88 | 5·54 | 27·02 | 4·01 = 99·85 |
| 14. Templeton | 2·791 | 42·82 | 23·86 | 1·42 | 27·64 | 4·82 MnO 0·10, MgO 0·09 = 100·75 |

**Pyr., etc.**—In the closed tube yields water. B.B. fuses at 2 with intumescence to a blebby enamel-like glass. Decomposed slowly by hydrochloric acid without gelatinizing; after fusion dissolves readily with gelatinization. *Coupholite*, which often contains organic matter, blackens and emits a burnt odor.

**Obs.**—Occurs chiefly in basic eruptive rocks, basalt, diabase, etc., as a secondary mineral in veins and cavities, often associated with some of the zeolites, also datolite, pectolite, calcite, but commonly one of the first formed of the series; also less often in granite, gneiss, syenite, and then frequently associated with epidote; sometimes associated with native copper, as in the L. Superior region.

At St. Christophe and l'Armentières, near Bourg d'Oisans in Dauphiné, associated with axinite and epidote; at Ratschinges in Tyrol, in the Fassathal, and near Campitello; in Salzburg; the Ala valley in Piedmont; the Saualpe in Carinthia; Joachimsthal in Bohemia; in Nassau, at Oberscheld and Uckersdorf; near Freiburg in Baden on the Rosskopf; Schwarzenberg in Saxony, in the Harz, near Andreasberg, with datolite, and near Harzburg in the Radauthal; in granite at

Striegau, Silesia, also at Jordansmühl; Arendal, Norway; Ædelfors in Sweden (*edelite*); Upsala, Sweden, in rifts in hornblendic granite, the decomposition of the hornblende having afforded the lime, and of the mica, the alumina (Paijkull); at Friskie Hall and Campsie in Dumbartonshire, and at Hartfield Moss, in Renfrewshire, in veins traversing trap, associated with analcite and thomsonite; also at Corstorphine Hill, the Castle and Salisbury Craig, near Edinburgh; Mourne Mts., Ireland. Handsome polished slabs of this mineral have been cut from masses from China.

In the United States, finely crystallized at Farmington, Woodbury, and Middletown, Conn., West Springfield, Mass., and Paterson and Bergen Hill, N. J.; in small quantities in gneiss, at Bellows Falls, Vt.; in syenite, at Somerville, Mass.; Milk Row quarry, Somerville, often in minute tabular crystals, with chabazite, also with epidote; also at Palmer (Three Rivers) and Turner's Falls, Mass., on the Connecticut, in trap, and at Perry, above Loring's Cove, Maine; at Westport, Essex Co., N. Y. (*chiltonite* Emmons), on a quartzose rock; on north shore of Lake Superior, between Pigeon Bay and Fond du Lac; in large veins in the Lake Superior copper region, often occurring as the veinstone of the native copper, sometimes including strings or leaves of copper; and at times in radiated nodules disseminated through the copper.

**Alt.**—Prehnite occurs altered to green earth and feldspar.

Named by Werner in 1790 after Col. Prehn, who first found the mineral at the Cape of Good Hope. Sage had called it (1777) *chrysolite*, and Romé de Lisle had referred it (1783) to the group of *schorl*.

**Ref.**—[1] Harzburg, Jb. Min., 314, 1870. [2] See Mlr., Min., p. 415, 1752; Dx., Min., **1**, 430, 1862. [3] Beutell, Jordansmühl, l. c.; cf. also Schubert, l. c., who, however, gives neither axes nor angles. [4] Riess and Rose, Pogg., **59**, 382, 1843. See also Hankel, Wied. Ann., **6**, 55, 1879. [5] On the methods of grouping and consequent optical anomalies, cf. Dx., Bull. Soc. Min., **5**, 58, 125, 1882; Mld., ib., p. 195; Wyrouboff, ib., p. 272; Emerson, Am. J. Sc., **24**, 270, 1882.

UIGITE *Heddle*, Ed. N. Phil. J., **4**, 162, 1856, Min. Mag., **5**, 26, 1882. In radiated sheafy clusters of plates, in nests in the amygdaloid of Uig, Isle of Skye, along with analcite and faroelite. H. = 5·5; G. = 2·284; luster pearly; color white, slightly yellowish. Composition, according to Heddle: $SiO_2$ 45·98, $Al_2O_3$ 21·93, CaO 16·15, $Na_2O$ 4·69, $H_2O$ 11·25. B.B. fuses readily and quietly to an opaque enamel, which is not frothy. It appears to be near prehnite in structure, and needs further investigation.

PREHNITOID. Prenitoide *Bechi*, Boll. Com. Geol., 66, 1870; Acc. Linc. Trans., **3**, 114, 1879. An impure massive prehnite filling crevices in the gabbro of Monte Catini, Tuscany. An analysis of a crystalline variety gave: $SiO_2$ 42·30, $CO_2$ 2·85, $B_2O_3$ 0·33, $Al_2O_3$ 22·06, $Fe_2O_3$ 0·70, CaO 28 86, MgO *tr.*, $H_2O$ 2·98, N 0·19 = 100·27. Cf. Corsi, l. c. This name belongs properly to a kind of scapolite, p. 471.

**412. HARSTIGITE.** Harstigit *G. Flink*, Ak. H. Stockh., Bihang, **12** (2), No. 2, 59, 1886.

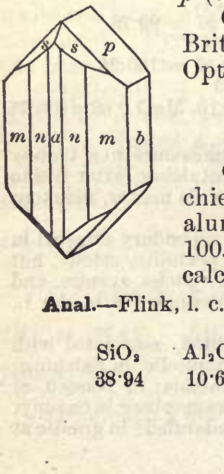
Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·71479 : 1 : 1·01495$ Flink[1].

$100 \wedge 110 = 35° 33\frac{1}{2}'$, $001 \wedge 101 = 54° 50\frac{2}{3}'$, $001 \wedge 011 = 45° 25\frac{1}{2}'$.

**Forms:** *a* (100, *i*-ī), *b* (010, *i*-ĭ); *n* (210, *i*-2̄), *m* (110, *I*); *p* (011, 1-ĭ); *s* (122, 1-2̆).

Angles, *an* = *19° 40′, *nn′* = 39° 20′, *mm‴* = 71° 7′, *pp′* = *90° 51′, *ss′* = 52° 58′, *ss″* = 102° 10′, *ss‴* = 79° 14′.

In small crystals, prismatic ∥ $\dot{c}$, with *b* prominent and terminated by the dome *p* (011) with *s* (122) small.



Cleavage not observed. Fracture small conchoidal to splintery. Brittle. H. = 5·5. G. = 3·049. Luster vitreous. Colorless. Optically +. Ax. pl. ∥ *b*. Bx ⊥ *a*. Axial angles, Flink:

$2H_{a.r} = 57° 50'$ $2H_{a.y} = 57° 56'$ $2H_{a.gr} = 58° 8'$ $2V_y = 90° 27'$

Also $\alpha_y = 1·6782$ $\gamma_y = 1·68308$ Na Ramsay[2].

**Comp.**—An acid orthosilicate of manganese and calcium chiefly, formula probably $H_7(Ca,Mn)_{12}Al_3Si_{10}O_{40}$ = Silica 39·2, alumina 10·0, manganese protoxide 13·9, lime 32·8, water 4·1 = 100. Here Mn : Ca = 3 : 1. Magnesium replaces part of the calcium.

**Anal.**—Flink, l. c.:

| $SiO_2$ | $Al_2O_3$ | MnO | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 38·94 | 10·61 | 12·81[a] | 29·23 | 3·27 | 0·35 | 0·71 | 3·97 = 99·89 |

[a] FeO *tr.*

**Pyr., etc.**—Reacts for manganese with the fluxes. Gives off water on strong ignition and turns black. The ignited powder dissolves easily in hydrochloric acid with evolution of chlorine.

**Obs.**—Occurs with yellowish red or brown garnets, in rhombic dodecahedrons, and crystals of pale red rhodonite at the Harstig mine, near Pajsberg, in Wermland, Sweden. These associated species occur lining the sides of a narrow vein which was ~~filled in~~ with calcite as a later deposit.

**Ref.**—[1] l. c. [2] Zs. Kr., **12**, 220, 1886.

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## 413. CUSPIDINE. *Scacchi*, Rendiconto R. Accad. Napoli, October 14, 1876; Zs. Kr., **1**, 398, 1877.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 0{\cdot}7243 : 1 : 1{\cdot}9342$. $\beta = 89° 22' = 001 \wedge 100$ Rath[1].

$100 \wedge 110 = 35° 54\frac{5}{6}'$, $001 \wedge 101 = {*}68° 55'$, $001 \wedge 011 = 62° 39\frac{1}{2}'$.

**Forms**[1]:
$b$ (010, $i$-ĭ)
$c$ (001, $O$)
$m$ (110, $I$)

$h$ (103, $-\frac{1}{3}$-ĭ)
$e$ (101, $-$ 1-ĭ)
$f$ ($\bar{1}$01, 1-ĭ)
$k$ (014, $\frac{1}{4}$-ĭ)

$g$ (012, $\frac{1}{2}$-ĭ)
$d$ (011, 1-ĭ)
$p$ (113, $-\frac{1}{3}$)
$n$ (111, $-$ 1)

$\pi$ ($\bar{1}$13, $\frac{1}{3}$)
$\nu$ ($\bar{1}$11, 1)
$t$ (211, $-$ 2-$\bar{2}$)
$\mu$ ($\bar{4}$32, 2-$\frac{4}{3}$)

$q$ (233, $-$ 1-$\frac{3}{2}$)
$s$ ($\bar{1}$21, 2-$\grave{2}$)
$r$ (872, $-$ 4-$\frac{8}{7}$)?

$mm''' = 71° 50'$
$ch = 41° 23\frac{1}{2}'$
$cf = 70° 1\frac{1}{2}'$
$kk' = 51° 36\frac{1}{2}'$

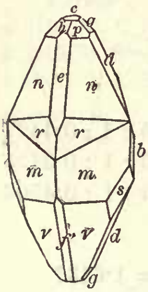
$gg' = 88° 5'$
$dd' = 125° 19'$
$cp = 47° 25'$
$cn = 72° 39\frac{1}{2}'$

$c\pi = 47° 59'$
$c\nu = 73° 36'$
$pp' = 51° 11'$
$nn' = 68° 6'$

$en = {*}34° 3'$
$\pi\pi' = 51° 40\frac{1}{2}'$
$\nu\nu' = 68° 29'$
$ss' = 107° 24'$

In minute spear-shaped crystals, aparently orthorhombic, but proved to be usually contact-twins with tw. pl. $a$, giving $c\underline{c} = {*}1° 16'$.

1.



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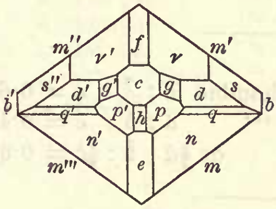

Monte Somma, Rath.

Cleavage: $c$ very distinct. Fracture uneven. Brittle. H. = 5–6. G. = 2·853–2·860. Luster vitreous. Color pale rose-red.

Ax. pl. ∥ $b$. $Bx_{a.y} \wedge \grave{c} = -5° 30'$. $2E_y = 110°$. Dispersion of the axis, also inclined very marked. Groth.

**Comp.**—Contains silica, lime, fluorine, and from alteration carbon dioxide. Formula doubtful.

A partial analysis by E. Fisher gave: CaO 59·8 (again 59·9), $Fe_2O_3$ 1·18, $CO_2$ 1·2; also F 9 to 10 p. c. Zs. Kr., 8, 39, 1883. Perhaps $Ca_2SiO_4$ with $CaF_2$.

**Pyr.**—B.B. fusible with difficulty. Readily soluble in nitric acid.

**Obs.**—From Vesuvius, in ejected masses from the tufa of Monte Somma. It occurs only very sparingly; in part in cavities with augite, hornblende, biotite, calcite, also a brown garnet and crystals of davyne; in part also embedded in a granular rock-like mass. The crystals are usually more or less altered on the surface, becoming covered with a shell of calcium carbonate.

Scacchi suggested as the probable composition $Ca_2SiO_4$ with about one-third of the lime replaced by $CaF_2$ and Fischer's trials, so far as they are conclusive, confirm this. The determination of the exact composition requires a more complete analysis, however, and it may prove not to belong to the orthosilicates with which it is provisionally placed.

Named from cuspis, *a spear*, in allusion to the characteristic form of the crystals.

**Ref.**—[1] Zs. Kr., **8**, 38, 1883, Ber. nied. Ges., 122, 1882; Groth, Zs. Kr., **8**, 43, 1888.

## IV. Subsilicates.

The species here included are basic salts, for the most part to be referred either to the metasilicates or orthosilicates, like many basic compounds already included in the preceding pages. Until their constitution is definitely settled, however, they are more conveniently grouped by themselves as SUBSILICATES. It may be noted that those species having an oxygen ratio of silicon to bases of 2 : 3, like topaz, andalusite, sillimanite, datolite, etc. (pp. 492–502 *et seq.*), also calamine, carpholite, and perhaps tourmaline, are sometimes regarded as salts of the hypothetical parasilicic acid, $H_8SiO_6$.

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### Division I. Oxygen Ratio for Si : R = 4 : 5. Formula $R_5Si_2O_9$.

### Humite Group.

| | | | |
|---|---|---|---|
| 414. **Humite** | $H_2(Mg,Fe)_{19}Si_8O_{34}F_4$? | Orthorhombic<br>or | $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}9258 : 1 : 4{\cdot}0764$<br>$\bar{b} : \breve{a} : \acute{c} = 1{\cdot}0802 : 1 : 4{\cdot}4033$ |
| 415. **Chondrodite** | | Monoclinic | $\grave{a} : \overset{\mid}{b} : \acute{c} = 1{\cdot}0863 : 1 : 3{\cdot}1447$<br>$\beta = 90°$ |
| 416. **Clinohumite** | | Monoclinic | $\grave{a} : b : \acute{c} = 1{\cdot}0803 : 1 : 5{\cdot}6588$<br>$\beta = 90°$ |

The species of the above group approximate closely in angle to chrysolite and chrysoberyl. The axial ratios may be compared as follows:

| | | |
|---|---|---|
| Humite | $\bar{b} : \breve{a} : \frac{1}{7}\acute{c}$ | $= 1{\cdot}0802 : 1 : 0{\cdot}6291$ |
| Chondrodite | $\grave{a} : \overset{\mid}{b} : \frac{1}{5}c$ | $= 1{\cdot}0863 : 1 : 0{\cdot}6289$ |
| Clinohumite | $\grave{a} : \overset{\mid}{b} : \frac{1}{9}c$ | $= 1{\cdot}0803 : 1 : 0{\cdot}6288$ |
| Chrysolite | $\bar{b} : 2\breve{a} : \acute{c}$ | $= 1{\cdot}0735 : 1 : 0{\cdot}6296$ |
| Chrysoberyl | $\bar{b} : 2\breve{a} : \acute{c}$ | $= 1{\cdot}0637 : 1 : 0{\cdot}6170$ |

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| | | | |
|---|---|---|---|
| 417. **Ilvaite** | $HCa\overset{\text{ii}}{Fe}_2\overset{\text{iii}}{Fe}Si_2O_9$ | Orthorhombic | $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}6665 : 1 : 0{\cdot}4427$ |
| 418. **Ardennite** | $H_5Mn_4Al_4VSi_4O_{23}$ | " | $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}4663 : 1 : 0{\cdot}3135$<br>or $\frac{3}{2}\breve{a} : \bar{b} : \frac{3}{2}\acute{c} = 0{\cdot}6995 : 1 : 0{\cdot}4703$ |

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| | | | |
|---|---|---|---|
| 419. **Langbanite** | $37Mn_5SiO_7.10Fe_3Sb_2O_8$? | Hexagonal | $\acute{c} = 1{\cdot}6437$ |

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### Kentrolite Group.

| | | | |
|---|---|---|---|
| 420. **Kentrolite** | $Pb_2Mn_2Si_2O_9$ | Orthorhombic | $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}6334 : 1 : 0{\cdot}8330$ |
| 421. **Melanotekite** | $Pb_2Fe_2Si_2O_9$ | | |

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| | | | |
|---|---|---|---|
| 422. **Bertrandite** | $H_2Be_4Si_2O_9$ | Orthorhombic | $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}5689 : 1 : 0{\cdot}5973$ |

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### Division II. Oxygen Ratio = 2 : 3. Formula $R_3SiO_5$.

| | | | |
|---|---|---|---|
| 423. **Calamine** | $H_2Zn_2SiO_5$ | Orthorhombic | $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}7834 : 1 : 0{\cdot}4778$ |
| 424. **Carpholite** | $H_4MnAl_2(SiO_5)_2$ | Monoclinic ? | |
| 425. **Cerite** | $H_6Ce_4Si_3O_{15}$ ? | Orthorhombic | $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}9988 : 1 : 0{\cdot}8127$ |
| 426. **Tourmaline** | | Rhombohedral | $rr' = 46° 52'$, $\acute{c} = 0{\cdot}4477$ |

## III. Basic Division.

| | | | |
|---|---|---|---|
| **427. Dumortierite** | $Al_8Si_3O_{18}$ ? | Orthorhombic | $\breve{a} : \bar{b} = 0{\cdot}532 : 1$ |
| **428. Staurolite** | $HFeAl_5Si_2O_{13}$? | Orthorhombic | $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}4734 : 1 : 0{\cdot}6828$ |
| **429. Kornerupine** | $MgAl_2SiO_6$ | Orthorhombic | $\breve{a} : \bar{b} = 0{\cdot}854 : 1$ |
| **430 Sapphirine** | $Mg_5Al_{12}Si_2O_{27}$ | Monoclinic | |

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## Humite Group.

**HUMITE—CHONDRODITE—CLINOHUMITE.** Chondrodit [= Silicate of Magnesia and Iron] *d'Ohsson,* Ak. H. Stockh., 206, 1817. Condrodite *H.* Maclureite, Fluosilicate of Magnesia (fr. Sparta, N. J.), *Seybert,* Am. J. Sc., 5, 336, 1822. Brucite (fr. N. J. and N. Y.) *Gibbs,* Cleaveland's Min., 295, 1822, Nuttall, Am. J. Sc., 5, 245, 1822. Humite *Bourn.,* Cat., 52, 1813. Umite *Ital.*

**414. HUMITE.** *Des Cloizeaux,* Phil. Mag., 2, 286, 1876, Jb. Min., 641, 1876. Humite, Type I, *A. Scacchi,* Accad. Sci. Napoli, 6, pp. 241-273, 1851 (read Nov. 12, 1850), and Pogg. Erg., 3, 161, 1851.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}92575 : 1 : 4{\cdot}07639$ or $1 : 1{\cdot}08021 : 4{\cdot}40334$ A. Scacchi[1].

$100 \wedge 110 = 42° 27\frac{1}{2}'$, $001 \wedge 101 = 77° 12\frac{1}{4}'$, $001 \wedge 011 = 76° 13'$.

**Forms**[2]:
*a* (100, *i*-ĭ, C, Scc.)
*b* (010, B, Scc.)
*c* (001, *O*, A, Scc.)
$o_2$ (210, *i*-$\bar{2}$)
*m* (110, *I*)[3]

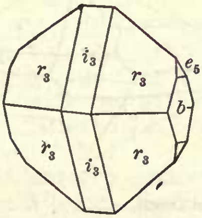
$o_1$ (230, *i*-$\frac{3}{2}$)
$i_1$ (105, $\frac{1}{5}$-ī)
$i_2$ (103, $\frac{1}{3}$-ī)
$i_3$ (101, 1-ī)
$e_y$ (017, $\frac{1}{7}$-ĭ) tw. pl.
$c_\alpha$ (016, $\frac{1}{6}$-ĭ)[4]

$e_1$ (015, $\frac{1}{5}$-ĭ)
$e_2$ (014, $\frac{1}{4}$-ĭ)
$e_3$ (013, $\frac{1}{3}$-ĭ)
$e_x$ (037, $\frac{3}{7}$-ĭ) tw. pl.
$e_4$ (012, $\frac{1}{2}$-ĭ)
$e_5$ (011, 1-ĭ)

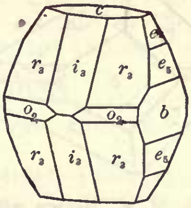
$e_\beta$ (021, 2-ĭ)[4]
$n_1$ (113, $\frac{1}{3}$)
$n_\alpha$ (112, $\frac{1}{2}$)[3]
$n_2$ (111, 1)
$r_1$ (2·1·10, $\frac{1}{5}$-$\bar{2}$)

$r_2$ (218, $\frac{1}{4}$-$\bar{2}$)
$r_3$ (216, $\frac{1}{3}$-$\bar{2}$)
$r_4$ (214, $\frac{1}{2}$-$\bar{2}$)
$r_5$ (212, 1-$\bar{2}$)

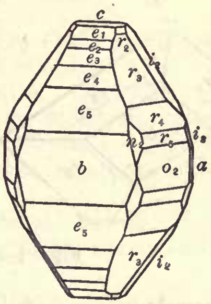
1.



2.



3.



Figs. 1, 2, Ladu mine, Sweden, H. Sjögren. 3, 4, Monte Somma, Rath; drawn with *b* (010) in front.

$o_2o_2''' = 49° 40\frac{1}{2}'$
$mm''' = 85° 35'$
$o_1o_1' = 108° 29'$
$ci_1 = 41° 22'$
$ci_2 = {*}55° 44'$
$ci_3 = 77° 12'$
$ce_y = 30° 13'$

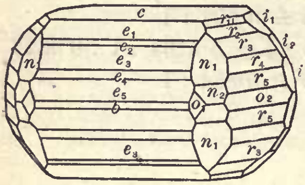
$ce_\alpha = 34° 11\frac{1}{2}'$
$ce_1 = 39° 12'$
$ce_2 = 45° 32\frac{1}{2}'$
$ce_3 = 53° 39'$
$ce_x = 60° 13'$
$ce_4 = 63° 52'$
$ce_5 = {*}76° 13'$

$ce_\beta = 83° 0\frac{1}{2}'$
$cn_1 = 63° 26'$
$cn_\alpha = 71° 34'$
$cn_2 = 80° 32'$
$cr_1 = 44° 8\frac{1}{2}'$
$cr_2 = 50° 30'$
$cr_3 = 58° 16'$

$cr_4 = 67° 36'$
$cr_5 = 78° 21'$
$n_2n_2' = 92° 45'$
$n_2n_2''' = 84° 9'$
$r_3r_3' = 101° 3'$
$r_3r_3''' = 41° 52'$
$r_5r_5''' = 48° 35'$

Twins[5]: tw. pl. (1) $e_y$ (017), with $c\underline{c}$ = 60° 26′ and 119° 34′; also (2) $e_x$ (037), with $c\underline{c}$ = 120° 25½′ and 59° 34½′; usually penetration-twins; sometimes also trillings. These two laws give nearly the same twinning angles. Crystals small and highly modified, usually elongated ‖ $\breve{a}$, or ‖ $\dot{c}$. Planes in zone *c e b* often horizontally striated.

4.



Cleavage: *c* distinct. Fracture subconchoidal to uneven. Brittle. H. = 6–6·5. G. = 3·1–3·2. Luster vitreous to resinous. Color white, yellowish white, light yellow, honey-yellow, chestnut-brown. Sometimes pleochroic.

Optically +. Double refraction strong. Ax. pl. ‖ *c*. $Bx_a \perp a$. Dispersion weak. $2H_{a.r}$ = 78° 18′–79°, Dx.

**Comp., Pyr., Obs., etc.**—See pp. 539, 540.

**Ref.**—[1] Mte. Somma, l. c. The position taken in this and the following cases is that of Scacchi and vom Rath, which seems to show the relations most simply. The letters are those of Scacchi, except for the pinacoids and unit prism. The lateral axes for the three species of this group are the same or nearly so; the vertical axes are closely in the ratio of 7 : 5 : 9 respectively. Cf. p. 534.

In the axial ratio taken by J. D. D. (Min., p. 362, 1868); also E. S. D. (Conn. Acad., **3**, 67, 1875, Am. J. Sc., **10**, 89, 1875), and H. Sjögren (Zs. Kr., **7**, 344, 1882), the vertical axes are divided by 3, 2 and 4 respectively. The axes assumed by Rath (Pogg. Erg., **5**, 324, 1870) are unsatisfactory, being deduced from measurements of clinohumite (Humite, Type III.). The following are the axial ratios (with $\breve{a}$ = 1) deduced by the authors named:

| | $\breve{a}$ : $\bar{b}$ : $\dot{c}$ | |
|---|---|---|
| Mte. Somma | 1 : 1·0802 : 4·4033 | A. Scc. |
| " " | 1 : 1·0803 : 4·4013 | Rath |
| Ladu mine, Sweden | 1 : 1·1096 : 4·3948 | H. Sj. |

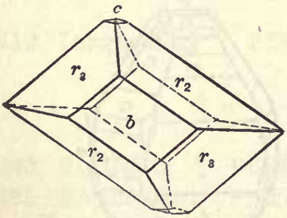
[2] A. Scc., l. c. [3] Rath, l. c., p. 325. [4] E. Scc., Rend. Acc. Napoli, Dec., 1883. See Rath, l. c., p. 330, for a description of the occurring twins.

**415. CHONDRODITE.** Des Cloizeaux, Phil. Mag., **2**, 286, 1876, **3**, 357, 1877; Jb. Min., 641, 1876, 500, 1877. Humite, Type II., *A. Scacchi*, Accad. Sc. Napoli, **6**, 1851.

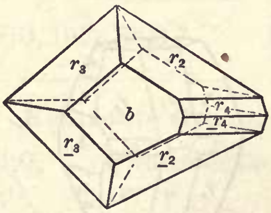
Monoclinic. Axes $\grave{a} : \bar{b} : \dot{c}$ = 1·08630 : 1 : 3·14472; β = 90° = 001 ∧ 100 E. S. Dana[1].

100 ∧ 110 = 47° 22′ 7″, 001 ∧ 101 = 70° 56′ 36″, 001 ∧ 011 = 72° 21′ 35″.

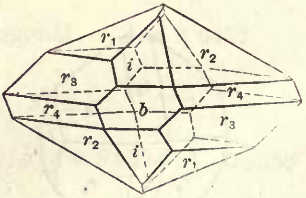
1.



2.



3.



Figs. 1–3, Brewster, N. Y., drawn with *b* (010) in front.

**Forms**[2]:
*a* (100, $i$-$\bar{i}$, B, Scc.)
*b* (010, $i$-$\grave{i}$, C, Scc.)
*c* (001, *O*, A, Scc.)
*o* (120, $i$-$\grave{2}$)[4]
$e_a$ (105, $\frac{1}{5}$-$\bar{i}$)[4]

$e_1$ (103, $\frac{1}{3}$-$\bar{i}$)
$e_\delta$ (102, $\frac{1}{2}$-$\bar{i}$)[5]
$e_\beta$ (305, $\frac{3}{5}$-$\bar{i}$)[3]
$e_2$ (101, 1-$\bar{i}$)
$e_\gamma$ (403, $\frac{4}{3}$-$\bar{i}$)[5]

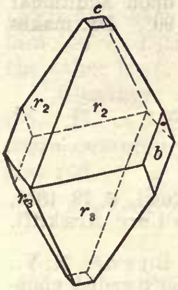
$i_\beta$ (015, $\frac{1}{5}$-$\grave{i}$)[4]
$i_a$ (014, $\frac{1}{4}$-$\grave{i}$)[3]
$i_\gamma$ (027, $\frac{2}{7}$-$\grave{i}$)[4]
$i_1$ (012, $\frac{1}{2}$-$\grave{i}$)
$i_2$ (011, 1-$\grave{i}$)[4]

$n_1$ (113, $\frac{1}{3}$)
$n_2$ (111, 1)
$\mathfrak{m}_1$ ($\bar{3}$25, $\frac{3}{5}$-$\frac{\bar{3}}{2}$)
$\mathfrak{m}_a$ ($\bar{3}$23, 1-$\frac{\bar{3}}{2}$)
$\mathfrak{m}_2$ ($\bar{3}$21, 3-$\frac{\bar{3}}{2}$)

$r_2$ (125, $\frac{2}{5}$-$\grave{2}$)
$r_4$ (121, 2-$\grave{2}$)
$r_1$ (127, $\frac{2}{7}$-$\grave{2}$)
$r_a$ ($\bar{2}$49, $\frac{4}{9}$-$\grave{2}$)[4]
$r_3$ ($\bar{1}$23, $\frac{2}{3}$-$\grave{2}$)

The forms $\bar{1}$03, $\bar{3}$05, $\bar{1}$01, 113, $\bar{1}$11, $\bar{3}$21 also occur, and perhaps others, in the negative quadrants; the + or − position as given is not in all cases certain For obvious reasons the + and − signs are omitted before Naumann's symbols.

4.



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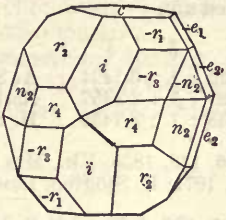

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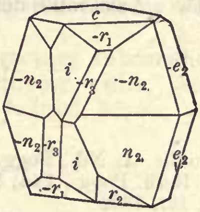

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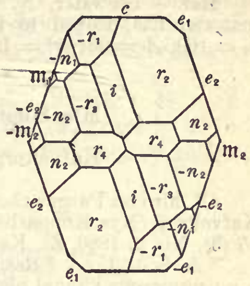

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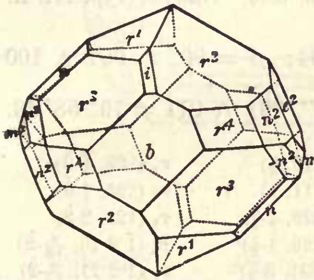
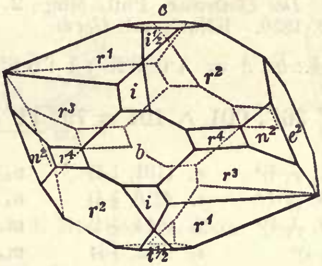
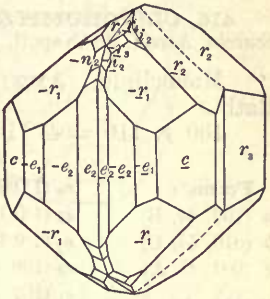


9.



10.



Figs. 4, 8, 9, Brewster, N. Y., all except 4 drawn with *b* (010) in front and $\grave{a}$ axis right and left. 5, 6, Kafveltorp, Sweden, Sjögren. 7, Mte. Somma, after Scc. 10, Mte. Somma, Rath.

$oo' = 49° \ 26'$
$ce_a = {}^*30° \ 4' \ 12''$
$ce_1 = 43° \ 59'$
$ce_\delta = 55° \ 22'$
$ce_\beta = 60° \ 4'$
$ce_2 = 70° \ 56\frac{1}{2}'$
$ci_\beta = 32° \ 10'$
$ci_a = 38° \ 10\frac{1}{2}'$

$ci_\gamma = 41° \ 56'$
$ci_1 = 57° \ 33'$
$ci_2 = 72° \ 21\frac{1}{2}'$
$cn = 54° \ 56'$
$cn_2 = 76° \ 50'$
$c\mathfrak{m}_1 = 65° \ 0'$
$c\mathfrak{m}_a = 74° \ 22'$
$c\mathfrak{m}_2 = 84° \ 40'$

$cr_1 = {}^*44° \ 41' \ 10''$
$cr_3 = 66° \ 34'$
$cr_2 = 54° \ 10'$
$cr_4 = 81° \ 47'$
$nn' = 74° \ 3'$
$n_2n_2' = 91° \ 3'$
$r_1r_1' = 79° \ 24'$

$r_3r_3' = 112° \ 55'$
$r_2r_2' = 94° \ 51\frac{1}{2}'$
$r_4r_4' = 128° \ 4'$
$e_2r_1 = 59° \ 14'$
$e_2i_1 = 79° \ 54\frac{1}{2}'$
$e_1r_1 = 103° \ 28'$
$e_2\mathfrak{m}_2 = 137° \ 3'$

Twins[6]: (1) tw. pl. $e_a$ (105), also as trillings; (2) $e_\beta$ (305) less common, but giving nearly the same twinning angles as the first law (since $e_a \wedge e_\beta' = 90° \ 8'$); these laws are analogous to those common with humite. (3) *c* (f. 2); often as polysynthetic twinning lamellæ, producing a horizontal striation, or successive bands with and without luster in the orthodome zone. Crystals varied in habit, often flattened ‖ *b*. Vicinal forms common. Also massive, compact; in embedded grains.

Cleavage: *c* sometimes distinct. Fracture subconchoidal. Brittle. H. = 6–6·5. G. = 3·1–3·2. Luster vitreous. Color light to dark yellow, honey-yellow, deep garnet-red, brownish red, hyacinth-red.

Pleochroism sometimes distinct, especially with brown crystals: $\mathfrak{c}$ yellowish gray, $\mathfrak{b}$ pale bluish gray; $\mathfrak{a}$ brownish yellow. In yellow crystals: $\mathfrak{c}$ yellowish white, $\mathfrak{b}$ grayish white, $\mathfrak{a}$ honey-yellow. Absorption $\mathfrak{a} > \mathfrak{c} > \mathfrak{b}$ Lévy-Lcx. Optically +. Ax. pl. and $Bx_a \perp b$. $Bx_o \wedge \grave{c} = \mathfrak{a} \wedge \grave{c} = +25° \ 52'$ Brewster, E. S. D.; 28° 56′ Kafveltorp, Sj.; 30° approx. Mte. Somma, Dx. Dispersion crossed. Axial angles:

Brewster $2H_{a.r} = 88° \ 48'$ E. S. D. Kafveltorp $2H_{a.r} = 86° \ 27'$ $2H_{a.bl} = 86° \ 38'$ Dx.
Kafveltorp, *brown* $2H_{a.r} = 85° \ 53'$ to $86° \ 43'$ $2H_{a.bl} = 85° \ 41'$ to $86° \ 33'$ Sj.
" *yellow* $2H_{a.r} = 89° \ 8'$ to $89° \ 20'$ $2H_{a.bl} = 89° \ 14'$ to $88° \ 28'$ Sj.
" $\alpha = 1{\cdot}607$ $\beta = 1{\cdot}619$ $\gamma = 1{\cdot}639$ Lévy-Lcx.

**Comp., Pyr., Obs., etc.**—See pp. 539, 540.

**Ref.**—[1] Brewster, N. Y., l. c. (see p. 536), a revision of earlier results upon additional material has proved to the author that $\beta$ cannot vary as much as 1′ from 90°. **Dx. makes** $e_2 = 100$, $A = 001$, $r^2 = 111$, etc. Axial ratios deduced are:

| | $\grave{a}$ : $\bar{b}$ : $\acute{c}$ | |
|---|---|---|
| Mte. Somma | 1·0796 : 1 : 3·1404 | A. Scc. |
| " " | 1·0828 : 1 : 3·1457 | Rath |
| Kafveltorp | 1·0853 : 1 : 3·1454 | H. Sj. |

Cf. also on Pargas chondrodite, A. Nd., Pogg., **96**, 118, 1855; Kk., Min. Russl., **6**, 73, 1870, Kafveltorp (Nya Kopparberg), Rath, Pogg., **144**, 563, 1871; H. Sjögren, Lunds Univ. Årsskrift. **17** (3), No. 2, 1880, Zs. Kr., **7**, 121, 1882.

[2] A. Scc., l. c. [3] Rath, Mte. Somma, Pogg. Erg., **5**, 338, 1870. [4] E. S. D., Brewster, N. Y., l. c.; numerous vicinal planes are also added; H. Sj. also adds vicinal planes for Swedish chondrodite. [5] E. Scc., Vesuvius, l. c. [6] Cf. Rath for description of twins.

### 416. CLINOHUMITE. *Des Cloizeaux*, Phil. Mag., **2**, 286, 1876. Humite, Type III. *A. Scacchi*, Accad. Sc. Napoli, **6**, 1850. Klinohumit *Germ.*

Monoclinic. Axes $\breve{a} : \bar{b} : \acute{c} = 1{\cdot}08028 : 1 : 5{\cdot}65884$; $\beta = 90° = 001 \wedge 100$ Rath[1].

$100 \wedge 110 = 47°\,12'\,36''$, $001 \wedge 101 = 79°\,11'\,32''$, $001 \wedge 011 = 79°\,58'\,43$.

**Forms**[2]:
$a$ (100, $i\text{-}\bar{i}$, B)
$b$ (010, $i\text{-}\grave{i}$, C)
$c$ (001, $O$, A)
$m$ (110, $I$)$^5$
$o_2$ (120, $i\text{-}\grave{2}$)$^5$

$e_\alpha$ $(1{\cdot}0{\cdot}21, \frac{1}{21}\text{-}\bar{i})^5$
$e_\beta$ $(1{\cdot}0{\cdot}15, \frac{1}{15}\text{-}\bar{i})^5$
$e_\gamma$ $(1{\cdot}0{\cdot}12, \frac{1}{12}\text{-}\bar{i})^5$
$e_\delta$ $(109, \frac{1}{9}\text{-}\bar{i})^4$
$e_1$ $(107, \frac{1}{7}\text{-}\bar{i})$
$e_2$ $(105, \frac{1}{5}\text{-}\bar{i})$
$e_3$ $(103, \frac{1}{3}\text{-}\bar{i})$

$e_4$ $(101, 1\text{-}\bar{i})$
$i_1$ $(016, \frac{1}{6}\text{-}\grave{i})$
$i_2$ $(014, \frac{1}{4}\text{-}\grave{i})$
$i_3$ $(012, \frac{1}{2}\text{-}\grave{i})$
$n_\alpha$ $(119, \frac{1}{9})$
$n_1$ $(117, \frac{1}{7})$
$n_2$ $(115, \frac{1}{5})$

$n_3$ $(113, \frac{1}{3})$
$n_4$ $(111, 1)$
$\mathfrak{m}_1$ $(\bar{3}29, \frac{1}{3}\text{-}\frac{\bar{3}}{2})$
$\mathfrak{m}_\alpha$ $(323, 1\text{-}\frac{\bar{3}}{2})^3$
$\mathfrak{m}_2$ $(\bar{3}21, 3\text{-}\frac{\bar{3}}{2})$
$s$ $(236, \frac{1}{2}\text{-}\frac{3}{2})^4$
$r_2$ $(1{\cdot}2{\cdot}13, \frac{2}{13}\text{-}\grave{2})$

$r_4$ $(129, \frac{2}{9}\text{-}\grave{2})$
$r_5$ $(125, \frac{2}{5}\text{-}\grave{2})$
$r_8$ $(121, 2\text{-}\grave{2})$
$r_1$ $(\bar{1}{\cdot}2{\cdot}15, \frac{2}{15}\text{-}\grave{2})$
$r_3$ $(\bar{1}{\cdot}2{\cdot}11, \frac{2}{11}\text{-}\grave{2})$
$r_6$ $(\bar{1}27, \frac{2}{7}\text{-}\grave{2})$
$r_7$ $(\bar{1}23, \frac{2}{3}\text{-}\grave{2})$

Also E. Scc.[5]: $p$ (563), $t$ (1·6·21), $t_2$ (1·6·15).

For most of the orthodomes, $e_1$ (107), etc., also the unit pyramids, $n_1$ (117), etc., the corresponding forms in the negative quadrants occur, that is, $-e_1$ (107), $-n_1$ ($\bar{1}17$), etc.

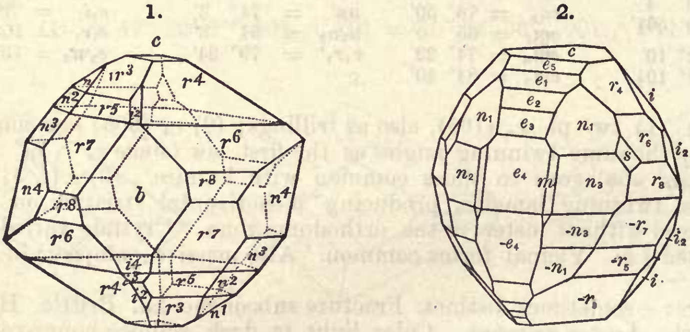


Fig. 1, Brewster. 2, Mte. Somma, Rath.

$mm''' = 94°\ 25'$
$o_2o_2' = 49°\ 40'$
$ce_\delta = 30°\ 12'$
$ce_1 = 36°\ 48\frac{1}{2}'$
$ce_2 = {}^*46°\ 20'$
$ce_3 = 60°\ 12'$
$ce_4 = 79°\ 11\frac{1}{2}'$
$ci_1 = 43°\ 19\frac{1}{2}'$
$ci_2 = 54°\ 45'$
$ci_3 = 70°\ 32'$
$cn_\alpha = 40°\ 35\frac{1}{2}'$

$cn_1 = 47°\ 46'$
$cn_2 = 57°\ 2\frac{1}{2}'$
$cn_3 = 68°\ 44\frac{1}{2}'$
$cn_4 = 82°\ 37'$
$c\mathfrak{m}_1 = 65°\ 4\frac{1}{2}'$
$c\mathfrak{m}_\alpha = 81°\ 12'$
$c\mathfrak{m}_2 = 87°\ 2\frac{1}{2}'$
$cr_1 = 39°\ 44\frac{1}{2}'$
$cr_3 = 48°\ 35'$
$cr_5 = 60°\ 42'$

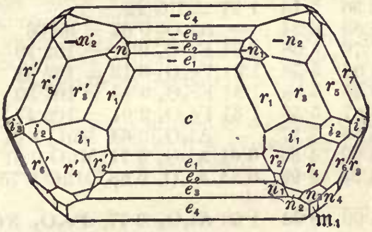
$cr_7 = 76°\ 28\frac{1}{2}'$
$cr_2 = 43°\ 49'$
$cr_4 = {}^*54°\ 11'$
$cr_6 = 68°\ 9'$
$cr_8 = 85°\ 25'$
$n_1n_1' = 65°\ 49\frac{1}{2}'$
$n_2n_2' = 70°\ 1'$
$n_3n_3' = 86°\ 18'$
$n_4n_4' = 93°\ 24'$
$r_3r_3' = 85°\ 47'$

$r_6r_5' = 104°\ 38'$
$r_7r_7' = 123°\ 56'$
$r_4r_4' = 94°\ 46'$
$r_5r_6' = 114°\ 46\frac{1}{2}'$
$r_8r_8' = 129°\ 32'$
$e_4r_6 = 63°\ 5'$
$e_4i_3 = 86°\ 25'$
$e_4r_7 = 110°\ 52\frac{1}{2}'$
$e_1n_4 = 129°\ 37'$
$e_1\mathfrak{m}_2 = 141°\ 51'$

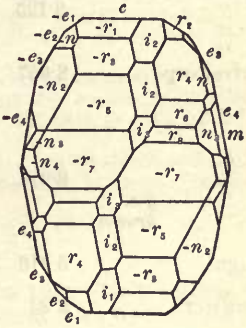
Twins: (1) tw. pl. $-e_3$ (103) common, less so (2) $+e_3$ (103); often cruciform twins and with both laws combined. (3) $c$ (f. 2); often as polysynthetic twinning lamellæ, as with chondrodite; these lamellæ present also in twins according to the other laws. Also massive.

Cleavage: $c$ sometimes distinct. Fracture subconchoidal. Brittle. H. = 6–6·5. G. = 3·1–3·2. Luster vitreous. Color white, yellowish or grayish white, more commonly light to dark brown, reddish brown, yellow, dark honey-yellow, also red.

3.



4.



3, 4. Mte. Somma, Rath.

Optically +. Ax. pl. and $Bx_a \perp b$. $Bx_o \wedge \dot{c} = \mathfrak{a} \wedge \dot{c} = +11°$ Dx.; $Bx_{o.y} \wedge \dot{c} = +12° 28'$ Klein, Mte. Somma[6]. $Bx_o \wedge \dot{c} = 7\frac{1}{2}°$ approx., Brewster[6]. Dispersion weak. Axial angles:

Mte. Somma $2H_{a.y} = 84° 40'$ to $85° 15'$ Klein
" *white* $2H_{.r} = 84° 38'$ to $85° 4'$ *yellow* $= 86° 40'$ to $87° 14'$ Dx.

**Comp., Pyr., Obs., etc.**—See below.
**Ref.**—[1] Mte. Somma, Pogg., Erg., **5**, p. 373, 1870. Other axial ratios are:

| | $\dot{a} : \bar{b} : \dot{c}$ | |
|---|---|---|
| Mte. Somma | 1·0808 : 1 : 5·6669 | A. Scc. |
| Brewster | 1·0863 : 1 : 5·6605 | E. S. D. |

Dx. makes $A = 001$, $e_4 = 100$, $r_4 = 111$, etc.
[2] A. Scc., l. c. [3] Hbg., Min. Not., **2**, 14, 1858. [4] Rath, l. c., p. 374. [6] E. Scc., l. c. [6] Dx., l. c., and Jb. Min., 645, 1876; Klein, ibid., p. 634; Cf. E. S. D., Am. J. Sc., **11**, 139, 1876.

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The composition, pyrognostic characters, and occurrence of the above three species are here discussed together.

**Comp.**—Fluo-silicates of magnesium, the same composition probably belonging to the three subspecies humite, chondrodite, and clinohumite (Wingard), viz.: $H_2Mg_{19}Si_8O_{34}F_4 = Mg_{13}(MgF)_4(MgOH)_2Si_8O_{32}$. Iron replaces part of the magnesium.

Cf. Rath, l. c., and Pogg., **147**, 258, 1872; Rg., Min. Ch., 434, 1875; Sjögren, Zs. Kr., **7**, 344, 1882. Sjögren attempts to establish a distinction in composition, which is not borne out by later analyses by Wingard.

**Anal.**—1, Rg., Pogg., **86**, 410, 1852. 2, Rath, ib., **147**, 246, 1872, also a second anal. 3–6, Wingard, Zs Anal. Ch., **24**, 344, 1885. 7, H. Sjögren, Lunds Univ. Års-skrift, **17**, 114, 1880.

8, Rg., l. c. 9, Rath, l. c., also a second anal. with 2·74 p. c. fluorine. 10, 11, Wingard, l. c. 12, Rath, l. c. 13–16, Wingard, l. c. 17, Widman, G. För. Förh., **3**, 13, 1876. 18, **19**, Sj., l. c. 20, Berwerth, Min. Mitth., 272, 1877. 21, Hawes, Am. J. Sc., **10**, 96, 1875.

22, Rg., l. c. 23, Rath, l. c. 24, 25, Wingard, l. c.

26, 27, Breidenbaugh, Am. J. Sc., **6**, 212, 1873. 28, Rg., l. c. Earlier analyses are given in 5th Ed., p. 364.

| | | G. | | $SiO_2$ | MgO | FeO | F | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| | I. *Humite.* | | | | | | | | |
| 1. | Mte. Somma | 3·216 | | 34·80 | 60·08 | 2·40 | 3·47 | — | = 100·75 |
| 2. | " | 3·208 | | 35·34 | 54·45 | 5·12 | 2·43 | — | $Al_2O_3$ 0·82, CaO 0·16 = 98·32 |
| 3. | " | | | 35·49 | 55·41 | 4·32 | 5·64 | 1·45 | = 102·31 |
| 4. | " | | | 35·38 | 57·17 | 3·08 | 5·64 | 1·45 | = 102·63 |
| 5. | " | | | 35·55 | 52·86 | 7·31 | 5·64 | 1·45 | = 102·73 |
| 6. | Ladu mine | | | 35·26 | 55 48 | 3·51 | 4·72 | 3·07 | = 102·04 |
| 7. | " " | | | 35·13 | 55·16 | 3·26 | 2·45 | 2·16 | MnO 0·41 = 98·57 |
| | II. *Chrondrodite.* | | | | | | | | |
| 8. | Mte. Somma | 3·190 | $\frac{2}{2}$ | 33·26 | 57·92 | 2·30 | 5·04 | — | CaO 0·74, $Al_2O_3$ 1·06 = 100·32 |
| 9. | " | 3·125 | | 33·82 | 59·23 | 1·78 | 2·44 | — | $Al_2O_3$ 0·94 = 98·21 |
| 10. | " | | | 33·49 | 58·29 | 3·80 | 5·25 | 1·37 | = 102·20 |
| 11. | " | | | 33·77 | 57·98 | 3·96 | 5·14 | 1·37 | = 102·22 |
| 12. | Kafveltorp | 3·057 | | 33·96 | 53·01 | 6·83 | 4·24 | — | $Al_2O_3$ 0·62 = 98·66 |
| 13. | " | | | 33·90 | 53·52 | 7·76 | 5·58 | 1·31 | $Fe_2O_3$ 0·11 = 102·10 |
| 14. | " | | | 33·53 | 52·93 | 8 96 | 5·58 | 1·31 | $Fe_2O_3$ 0 12 = 102·54 |
| 15. | " | | | 33·36 | 52·71 | 9·28 | 5 58 | 1·31 | $Fe_2O_3$ 0·13 = 102·30 |
| 16. | " | | | 31·56 | 43·41 | 18·67 | 5·58 | 1·31 | $Fe_2O_3$ 2·01 = 102·47 |
| 17. | " | 3·214 | | 35·13 | 52·62 | 5·65 | 7·17 | — | $Al_2O_3$ 0·64, MnO 1·31 = 102·52 |
| 18. | " *yw.* | | | 34 01 | 54·97 | 4·62 | 4·56 | 0·61 | $Al_2O_3$ 0·71, MnO 0·81 = 100·29 |
| 19. | " *brown* | | | 33·13 | 54·71 | 4·95 | 4·99 | 0·55 | $Al_2O_3$ 0·68, MnO 0·75, CaO *tr.*<br>[= 99·76 |
| 20. | Pargas | 3·216 | | 29·56 | 51·01 | 5·09 | 8·62 | 1·58 | $Al_2O_3$ 0·77, $Fe_2O_3$ 3·06, $Na_2O$<br>[2·11, $K_2O$ 1·31 = 103·11 |
| 21. | Brewster | 3·22 | $\frac{2}{2}$ | 34·10 | 53·72 | 7·28 | 4·14 | — | $Al_2O_3$ 0·48 = 99·72 |
| | III. *Clinohumite.* | | | | | | | | |
| 22. | Mte. Somma | 3·18–3·21 | | 36·67 | 56·83 | 1·67 | 2·61 | — | = 97·78 |
| 23. | " | 3·191 | | 36·82 | 54·92 | 5·48 | 2·20 | — | $Al_2O_3$ 0·24 = 99·66 |
| 24. | " | | | 33·40 | 51·62 | 9·63 | 5·67 | 1·41 | $Fe_2O_3$ 0·82 = 102·43 |
| 25. | " | | | 33·20 | 51·45 | 9·78 | 5·67 | 1·41 | $Fe_2O_3$ 0·96 = 102·53 |
| | *Massive, Chondrodite?* | | | | | | | | |
| 26. | Brewster, *gr. brown* | | | 35·42 | 54·22 | 5·72 | 9·00 | — | = 104·36 |
| 27. | " *red* | | | 35·42 | 51·88 | 9·73 | 5·38 | — | = 102·41 |
| 28. | " | 3·19–3 22 | $\frac{5}{5}$ | 33·52 | 56·30 | 2·96 | 7·46 | — | = 100·24 |

**Pyr., etc.**—B.B. infusible; some varieties blacken and then burn white. Fused with potassium bisulphate in the closed tube gives a reaction for fluorine. With the fluxes a reaction for iron. Gelatinizes with acids. Heated with sulphuric acid gives off silicon fluoride.

**Obs.**—Humite, chondrodite, and clinohumite (humite, Types I, II, III, Scc.) all occur at Vesuvius in the ejected masses both of limestone or feldspathic type found on Monte Somma. They are associated with chrysolite, biotite, pyroxene, magnetite, spinel, vesuvianite, calcite, etc.; also less often with sanidine, meionite, nephelite. Of the three species, humite is the rarest and clinohumite of most frequent occurrence. They seldom all occur together in the same mass (though this has in one case been noted by E. Scacchi), and only rarely two of the species (as humite and clinohumite) appear together. Occasionally clinohumite interpenetrates crystals of humite, and parallel intergrowths with chrysolite have also been observed.

*Humite* has also been identified at the Ladu mine near Filipstad, Wermland, Sweden, with magnetite in crystalline limestone; it is in part altered to serpentine. In crystalline limestone with clinohumite in the Llanos de Juanar, Serrania de Ronda, Andalusia (Lévy-Lcx., Bull. Soc. Min., **9**, 81, 1886). Also in large coarse, partly altered, crystals at the Tilly Foster iron-mine at Brewster, N. Y.

*Chondrodite* at Mte. Somma, as above noted; at Pargas, Finland, of honey-yellow color in limestone, also at other points in Finland; at Kafveltorp, Nya-Kopparberg, Sweden, associated with chalcopyrite, galena, sphalerite. In granular limestone of Strehlen, Silesia. Abundantly at Brewster, N. Y., at the Tilly Foster magnetic iron mine in deep garnet-red crystals of great beauty and variety of form. Also probably at numerous points where the occurrence of "chondrodite" has been reported.

*Clinohumite* occurs at Mte. Somma as noted above; in Andalusia, Llanos de Juanar, embedded in limestone as polysynthetic lamellæ in parallel intergrowth with humite (Lévy-Lcx., l. c.); in crystalline limestone near L. Baikal in East Siberia; at Brewster, N. Y., in rare but highly modified crystals.

Numerous other localities of "chondrodite" have been noted, chiefly in crystalline limestone; most of them are probably to be referred to the species chondrodite, but the identity in many cases is yet to be proved. Some of the foreign localities are: Strehlen in Silesia; Boden near Marienberg, Saxony; Loch Ness, Scotland; Achmatovsk in the Ural; with spinel in the limestone of Huerta and Sierra de Cordoba, Argentine Republic; Heteroland, S. Africa; with spinel in crystalline limestone in Spitzbergen.

At Brewster large quantities of massive "chondrodite" occur associated with magnetite, enstatite, ripidolite, and from its extensive alteration serpentine has been formed on a large scale.

The granular mineral is common in limestone in Sussex Co., N. J. (chondrodite, Lévy & Lex), and Orange Co., N. Y., associated with spinel, and occasionally with pyroxene and corundum. In *N. Jersey*, at Bryam, orange and straw-colored chondrodite, and also a variety nearly black, occurs with spinel; at Sparta, a fine locality of honey-yellow chondrodite; a mile to the north of Sparta the best locality of this mineral in N. J.; at Vernon, Lockwood, and Franklin. In *N. York*, in Orange Co., in Warwick, Monroe, Cornwall, near Greenwood Furnace, and at Two Ponds, and elsewhere; near Edenville in fine specimens on the land of Mr. Houston; also sparingly in Rossie, on the bank of Laidlaw Lake. In *Mass.*, at Chelmsford, with scapolite; at South Lee, in limestone. In *Penn.*, near Chaddsford, in Harvy's quarry, of yellow and orange colors, abundant. In *Canada*, in limestone at St. Crosby, St. Jerome, St. Adèle, Grenville, etc., abundant.

The name chondrodite is from *χόνδρος*, *a grain*, alluding to the granular structure. *Brucite* was given by Col. Gibbs after Dr. Bruce (1777–1818), editor of the American Mineralogical Journal; *Maclureite* by Seybert, after Wm. Maclure (1763–1840). Humite is from Sir Abraham Hume.

**Alt.**—Chondrodite altered to serpentine occurs at Sparta, N. J., with spinel and mica; also at Brewster, N. Y., where it is extensively altered, yielding serpentine in large quantities, see J. D. D., Am. J. Sc., **8**, 371, 1874.

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**417. ILVAITE.** Yenite (fr. Elba) *Lelièvre*, J. Mines, **21**, 65, 1807. Ilvait *Steffens*, Orykt., **1**, 356, 1811. Lievrit *Wern.*, Hoffm. Min., **2**, a. 376, 1812. Wehrlit *Kbl.*, Grundz, 313, 1838.

Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c} = 0{\cdot}6665 : 1 : 0{\cdot}4427$ Des Cloizeaux[1].
$100 \wedge 110 = 33° 41'$, $001 \wedge 101 = 33° 35\frac{1}{2}'$, $001 \wedge 011 = 23° 52\frac{3}{4}'$.

**Forms**[2]:
*a* (100, $i$-ī)
*b* (010, $i$-ĭ)
*c* (001, *O*)
*η* (730, $i$-$\frac{7}{3}$)[8]
*h* (210, $i$-2̄)
*ϑ* (530, $i$-$\frac{5}{3}$)[5]
*μ* (540, $i$-$\frac{5}{4}$)[8]
*m* (110, *I*)
*ν* (340, $i$-$\frac{4}{3}$)[8]
*ρ* (230, $i$-$\frac{3}{2}$)[3]
*s* (120, $i$-2̆)
*t* (130, $i$-3̆)
*d* (140, $i$-4̆)
*κ* (106, $\frac{1}{6}$-ī)[7]
*r* (101, 1-ī)
*w* (301, 3-ī)
*n* (012, $\frac{1}{2}$-ĭ)
*ϕ* (011, 1-ĭ)[8]
*e* (021, 2-ĭ)
*o* (111, 1)
*k* (411, 4-4̄)[4]
*y* (311, 3-3̄)[3]
*x* (211, 2-2̄)
*l* (421, 4-2̄)[6]
*i* (121, 2-2̆)[3]
*u* (131, 3-3̆)[3]

Lorenzen[6] gives the following vicinal forms on Greenland crystals: 0·10·1, 0·12·1, 0·190·1, 280·840·3. Bauer[8] also the following on the ilvaite from Herbornseelbach: *d* (13·17·0), (7·11·0), *υ* (4·11·0), *ω* (28·25·28), *β* (32·31·32), *τ* (18·19·19).

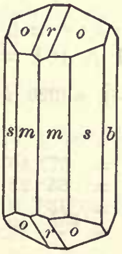
$hh''' = 36° 52'$
$mm''' = 67° 22'$
$ss' = 73° 45'$
$tt' = 53° 9'$
$rr' = 67° 11'$
$ww' = 126° 42'$
$nn' = 24° 58'$
$\phi\phi' = 47° 45\frac{1}{2}'$
$ee' = 83° 3'$
$oo' = {}^*62° 33'$
$xx' = 101° 5'$
$ii' = 52° 53'$
$uu' = 43° 33\frac{1}{2}'$
$oo'' = {}^*77° 12'$
$oo''' = 40° 29'$
$yy'' = 22° 28'$
$ii''' = 72° 49'$
$uu''' = 95° 47'$

Commonly in prisms, with prismatic faces vertically striated; also faces *o r* striated ‖ edge *b/o*. Columnar or compact massive.

Cleavage: *b*, *c* rather distinct; *a* indistinct; *m*, *r* imperfect (Mlr.). Fracture uneven. Brittle. H. = 5·5–6. G. = 3·99–4·05. Luster submetallic. Color iron-black, or dark grayish black. Streak black, inclining to green or brown. Opaque.

**Comp.**—$HCa\overset{II}{Fe}_2\overset{III}{Fe}Si_2O_9$ or $H_2O.CaO.4FeO.Fe_2O_3.4SiO_2$ = Silica 29·3, iron sesquioxide 19·6, iron protoxide 35·2, lime 13·7, water 2·2 = 100. Manganese may replace part of the ferrous iron.

1.



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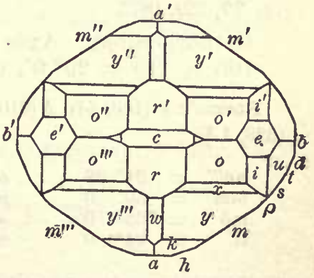


Figs. 1, 2, Elba; 2, Rath.

The formula may be written (Groth) as a basic orthosilicate $CaFe_2(FeOH)(SiO_4)_2$.

**Anal.**—1, Städeler, J. pr. Ch., **99**, 70, 1866. 2, Sipöcz, Min. Mitth., 72, 1875. 3, Lorenzen Min. Mag., **5**, 63, 1882. 4, Early, Proc. Irish Ac., **3**, 52, 1877. 5, Tobler, Lieb. Ann., **99**, 122, 1866. 6, Seger, Rg., Min. Ch., 661, 1875. In former analyses (as in 4) the water was mostly overlooked or regarded as unessential, 5th Ed. p. 296. The correct formula was first given by Städeler, and confirmed by Sipöcz and Lorenzen.

| | G. | | $SiO_2$ | $Fe_2O_3$ | FeO | MnO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 1. Elba | 4·023 | $\frac{4}{4}$ | 29·20 | 20·74 | 34·13 | 1·02 | 12·90 | 2·36 = 100·35 |
| 2. " | 4·037 | $\frac{4}{4}$ | 29·67 | 21·26 | 33·09 | 0·74 | 13·33 | 2·32 = 100·41 |
| 3 Greenland | 4·05 | | 29·30 | 20·30 | 33·50 | 1·97 | 13·71 | 1·90 = 100·68 |
| 4. Elba | | | 29·93 | 20·16 | 31·83 | 3·02 | 13·71 | 0·42 $Al_2O_3$ 0·36, MgO 0·30, alk. 0·49 [= 100·22 |
| 5. Nassau | | | 33·30 | 22·57 | 24·02 | 6 78 | 11·68 | 1·12 = 99·47 |
| 6. " | | | 27·53 | 26·18 | 22·70 | 8·66 | 13·24 | 0·34 = 98·65 |

**Pyr., etc.**—B.B. fuses quietly at 2·5 to a black magnetic bead. With the fluxes reacts for iron. Some varieties give also a reaction for manganese. Gelatinizes with hydrochloric acid.

**Obs.**—First found on the Rio la Marina, and at Capo Calamita, on Elba, by M. Lelièvre, in 1802, where it occurs in large solitary crystals, and aggregated crystallizations in dolomite with pyroxene, etc. Also found near Andreasberg in the Harz; between Herborn and Herbornseelbach in Nassau; Kupferberg, Silesia; at the mine of Temperino in Tuscany, granular, in limestone with actinolite; on Mt. Mulatto near Predazzo, Tyrol, in granite; at Schneeberg in Saxony; Fossum near Skeen in Norway; Thyrill, Iceland; in the sodalite-syenite of the Kangerdluarsuk fiord in South Greenland (cf. Lorenzen, Min. Mag., **5**, 70, 1882).

Reported as formerly found at Cumberland, R. I., in slender black or brownish black crystals, traversing quartz along with magnetite and hornblende; also at Milk Row quarry, Somerville, Mass.

Named *Ilvaite* from the Latin name of the island (Elba) on which it was found; *Lievrite* after its discoverer; *Yenite* (should have been Jenite) in commemoration of the battle of Jena, in 1806. The Germans, and later the French, have rightly rejected the name *yenite*, on the ground that commemorations of political hostility or triumph are opposed to the spirit of science. Des Cloizeaux adopts *Ilvaite*.

*Wehrlite* of Kobell has been referred to lievrite, as suggested by Zipser. It is massive granular. H. = 6–6·5 G. = 3 90. Analysis by Wehrle, $SiO_2$ 34·60, $Fe_2O_3$ 42·38, $Mn_2O_3$ 0·28, $Al_2O_3$ 0·12, FeO 15·78, CaO 5 84, $H_2O$ 1·00 = 100. B.B. fuses with difficulty on the edges. Imperfectly soluble in hydrochloric acid. From Szurraskö, Hungary. Some of the specimens so called have proved to be highly heterogeneous, cf. Szabó, Zeph., Min. Lex. Öest., **2**, 343, 1873.

**Ref.**—[1] Ann. Mines, **8**, 402, 1855, Min., **1**, 217, 1862. Other axial ratios deduced by Lorenzen and by Flink (ref. below) are:

Greenland $\breve{a} : \bar{b} : \grave{c}$ = 0·67437 : 1 : 0·44845 Lorenzen
Iceland $\breve{a} : \bar{b} : \grave{c}$ = 0·66195 : 1 : 0·43897 Flink

On the relation in form and composition between ilvaite and humite, see Websky, Ber. Ak. Berlin, 201, 1876.

[2] Cf. Mlr., Min., 324, 1852. [3] Dx., l. c. [4] Hbg., Min. Not., **3**, 1, 1860; see also Rath, Zs. G. Ges., **22**, 710, 1870. [5] Achiardi, Nuovo Cimento, 3, Feb., 1870. [6] Lorenzen, Greenland, Zs. Kr., **7**, 243, 1884. [7] Flink, Thyrill, Iceland, Ak. H. Stockh., Bihang, **12** (2), No. 2, 44, 1887. [8] Bauer, Herbornseelbach, Jb. Min., **1**, 31, 1890.

**418. ARDENNITE.** Mangandisthen *Lasaulx*. *Lasaulx* and *Bettendorff*, Ber. nied. Ges., **29**, 189, Nov. 24, 1872; Pogg., **149**, 241, 1873. Dewalquite *Pisani*, C. R., **75**, 1542, Dec. 2, 1872; **77**, 329, 1873.

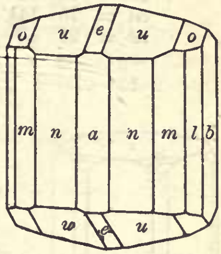
Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c} = 0·4663 : 1 : 0·3135$ Rath[1].
$100 \wedge 110 = 25° 0'$, $001 \wedge 101 = 33° 54\frac{5}{6}'$, $001 \wedge 011 = 17° 24\frac{1}{3}'$.

**Forms**[1]: *a* (100, *i*-ī), *b* (010, *i*-ĭ); *n* (320, *i*-$\frac{3}{2}$), *m* (110, *I* ), *l* (120, *i*-2̆); *e* (101, 1-ī); *o* (111, 1); *u* (323, 1-$\frac{3}{2}$).

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *nn'''* | = | 34° 32' | *ee'* | = | 67° 50' | *uu'* | = | 66° 42' | *au* | = | 56° 39' |
| *mm'''* | = | 50° 0' | *oo'* | = | 65° 22' | *uu''* | = | 70° 18' | *bo* | = | 75° 25' |
| *mb* | = | *65° 0' | *oo''* | = | 73° 8' | *uu'''* | = | 19° 41' | *bu* | = | 80° 9½' |
| *ll'* | = | 94° 0' | *oo'''* | = | *29° 10' | *ao* | = | 57° 19' | | | |

In prismatic crystals resembling ilvaite; prismatic faces strongly striated; pyramidal faces smooth; distinct crystals rare.

Cleavage: *b* perfect; *m* very distinct; parting ‖ *c*, with horizontal striations similar to cyanite. Fracture subconchoidal to uneven. Brittle. H. = 6–7. G. = 3·620; 3·577 Pisani. Color yellow to yellowish brown; in thin splinters translucent, red.



Ardennite, Lasaulx.

Pleochroism strong. Optically +. Ax. pl. ‖ *a*. Bx ⊥ *b*. Axial angles variable·

$2E_r$=68° 36′–69° 52′ $2E_y$=65° 45′–67° 29′ $2E_{gr}$=62° –62° 56′ Pisani
$2E_r$=76° 7′–79° 9′ $2E_y$=72° 55′–74° 26′ $2E_{gr}$=68° 36′–70° 59′ Dx.

Lévy-Lcx. give: Ax. pl. ‖ *b*. Bx ⊥ *c*. Pleochroism: 𝔠 pale yellow, 𝔟 gold-yellow, 𝔞 deep brownish yellow.

**Comp.**—A vanadio-silicate of aluminium and manganese, composition uncertain; probable empirical formula $H_5Mn_4Al_4VSi_4O_{23}$ or $5H_2O.8MnO.4Al_2O_3.V_2O_5.8SiO_2$ = Silica 27·8, vanadium pentoxide 10·6, alumina 23·6, manganese protoxide 32·8, water 5·2 = 100.

Arsenic replaces the vanadium in varying amounts, but probably from alteration (Lsx.); magnesium and calcium replace part of the manganese, also ferric iron the aluminium in small amount.

**Anal.**—1, Lasaulx and Bettendorff, Pogg., **149**, 245, 1873. 2, 3, Bettendorff, ib., **160**, 126, 1877. 4, Pisani, C. R., **77**, 329, 1873, also an earlier one, ib., **75**, 1542, 1872, giving 8·71 p. c. $V_2O_5$ and no $As_2O_5$.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MnO | MgO | CaO | $V_2O_5$ | $As_2O_5$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. *Dark brown* | 3·620 | $\frac{2}{2}$ 29·74[a] | 23·50 | 1·95 | 25·95 | 3·42 | 2·05 | 9·14 | — | 4·04 | CuO,$P_2O_5$ [*tr.* = 99·79 |
| 2. *Brown, transp.* | 3·643 | 27·84 | 24·22 | | 26·70 | 3·01 | 2·17 | 9 20 | 2·76 | 5·01 | = 100·91 |
| 3. *Yellow, opaque* | 3·656 | 27·50 | 22·76 | 1·15 | 30·61 | 1·38 | 1·83 | 0·53 | 9·33 | 5·13 | CuO 0·17= [100·39 |
| 4. *Yellow-brown* | | 28·40 | 24·80 | 1·31 | 25·70 | 4·07 | 2·98 | 3·12 | 6·35 | 5·20[b] | CuO 0·22= [102·15 |

[a] Probably contains free quartz. [b] Ign.

Other arsenic determinations gave Bettendorff: 1·83, 2·31, 2·53, 2·98, 6·64 $As_2O_5$; the color grows lighter with the increase in arsenic.

**Pyr., etc.**—B.B. easily fusible with intumescence to a black glass. With borax gives a manganese bead. The water can only be driven off at a strong red heat. Not attacked by hydrochloric and nitric acids, and only feebly attacked by sulphuric acid.

**Obs.**—Found at Salm Chateau near Ottrez in the Ardennes, Belgium, in quartz veins in the Ardennes schists. It is usually embedded in the quartz (containing particles of pyrolusite) and associated with a reddish white crystalline aggregate of albite.

Lasaulx first noticed this mineral under the name of *mangandisthen*, in consequence of a supposed resemblance to cyanite. This, as Pisani urges, is on several accounts an objectionable name, and is naturally superseded by the name *ardennite*, which too has the right of priority over *dewalquite*.

The name ardennite refers to the locality; dewalquite was given for the Belgian geologist, Prof. G. Dewalque.

**Ref.**—[1] Pogg., **147**, 247, 1873.

**419. LÅNGBANITE.** *G. Flink*, Zs. Kr., **13**, 1, 1887, Öfv. Ak. Stockh., Bihang, **13** (2), No. 7, 91, 1888. Longbanite.

Hexagonal. Axis $\dot{c}$ = 1·6437; 0001 ∧ $10\bar{1}1$ = *62° 13′ Flink[1].

**Forms:**
*c* (0001, *O*)
*m* ($10\bar{1}0$, *I*)
*a* ($11\bar{2}0$, *i*-2)
*l* ($41\bar{5}0$, *i*-$\frac{5}{4}$)
*p* ($10\bar{1}2$, $\frac{1}{2}$)
*o* ($10\bar{1}1$, 1)
*d* ($20\bar{2}1$, 2)
*e* ($11\bar{2}6$, $\frac{1}{3}$-2)
*f* ($11\bar{2}3$, $\frac{2}{3}$-2)
*g* ($22\bar{4}3$, $\frac{4}{3}$-2)
*h* ($21\bar{3}1$, 3-$\frac{3}{2}$)
*i* ($41\bar{5}6$, $\frac{5}{6}$-$\frac{5}{4}$)

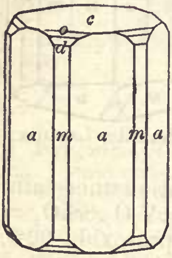
*cp* = 43° 30′
*co* = *62° 13′
*cd* = 75° 14½′
*ce* = 28° 43′

*cf* = 47° 37′
*cg* = 65° 28½′
*ch* = 78° 44′

*pp′* = 40° 16′
*oo′* = 52° 30½′
*ff′* = 43° 21′

*ao* = 39° 59′
*ah* = 15° 37′
*mh* = 22° 4′

1.



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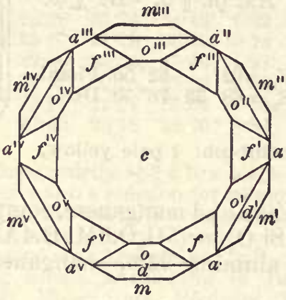

Figs. 1, 2, Långban, Flink.

Crystals hexagonal in habit, long or short prismatic; faces *a* prominent and vertically striated; *m* small and bright.

Cleavage none. Fracture conchoidal. Brittle. H. = 6·5. G. = 4·918. Luster metallic, brilliant. Color iron-black. Powder dark reddish brown. Opaque.

**Comp.**—Manganese silicate with ferrous antimonate; formula doubtful. Flink calculates $37Mn_6SiO_7.10Fe_3Sb_2O_8$. The state of oxidation of the metals present is not definitely settled.

**Anal.**—Flink, l. c.

$SiO_2$ 10·88 $Sb_2O_5$ 15·42 MnO 64·00 FeO 10·32 = 100·62

**Pyr.**—B.B. infusible, but becomes dull on the surface. On charcoal gives a faint white sublimate, and with salt of phosphorus a silica skeleton. Fused with soda and saltpeter gives a deep green mass. Difficultly soluble in hydrochloric acid without evolution of chlorine.

**Obs.**—Occurs sparingly at Långban, Wermland, Sweden, with schefferite in granular crystalline limestone, also associated with richterite, braunite, magnetite, hausmannite. Probably also with rhodonite at the Sjö mines, Gryhytte parish, Örebro, Sweden (Igelström).

**Ref.**—[1] L. c., and Zs. Kr., **15**, 93, 1888. See further p. 1039.

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## Kentrolite Group.

**420. KENTROLITE.** *A. Damour* and *G. vom Rath*, Zs. Kr, **5**, 32, 1880.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c}$ = 0·6334 : 1 : 0·8830 Rath.
100 ∧ 110 = 32° 21′, 001 ∧ 101 = 54° 20⅚′, 001 ∧ 011 = 41° 26⅔′.

Forms: *b* (010, *i-ĭ*); *m* (110, *I*); *o* (111, 1).

Angles. *mm′′′* = *64° 42′, *oo′* = 92° 31′, *oo′′* = 117° 34′, *oo′′′* = *54° 28′, *om* = 31° 13′.

Crystals minute, prismatic in habit terminated by the pyramid *o* (111); often grouped in sheaf-like forms resembling stilbite. Faces rather rough, the prismatic horizontally striated. Also massive.

Cleavage: *m* distinct. Fracture uneven. Brittle. H. = 5. G. = 6·19. Luster vitreous to submetallic, dull. Color dark reddish brown, becoming black on the surface.

**Comp.**—Perhaps $2PbO.Mn_2O_3.2SiO_2$ = Silica 16·6, manganese sesquioxide 21·8, lead protoxide 61·6 = 100.

**Anal.**—Damour, l. c.

$SiO_2$ 15·95 $MnO_2$ 24·50 (or $Mn_2O_3$ 22·26) PbO 59·79 = 100·24

The state of oxidation of the manganese, and hence the true composition of the mineral, is not definitely settled; if $MnO_2$ is present, the formula becomes $Pb\overset{IV}{Mn}SiO_5$, which requires: $SiO_2$ 16·3, $MnO_2$ 23·5, PbO 60·2 = 100. The formula given above corresponds to that of melanotekite.

**Pyr., etc.**—B.B. on charcoal gives a lead coating and with soda a globule of lead. In a salt of phosphorus bead dissolves and gives in R.F. a slight yellowish color, after the addition of saltpeter becomes bright violet. Dissolves in part in dilute sulphuric acid with the separation of manganese oxide mixed with silica. With hydrochloric acid chlorine is disengaged.

**Obs.**—From southern Chili, exact locality unknown. Occurs with quartz, barite, apatite. Named from *κέντρον*, *spike.* See also p. 1039.

**421. MELANOTEKITE.** *G. Lindström*, Öfv. Ak. Stockh., 35, No. 6, 53, 1880. Melanotecite.

Massive.

Cleavage in two directions, in one of these most distinct. H.$=6{\cdot}5$. G.$=5{\cdot}73$. Luster metallic to greasy. Color black to blackish gray. ~~Streak~~ greenish gray. Nearly opaque but translucent in thin sections. Pleochroic, bottle-green and red brown.

**Comp.**—$Pb_2Fe_2Si_2O_9$ or $2PbO.Fe_2O_3.2SiO_2$ = Silica 16·6, iron sesquioxide 22·0, lead protoxide 61·4 = 100.

**Anal.**—1, 2, Lindström; 1, after deducting 2·36 p. c. impurities; 2, after deducting 3·30 p. c.:

| | $SiO_2$ | $Fe_2O_3$ | PbO | MnO | CaO | MgO | $K_2O$ | $Na_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 17·32 | 23·18 | 55·26 | 0·69 | 0·02 | 0·59 | 0·24 | 0·54 | ign. 0·93, X 1·27 = 100·04 |
| 2. | 17·22 | 22·81 | 58·42 | 0·57 | — | 0·33 | 0·18 | 0·33 | |

X = CuO 0·20, FeO 0·75, BaO 0·11 (?), Cl 0·14, $P_2O_5$ 0·07.

**Pyr., etc.**—B.B. fuses with intumescence to a black bead; with soda on charcoal gives a globule of lead and a lead coating. With borax reacts for iron, but on strong heating in R.F. becomes on cooling black and opaque (reduced lead), with salt of phosphorus gives a skeleton of silica Decomposed by nitric acid.

**Obs.**—Occurs with native lead, intimately mixed with magnetite and yellow garnet at Långban in Wermland, Sweden. This locality has also furnished the lead silicates, hyalotekite and ganomalite (p. 422). Named, in allusion to the related hyalotekite, from μέλας, *black*, and τήκειν, *to melt*. Lindström calls attention to the fact that of the two possible formulas for kentrolite proposed by Damour and Rath, the second corresponds exactly to the above composition of melanotekite.

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**422. BERTRANDITE.** Nouveau mineral des environs de Nantes *E. Bertrand*, Bull. Soc. Min., 3, 96, 1880, 6, 248, 1883. Dx., ib., 5, 176, 1882. Bertrandite *Damour*, ib., 6, 252, 1883.

Orthorhombic; hemimorphic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}56885 : 1 : 0{\cdot}5973$ Penfield[1].

$100 \wedge 110 = 29° \ 38'$, $001 \wedge 101 = 46° \ 23\frac{5}{6}'$, $001 \wedge 011 = 30° \ 51'$ Pfd.

**Forms**[2]:

| | | | | |
|---|---|---|---|---|
| | *c* (001, *O*) | *f* $(130, i\text{-}\breve{3})$ | ϵ $(011, 1\text{-}\breve{i})$ | *e* $(031, 3\text{-}\breve{i})$ |
| *a* $(100, i\text{-}\bar{i})$ | *h* $(310, i\text{-}\bar{3})$ | *d* $(102, \frac{1}{2}\text{-}\bar{i})$[4] | η $(021, 2\text{-}\breve{i})$[3] | *x* $(162, 3\text{-}\breve{6})$[4] |
| *b* $(010, i\text{-}\breve{i})$ | *m* (110, *I*) | *i* $(049, \frac{4}{9}\text{-}\breve{i})$[5] | | |

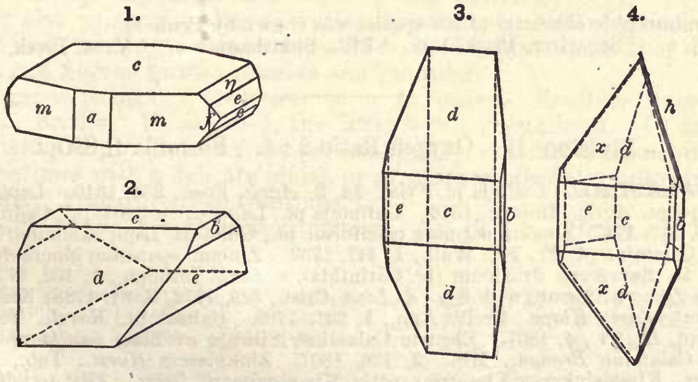
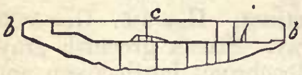


Fig. 1, Pisek, Vrba 2–4, Stoneham, Me., Pfd.

| | | | |
|---|---|---|---|
| $hh''' = 21° \ 28\frac{1}{2}'$ | $cd = {}^*27° \ 42'$ | $\eta\eta' = 100° \ 8'$ | $xx' = 28° \ 42'$ |
| $mm''' = {}^*59° \ 16'$ | $dd' = 55° \ 24'$ | $ee' = 121° \ 40'$ | $cx = 61° \ 50'$ |
| $ff' = 60° \ 44'$ | $\epsilon\epsilon' = 61° \ 42'$ | $de = 64° \ 26'$ | |

Twins heart-shaped, with axes crossing at angles of about 60° and 120°, tw. pl. $\epsilon$ (011), perhaps also $f$ (130) and $e$ (031), but the last two not quite certain (cf. Vrba). Also tw. pl. $c$ Pfd. Crystals often tabular ‖ $c$; also ‖ $b$; often hemimorphic in the direction of the vertical axis.

5.



Mt. Antero, Pfd.

Cleavage: $m$ perfect; also $b$ and $c$, the last perhaps due to lamellar structure. H. = 6–7. G. = 2·59–2·60. Luster vitreous; pearly on $c$. Colorless to slightly yellow. Transparent. Pyroelectric, the flat plane (f. 5) $c$ + on cooling, the rounded face −.

Optically −. Ax. pl. ‖ $b$. $Bx_a \perp a$. Dispersion $\rho < v$. Axial angles:

Nantes $2H_{a.y} = 82°$ $2H_{o.y} = 118°$ $\therefore$ $2V_y = 74° 51\frac{1}{2}'$ $\beta' = 1·569$ Btd.
Mt. Antero $2K_{o.y} = 101° 10'$ $\therefore$ $(\beta = 1·569)$ $2V_{o.y} = 108° 42'$ $2V_{a.y} = 71° 18'$ Pfd.

**Comp.**—$H_2Be_4Si_2O_9$ or $H_2O.4BeO.2SiO_2$ = Silica 50·3, glucina 42·1, water 7·6 = 100.

The water goes off only at a red heat. Groth writes the formula as a basic orthosilicate.

**Anal.**—1, Damour, l. c. 2, Pfd., on 0·13 gr., l. c. 3, Preis, Zs. Kr., **15**, 200, 1889.

| | | $SiO_2$ | BeO | $H_2O$ | |
|---|---|---|---|---|---|
| 1. Barbin | G. = 2·586 | 49 26 | 42 00 | 6·90 | $Fe_2O_3$ 1·40 = 99·56 |
| 2. Mt. Antero | G. = 2·598 | 51·8 | 39·6 | 8·4 | CaO 1·0 = 100·8 |
| 3. Pisek | G. = 2·599 Vrba | 49·90 | 42·62 | 7·94 | $Al_2O_3, Fe_2O_3$ *tr.* = 100·46 |

**Pyr.**—B.B. infusible but becomes opaque. Insoluble in acid.

**Obs.**—Occurs implanted upon quartz or feldspar in cavities of a pegmatyte forming veins in gneiss at Petit-Port and at the quarries of Barbin near Nantes, France; also from la Villeder, Morbihan (Bull. Soc. Min., **12**, 514, 1889). In a feldspar quarry at Pisek, Bohemia, with corroded beryl, in part aquamarine, also apatite, tourmaline, etc. On Mt. Antero, Chaffee Co., Colorado, with phenacite and sometimes inclosing it as of earlier formation; both are implanted upon corroded aquamarine crystals. Also at Stoneham, Me., in cavities with herderite. At Amelia Court House, Va., with etched beryl.

Named for E. Bertrand, the French Mineralogist.

**Ref.**—[1] Stoneham, Am. J. Sc., **37**, 213, 1889. For Mt. Antero he obtained $\breve{a} : \bar{b} : \dot{c}$ = 0·5723 : 1 : 0 5993, ib., **36**, 52, 1888, **40**, 490, 1890. Scharizer suggested a monoclinic form for the Pisek mineral, Zs. Kr., **14**, 33, 1888, which is not confirmed by optical characters nor by Vrba's measurements, Zs. Kr., **15**, 194, 1889; the latter shows that there is an apparent relation in form to calamine, although the formulas differ by one molecule of water, thus:

*Bertrandite* $\frac{3}{4}\breve{a} : \dot{c} : \frac{1}{4}\bar{b}$ = 0·7243 : 1 : 0·4186 Stoncham, Pfd.
" 0·7191 : 1 : 0·4206 Pisek, Vrba.
*Calamine* $\breve{a} : \bar{b} : \dot{c}$ = 0·7834 : 1 : 0·4778 Schrauf.

The hemimorphic character of the species was shown by Penfield.

[2] Btd., l. c. [3] Scharizer, Pisek, l. c. [4] Pfd., Stoneham, l. c. [5] Vrba, Pisek, l. c.

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### Division II. Oxygen Ratio 2 : 3. Formula $R_3SiO_5$.

**423. CALAMINE.** Cadmia pt. *Plin.*, **34**, 2; *Agric.* Foss., 255, 1546. Lapis calaminaris, *Germ.* Galmei pt. *Agric.*, Interpr., 1546. Gallmeja pt., Lapis calaminaris pt., Cadmia officin. pt., *Wall.*, Min., 247, 1747; Zincum naturale calciforme pt., Galmeja, Lapis calaminaris pt., Cronst., 197, 1758. Calamine pt. *Fr. Trl.* Wall., **1**, 447, 1753. Zincum spatosum cinereum compactum electricum, ib. flavescens drusicum (fr. Carinthia), *v. Born*, Lithoph., **1**, 132, 1772. Calamine pt., Mine de Zinc vitriforme (with figs.) *de Lisle*, Crist., 329, 1772, **3**, 81, 1783; Kieselerde, Zinkoxyd (fr. Derbyshire), *Klapr.*, Crell's Ann., **1**, 391, 1788. Galmei pt. *Karst.*, Tab., 24, 1791. Zinc oxydé pt. *H.*, Tr., **4**, 1801. Electric Calamine, Silicate of Zinc, *Smithson*, Phil. Trans., 1803 Zinc Calamine *Brongn.*, Min., **2**, 136, 1807. Zinkglaserz *Karst.*, Tab., 70, 100, 1808. Zinkkieselerz, Kieselzinkerz, Kieselzinkspath, Kieselgalmey, *Germ.* Zinc oxydé silicifère *H.* Calamine *Beud.*, Min., **2**, 190, 1832. Smithsonite *B. & M.*, Min., 1852 [not Smithsonite *Beud.*]. Hemimorphit *Kenng.*, Min., 67, 1853. Wagit *Radoszkovski*, C. R., **53**, 107, 1862.

Orthorhombic; hemimorphic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·78340 : 1 : 0·47782 Schrauf[1]. 100 ∧ 110 = 38° $4\frac{1}{2}'$, 001 ∧ 101 = 31° $22\frac{5}{6}'$, 001 ∧ 011 = 25° $32\frac{1}{3}'$.

**Forms**[2]:
$a$ (100, $i$-$\bar{i}$)
$b$ (010, $i$-$\breve{i}$)
$c$ (001, $O$)

$m$ (110, $I$)
$n$ (120, $i$-$\breve{2}$)[5,6]
$o$ (130, $i$-$\breve{3}$)[3]
$\Pi$ (290, $i$-$\breve{\tfrac{9}{2}}$)[5]
$q$ (150, $i$-$\breve{5}$)[3]

$\vartheta$ (106, $\tfrac{1}{6}$-$\bar{i}$)[7]
$\nu$ (105, $\tfrac{1}{5}$-$\bar{i}$)[11]
$r$ (103, $\tfrac{1}{3}$-$\bar{i}$)[4]
$\rho$ (205, $\tfrac{2}{5}$-$\bar{i}$)[10]
$\eta$ (102, $\tfrac{1}{2}$-$\bar{i}$)[7]
$s$ (101, 1-$\bar{i}$)
$\psi$ (403, $\tfrac{4}{3}$-$\bar{i}$)[7]
$\mu$ (201, 2-$\bar{i}$)?
$t$ (301, 3-$\bar{i}$)

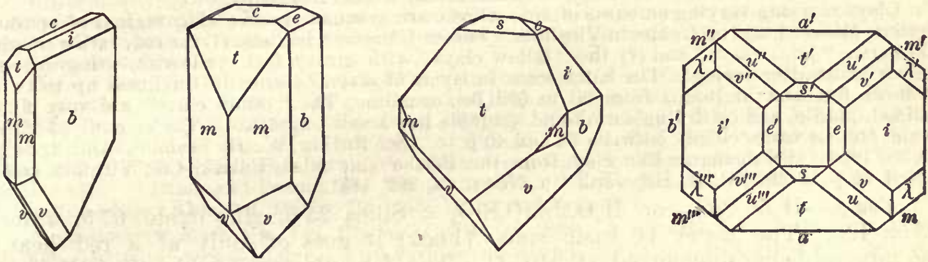
$\alpha$ (018, $\tfrac{1}{8}$-$\breve{i}$)?[7]
$d$ (012, $\tfrac{1}{2}$-$\breve{i}$)[3]
$e$ (011, 1-$\breve{i}$)
$\epsilon$ (043, $\tfrac{4}{3}$-$\breve{i}$)[9]
$f$ (032, $\tfrac{3}{2}$-$\breve{i}$)[6]
$g$ (053, $\tfrac{5}{3}$-$\breve{i}$)[5,6]
$B$ (074, $\tfrac{7}{4}$-$\breve{i}$)[7]?
$h$ (021, 2-$\breve{i}$)
$i$ (031, 3-$\breve{i}$)
$k$ (051, 5-$\breve{i}$)[3]

$l$ (071, 7-$\breve{i}$)[3]

$\gamma$ (112, $\tfrac{1}{2}$)[4]
$\delta$ (334, $\tfrac{3}{4}$)[10]
$\pi$ (111, 1)[4]
$x$ (332, $\tfrac{3}{2}$)[4]

$u$ (211, 2-$\bar{2}$)
$\beta$ (321, 3-$\bar{\tfrac{3}{2}}$)
$y$ (431, 4-$\bar{\tfrac{4}{3}}$)[3]

$\chi$ (231, 3-$\breve{\tfrac{3}{2}}$)[4]
$\tau$ (471, 7-$\breve{\tfrac{7}{4}}$)[6]
$v$ (121, 2-$\breve{2}$)
$\omega$ (132, $\tfrac{3}{2}$-$\breve{3}$)[6]
$\phi$ (3·10·1, 10-$\overset{\smile}{\tfrac{10}{3}}$)[11]
$\xi$ (143, $\tfrac{4}{3}$-$\breve{4}$)[4]
$\lambda$ (141, 4-$\breve{4}$)[3]
$z$ (163, 2-$\breve{6}$)[6]
$\sigma$ (172, $\tfrac{7}{2}$-$\breve{7}$)[6]


1. 2. 3. 4.

Figs. 1–4, Altenberg, after Rose.

$mm''' = 76° 9'$
$nn' = 65° 6'$
$oo' = 46° 6'$

$qq' = 28° 38\tfrac{1}{2}'$
$rr' = 22° 59'$
$\eta\eta' = 33° 55'$
$ss' = 62° 46'$
$tt' = 122° 41'$

$dd' = 26° 52'$
$ee' = 51° 5'$
$gg' = 77° 4'$
$hh' = 87° 24'$
$ii' = 110° 12'$
$bi = {}^*34° 54'$
$mi = {}^*59° 37'$
$c\gamma = 21° 10'$

$c\pi = 37° 46'$
$cx = 49° 17'$
$cu = 52° 38'$
$cv = 48° 35'$

$\pi\pi' = 57° 39'$
$\pi\pi''' = 44° 23'$
$au = 42° 16$
$a\beta = 37° 6$

$av = 66° 12'$
$ay = 35° 37'$
$a\lambda = 74° 12'$
$b\lambda = 31° 30'$
$bv = 50° 47'$
$b\chi = 47° 44'$
$bu = 73° 8'$
$it = 74° 4'$

Twins: tw. pl. *c*, axes parallel and antilogous poles of crystals together. Crystals hemimorphic with the upper extremity, the analogous pole, often highly modified with macrodomes and brachydomes prominent, and the lower, the antilogous pole, terminated by the pyramids *u*, *v*, also *e*, or with *e* rounded and rarely *π* and *c*[8]. Usually implanted and showing one extremity only. Crystals often tabular ∥ *b*; also prismatic; faces *b* vertically striated. Often grouped in sheaf-like forms and forming drusy surfaces in cavities. Also stalactitic, mammillary, botryoidal, and fibrous forms; massive and granular.

Cleavage: *m* perfect; *s* (101) less so; *c* in traces. Fracture uneven to subconchoidal. Brittle. H. = 4·5–5, the latter when crystallized. G. = 3·40–3·50, 3·43–3·49, Altenberg. Luster vitreous; *c* subpearly, sometimes adamantine. Color white; sometimes with a delicate bluish or greenish shade; also yellowish to brown. Streak white. Transparent to translucent.

Optically +; double refraction strong. Ax. pl. ∥ *a*. $Bx_a \perp c$. Indices and axial angles:

$\alpha_r = 1·61069$ $\beta_r = 1·61416$ $\gamma_r = 1·63244$ $\therefore$ $2V_r = 47° 30'$ $2E_r = 81° 7'$ Lang
$\alpha_y = 1·61358$ $\beta_y = 1·61696$ $\gamma_y = 1·63597$ $\therefore$ $2V_y = 46° 9'$ $2E_y = 78° 39'$ "
$\alpha_{gr} = 1·61706$ $\beta_{gr} = 1·62020$ $\gamma_{gr} = 1·63916$ $\therefore$ $2V_{gr} = 44° 42'$ $2E_{gr} = 76° 31'$ "

Also, measured $2E_r = 81° 3'$ $2E_y = 78° 7'$ $2E_{gr} = 76°$ Lang[12]
$2E_r = 82° 30'$ $2E_y = 80°$ $2E_{gr} = 75°$ Dx.
$2E_r = 85° 21'$ at 8°·8, 82° 50′ at 17°, 77° 50′ at 95°·5, 76° 32′ at 121° Dx.

Strongly pyroelectric, the more highly modified extremity of the crystals (as ordinary developed, cf. f. 4) the analogous pole, the lower the antilogous;

in twins the latter poles in contact. See Riess and Rose[13]; also later Bauer and Brauns[13], who used the Kundt method of investigation and describe the results with great fullness.

**Var.**—1. *Ordinary.* (*a*) In crystals as described above. (*b*) Mammillary or stalactitic. (*c*) Massive; often cellular. *Wagite* is a concretionary light blue to green calamine from Nizhni Yagurt in the Ural; G. = 2·707.

2. *Carbonated.* Sullivan has described (Dublin Q. J. Sc., **2**, 150, 1862) a variety of calamine from the Dolores mine in the province of Santander, Spain, occurring in concentric pisolitic masses, frequently containing a semitranslucent, opal-like nucleus. This mineral, produced from the hydrous carbonate by the action of silicated waters, contains from 12 to 20 per cent. of zinc carbonate; G. = 2·88–3·69.

3. *Argillaceous.* Another calamine from Spain, analyzed by Schönichen (B. H. Ztg., **22**, 163), contains 20 to 26 p. c. of alumina, with 31·5 p. c. of silica, 21 to 28·5 p. c. of zinc oxide, and 18 to 20 of water; and is apparently calamine mixed with clay. It occurs massive; color at first white, changing in the air to violet, brown, and finally black; feel soapy.

Clays carrying varying amounts of zinc silicate are common in the zinc regions of southwestern Missouri, and occur also in Virginia. Those of Missouri include: (1) the red, rather tough and harsh "joint clays" and (2) the "tallow clays" with greasy feel, yellowish, ash-gray, or brown colors after drying. The latter occur in layers of several inches in thickness up to two or three feet and in lumps from 50 to 500 lbs. or more. The "tallow clays" are very fine grained, plastic, and on drying shrink and crumble into small fragments. The amount of zinc oxide present varies chiefly between 30 and 40 p. c. See further W. H. Seamon, Am. J. Sc., **39**, 38, 1890. A lithomarge-like clay from the Bertha zinc mine, Pulaski Co., Virginia, contained 12 p. c. ZnO, B. H. Heyward, Ch. News, **44**, 207, 1881.

**Comp.**—$H_2Zn_2SiO_5$ or $H_2O.2ZnO.SiO_2$ = Silica 25·0, zinc oxide 67·5, water 7·5 = 100. The water is basic since (Fock) it goes off only at a red heat, the mineral being unchanged at 340° C. The formula is probably $(ZnOH)_2SiO_3$ or a basic metasilicate.

For analyses see 5th Ed., p. 408. Also 1, Genth., Am. Phil. Soc., **23**, 46, 1886. 2, Eyerman, Am. J. Sc., **37**, 501, 1889.

| | $SiO_2$ | ZnO | $H_2O$ | |
|---|---|---|---|---|
| 1. Pulaski Co., Va. | 25·01 | 67·42 | 8·32 | = 100·75 |
| 2. Friedensville | 24·32 | 65·05 | 7·86 | $Fe_2O_3$ 2·12 = 99·15 |

**Pyr., etc.**—In the closed tube decrepitates, whitens, and gives off water. B.B. almost infusible (F. = 6); moistened with cobalt solution gives a blue color when heated. On charcoal with soda gives a coating which is yellow while hot, and white on cooling. Moistened with cobalt solution, and heated in O.F., this coating assumes a bright green color. Gelatinizes with acids even when previously ignited. Decomposed by acetic acid with gelatinization. Soluble in a strong solution of caustic potash.

**Obs.**—Calamine and smithsonite are usually found associated in veins or beds in stratified calcareous rocks accompanying sulphides of zinc, iron, and lead. Thus at Aix-la-Chapelle; Raibel and Bleiberg, in Carinthia, in the upper Triassic; Moresnet in Belgium, Freiburg in Baden, Iserlohn, Tarnowitz, Olkucz, Miedzanagora, Rezbánya, Schemnitz. At Roughten Gill, in Cumberland, in acicular crystals and mammillary crusts, sky-blue and fine green; at Alston Moor, white; at the Rutland mine, near Matlock, in Derbyshire, in brilliant crystals, and grayish white and yellow, and mammillary; at Castleton, in crystals; on the Mendip Hills, mostly brownish yellow, and in part stalactitic; in Flintshire, etc., Wales; Leadhills, Scotland. Large crystals have been found at Nerchinsk, in Eastern Siberia.

In the United States occurs at Sterling Hill, near Ogdensburg, N. J., in fine clear crystalline masses In Pennsylvania, at the Perkiomen and Phenixville lead mines; in a lower Silurian rock two miles from Bethlehem, at Friedensville, in Saucon valley, abundant and extensively worked: on the Susquehanna, opposite Selinsgrove. Abundant in Virginia, at Austin's mines in Wythe Co. A pale yellow, fusible zinciferous clay occurs in considerable abundance with calamine at the Ueberroth mine, Friedensville. With the zinc deposits of southwestern Missouri, especially about Granby, both as crystallized and massive calamine, and mixed with an aluminous silicate forming the "tallow clays" above described. According to Seamon (l. c.) the calamine has been gradually crystallized out of the zinciferous clays, these having been first formed. At the Emma mine, Cottonwood Cañon, Utah, in greenish blue mammillary forms with wulfenite and cerussite.

The name *Calamine* (with *Galmei* of the Germans) is commonly supposed to be a corruption of *Cadmia.* Agricola says it is from *calamus*, a *reed*, in allusion to the slender forms (stalactitic) common in the *cadmia fornacum.*

The *cadmia* of Pliny and of other ancient authors included both the native silicate and carbonate, and the oxide from the chimneys of furnaces (cadmia fornacum). The two native ores continued to be confounded under the name *lapis calaminaris*, *calamine* or *galmei*, until investigated chemically by Smithson in 1803. Earlier analyses had made out chemical differences, and some authors, before 1790, had rightly suggested a division of the species: Bergmann having found 28 p. c. carbon dioxide in a Holywell specimen (J. Phys., **16**, 17, 1780); and Pelletier, in a kind from Freiburg in Breisgau, which had been called *Zeolite of Breisgau* because it gelatinized with acids, 52 p. c. silica, with 36 zinc oxide, and 12 water (J Phys., **20**, 420, 1782); and Klaproth, in another, similarly gelatinizing, 66 zinc oxide and 33 silica. But Smithson was the first to make known the true composition, and clear away all doubts.

De Lisle noticed the crystalline forms of the two species, describing one kind as prismatic with dihedral summits, and the other as scalenohedral like dogtooth spar, yet did not fully appreciate the importance of the observation; while Haüy, 14 years later, in his *Traité*, describes only the crystals of the *silicate*, and takes the ground that the *zinc carbonatée* was only an impure calcareous "zinc oxydé."

In 1807 Brongniart called the silicate *calamine*, leaving for the other ore the chemical name *zinc carbonatée*. In 1832, Beudant followed Brongniart in the former name, and designated the latter *Smithsonite* after SMITHSON, who had analyzed in 1803 the carbonate as well as silicate. Thus the two species were, at last, not only distinguished, but mineralogically named.

Unfortunately, Brooke & Miller, in 1852, reversed Beudant's use of these names, with no good reason; and in 1853, Kenngott, on account of the confusion of names, as he says, introduced for the silicate the new name *Hemimorphite*, and so added to the confusion. These innovations should have no favor.

**Ref.**—[1] Ber. Ak. Wien, **38** (1), 789, 1859. [2] See Schrauf, l. c., for early authorities (Mohs, etc.); also Gdt., Index, **2**, 227, 1890, and Bauer and Brauns, ref. below. [3] Rose, Abh. Ak. Berlin, 70, 1843, Pogg., **59**, 362, 1863. [4] Dbr., Pogg., **92**, 245, 1854. [5] Hbg., Min. Not., **2**, 20, 1858. [6] Schrauf, l. c. [7] Dx., Min., **1**, p. 117, 1862. [8] Slg., Zs. Kr., **1**, 342, 1877. [9] Cesàro, Bull. Soc. Min., **9**, 242, 1886. [10] Schulze. Mitth. Ver. Neuvorpommern u. Rügen, 59, 1886 (Mitth. Univ. Greifswald). [11] Bauer and Brauns, Jb. Min., **1**, 1, 1889. [12] Lang, Ber. Ak. Wien, **37**, 379, 1859. [13] Riess and Rose, Abh. Ak. Berlin, 70, 1843; Bauer and Brauns, l. c.

MORESNETITE *Risse*, Vh. Ver. Rheinl., C.-Bl., 98, 1865. A mineral from Altenberg, near Aachen, occurring with calamine. Two varieties are found, one dark to leek-green and opaque; the other light emerald-green, transparent. The latter is the purest; it has H. = 2·5, conchoidal fracture, streak white. It afforded on analysis: $SiO_2$ 30·31, $Al_2O_3$ 13·68, FeO 0·27, NiO 1·14, ZnO 43·41, MgO *tr.*, CaO *tr.*, $H_2O$ 11·37 = 100·18. Difficultly soluble in acids.

VANUXEMITE *C. U. Shepard*, Contrib. Min., 1876. A product of the decomposition of zinc ores at Sterling Hill, N. J. Occurs in irregular white patches in a firm ochery aggregate. G. = 2·5. Does not adhere to the tongue, but emits a slight clayey odor on being breathed upon. An analysis gave: $SiO_2$ 35·64, $Al_2O_3$ 11·70, ZnO 32·48–36·0, $H_2O$ 14·80–19·88. Obviously a mixture of white clay with zinc silicate.

## 424. CARPHOLITE. Karpholith *Wern.*, Letztes Min. Syst., **10**, 43, 1817. Strohstein *Germ.* Strawstone.

Monoclinic. Prismatic angle 68° 33′. In radiated and stellated tufts, and groups of acicular crystals. Twins: tw. pl. *a* (100).

Very brittle. H. = 5–5·5. G. = 2·935. Luster silky, glistening. Color pure straw-yellow to wax-yellow. Pleochroism distinct: $\mathfrak{c}$ colorless, $\mathfrak{b}$, $\mathfrak{a}$ pale yellow. Optically −. $Bx_a \perp b$ (010). $Bx_o \wedge \dot{c} = 3°$ to 5° Lévy-Lcx.[1] 2V = 60° approx.

**Comp.**—$H_4MnAl_2Si_2O_{10}$ or $2H_2O.MnO.Al_2O_3.2SiO_2$ = Silica 36·5, alumina 31·0, manganese protoxide 21·5, water 11·0 = 100.

The water goes off at a red heat; hence probably (Groth) as a basic metasilicate.

**Anal.**—1, Hauer, Ber. Ak. Wien, **12**, 505, 1854. 2, Bülowius, Zs. G. Ges., **22**, 456, 1870. 3, Koninck, Bull. Ac. Belg., **47**, 564, 1879. For earlier analyses, 5th Ed., p. 419.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Schlackenwald | 36·15 | 19·74 | 9·87 | 20·76 | — | — | — | 2·56 | 10·19 | F 1·74 = 101·01 |
| 2. Wippra, Harz | 38·02 | 29·40 | 2·89 | — | 4·07 | 11·78 | 1·80 | — | 10·17 | Alk. 0·46, quartz 1·17 = 99·76 |
| 3. Meuville | 37·15 | 30·11 | 2·27 | — | — | 17·97 | 0·41 | — | 11·22 | Alk. 0·54, CuO 0·33 = 100 |

From 3, 34 p. c. quartz have been deducted.

**Pyr., etc.**—In the closed tube gives water, which reacts acid and attacks the glass (fluorine). B.B. swells up and fuses at 3·5 to a brown glass. With the fluxes gives reactions for manganese and iron. Not decomposed by hydrochloric acid. Decomposed on fusion with alkaline carbonates.

**Obs.**—Occurs in minute divergent tufts, disposed on granite, with fluorite and quartz, in the tin mines of Schlackenwald: also at Wippra in the Harz on quartz; near Meuville in the Ardennes in quartz pebbles; in the Beaujolais, France. It was named by Werner in allusion to its color, from κάρφος, *straw*.

**Ref.**—[1] Min. Roches, 164, 1888.

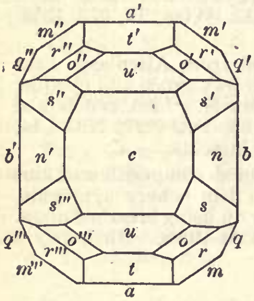
**425. CERITE.** Ferrum calciforme terra quadam incognita intime mixtum, Tungsten von Bastnäs, *Cronstedt*, Ak. H. Stockholm, 1751, Min., 183, 1758. Cerit *His. & Berz.*, Cerium en ny Metal, etc., 1804, Gehlen's J., **2**, 397, 1804, Afh., **1**, 58. 1806. Ochroit *Klapr.*, Gehlen's J., **2**, 303, 1804. Cererit *Klapr.*, Beitr., **4**, 140, 1807; *Karst.*, Tab., **74**, 1808. Cerium oxydé siliceux. *H.*, Tabl., 1809. Cerin-Stein *Wern.*, Hoffm. Min., **4**, a, 286, 1817. Kieselcerit *Germ.* Lanthanocerit *Hermann*, J. pr. Ch, **82**, 406, 1861.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·9988 : 1 : 0·8127$ A. E. Nordenskiöld[1].
$100 \wedge 110 = 44° 58'$, $001 \wedge 101 = 39° 8'$, $001 \wedge 011 = 39° 6'$.

**Forms:** *c* (001, *O*) *u* (101, 1-$\bar{i}$) *n* (011, 1-$\breve{i}$) *r* (321, 3-$\frac{3}{2}$)
*a* (100, *i*-$\bar{i}$) *m* (110, *I*) *t* (301, 3-$\bar{i}$) *o* (523, $\frac{5}{3}$-$\frac{5}{2}$) *s* (134, $\frac{3}{4}$-$\breve{3}$)
*b* (010, *i*-$\breve{i}$) *q* (130, *i*-$\breve{3}$)

*mm'''* = *89° 56′ *tt'* = 135° 27′ *ao* = 39° 59′ *bs* = 59° 9′
*qq'* = 36° 55′ *nn* = 78° 12 *ar* = 38° 1′ *oo'''* = 35° 39′
*au* = *50° 52′ *co* = 32° 43′ *ss'* = 19° 42½′ *rr'''* = 63° 17′
*uu'* = 78° 16′

Crystals rare, highly modified; habit short prismatic. Commonly massive; granular.



Cleavage not observed. Fracture splintery. Brittle. H. = 5·5. G. = 4·86 Nd.; 4·912 Haid. Luster dull adamantine or resinous. Color between clove-brown and cherry-red, passing into gray. Streak grayish white. Slightly subtranslucent.

**Comp.**—A silicate of the metals of the cerium group with iron and calcium in small amount, also water; formula doubtful.

Rammelsberg's analysis corresponds nearly to $3H_2O.2Ce_2O_3.3SiO_2$ which requires: Silica 20·1, cerium trioxide 73·8, water 6·1 = 100. Lindström's analysis, however, gives approximately $3H_2O.2(Ca,Fe)O.3Ce_2O_3.6SiO_2$; Groth writes the formula $(Ca,Fe)(CeO)(OH)_3Ce_2(SiO_3)_3$.

On the rare earths in cerite. cf. Crookes, Ch. News, **54**, 21, 40, etc.; also Krüss and Nilson, Öfv. Ak. Stockh., **44**, 371, 1887; the latter identity didymium chiefly, also samarium.

Hermann (l. c.) gave the name *lanthanocerite* to the mineral analyzed by him, which he found to contain lanthanum and didymium chiefly, with but little cerium.

**Anal.**—1, Rg., Pogg., **107**, 631, 1859. 2, Lindström, Öfv. Ak. Stockh., **30**, 13, 1873. 3, Stolba and Kettner, Ber. Böhm. Ges., 372, 1879. Also Hisinger, Hermann, Kjerulf, see 5th Ed., p. 414.

| | $SiO_2$ | $Ce_2O_3$ | $Di_2O_3,La_2O_3$ | FeO | $Al_2O_3$ | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. | 19·18 | 64·55 | 7·28 | 1·54 | — | 1·35 | 5·71 | = 99·61 |
| 2. G. = 4·86 | 22·79 | 24·06 | 35·37 | 3·92 | 1·26 | 4·35 | 3·44 | gangue 4·33 = 99·52 |
| 3. | 18·18 | 33·25 | 34·60 | 3·18 | — | 1·69 | 5·18 | = 96·08 |

**Pyr., etc.**—In a matrass yields water. B.B. infusible alone; with borax in the outer flame forms a yellow globule, which becomes almost colorless on cooling; in the inner flame a weak iron reaction. With soda not dissolved, but fuses to a dark yellow slaggy mass. Gelatinizes with hydrochloric acid.

**Obs.**—Occurs at Bastnäs, near Riddarhyttan, in Westmanland, Sweden, forming a bed in gneiss, and associated with mica, hornblende, chalcopyrite, cerine (allanite), etc. It bears considerable resemblance to the red granular variety of corundum, but is readily distinguished by its inferior hardness.

Hisinger and Berzelius, in 1803–4, detected in this mineral a new metal which they named *cerium*, after the planet *Ceres*, then recently announced; and the mineral they called *cerite*. Klaproth made the same discovery about the same time, and gave the name *ochroite* to the mineral, and *ochroite earth* to the new earth (alluding to its color, from ὠχρός, *brownish yellow*). In his Beiträge, 1807, Klaproth accepted the names of Hisinger and Berzelius, yet added a syllable (lest they should appear to come from κηρα, *wax*), making them *cererium* and *cererite*—a change not accepted. In 1839 Mosander proved that the oxide of cerium contained the new metal *lanthanum*, and in 1842 another new metal, *didymium*.

**Ref.**—[1] Öfv. Ak. Stockh., **30**, 13, 1873.

**426. TOURMALINE.** *Early syn. of precious T.* Turamali, Turmalin (fr. Ceylon), *Ceylon name, Garmann,* Curiosæ Speculationes, etc., von einem Liebhaber, der immer gern speculirt, Chemnitz, 1707. Pierre de Ceylan; un petit aiman; *M. Lemery* la fit voir, etc., Hist. Ac. Sci., Paris, p. 8, 1717. Aschentrecker *Holl.;* Aschenzieher *Germ.;* Ash-drawer *Engl.* [alluding to electrical property]. Zeolithus vitreus electricus, Tourmalin, *Rinmann,* Ak. H. Stockh., 1766; *v. Born,* Lithoph., **1**, 47, 1772. Borax electricus *Linn.,* Syst., 96, 1768. Tourmaline Garnet *Hill,* Foss., 148, 1771. Tourmaline *Kirw.,* Min., **1**, 271, 1794.

*Early syn. of opaque T.* Schurl pt. *Erker,* 1595; Schirl pt. *Brückmann,* 1727 [see p. 206]. Skiörl pt., Corneus crystallisatus pt., *Wall.,* 139, 1747. Basaltes cryst. pt., Skörl-Crystall pt., *Cronst.,* 70, 1758. Schörl, Stangenschörl, *Germ.;* Shorl, Shirl, Cockle, *Engl.* Borax Basaltes *Linn.,* Syst., 95, 1768. Basaltes crystallisatus *v. Born,* Lithoph., **1**, 34, 1772, **2**, 95, 1775. Shorl *Kirw.,* Min., **1**, 265, 1794.

*Syn. from union of T. and S. in one species.* Tourmaline ou Basalte transparent = Schorl, *de Lisle,* Crist., 266, with fig. cryst. (and proofs of ident. of T. & S.), 1772. Schorl transparent rhomboidal dit Tourmaline et Peridot = Schorl, *de Lisle,* Crist., **2**, 344, with figs., 1783. Schörl, Stangenschörl (incl. var. (1) Schwarzer S., (3) Elektrischer S. = Turmalin), *Wern.,* Cronst., 169, 1780; Bergm. J., **1**, 374, 1789; *Jameson,* Min., 1816. Tourmaline *H.,* Tr., **3**, 1801.

*Var. introd. as Sp.* Rubellite (fr. Siberia) *Kirw.,* Min., **1**, 288, 1794 = Daourite *Delameth.,* T. T., **2**, 303, 1797 = Siberite *l'Hermina,* J. de l'École Polytechn., **1**, 439 = Tourmaline apyre *H.,* **4**, 1801 = Apyrit *Hausm.,* Handb., 642, 1813. Indicolite and Aphrizite (fr. Norway) *d'Andrada,* J. Phys., **51**, 243, 1800, Scherer's J., **4**, 19, 1800. Taltalite *Domeyko,* Min., 139, 1860 = Cobre negro estrellado de Tantal (Atacama).

*Var. introd. as Subsp.* Achroit (fr. Elba) *Herm.,* J. pr. Ch., **35**, 232, 1845. Dravit *Tschermak,* Min., 472, 1883.

Rhombohedral; hemimorphic. Axis $\dot{c} = 0·44767$; $0001 \wedge 10\bar{1}1 = 27° 20' 8''$ Kupffer[1].

**Forms**[2]:

$c$ $(0001,\ O)$
$m$ $(10\bar{1}0,\ I)$
$a$ $(11\bar{2}0,\ i\text{-}2)$
$\rho$ $(8·5·\bar{1}\bar{3}·0,\ i\text{-}\frac{13}{8})$
$\sigma$ $(21\bar{3}0,\ i\text{-}\frac{3}{2})$
$l$ $(52\bar{7}0,\ i\text{-}\frac{7}{5})$
$h$ $(41\bar{5}0,\ i\text{-}\frac{5}{4})$
$\psi$ $(71\bar{8}0,\ i\text{-}\frac{8}{7})$

$\chi$ $(10·1·\bar{1}\bar{1}·0,\ i\text{-}\frac{11}{10})$
$\phi$ $(13·1·\bar{1}\bar{4}·0,\ i\text{-}\frac{14}{13})$
$w$ $(12·1·\bar{1}\bar{3}·0,\ i\text{-}\frac{13}{12})$
$f$ $(10\bar{1}4,\ \frac{1}{4})$
$g$ $(10\bar{1}2,\ \frac{1}{2})$
$r$ $(10\bar{1}1,\ R)$
$k$ $(70\bar{7}4,\ \frac{7}{4})$
$d$ $(50\bar{5}2,\ \frac{5}{2})$
$y$ $(40\bar{4}1,\ 4)$

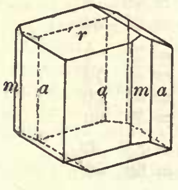
$\epsilon$ $(10·0·\bar{1}\bar{0}·1,\ 10)$
$e$ $(01\bar{1}2,\ -\frac{1}{2})$
$z$ $(01\bar{1}1,\ -1)$
$\alpha$ $(05\bar{5}4,\ -\frac{5}{4})$
$o$ $(02\bar{2}1,\ -2)$
$\zeta$ $(07\bar{7}2,\ -\frac{7}{2})$
$\Psi$ $(0·15·\bar{1}\bar{5}·4,\ -\frac{15}{4})$
$\beta$ $(09\bar{9}2,\ -\frac{9}{2})$
$\kappa$ $(05\bar{5}1,\ -5)$

$\Omega$ $(0·11·\bar{1}\bar{1}·1,\ -11)$
$H$ $(11\bar{2}3,\ \frac{2}{3}\text{-}2)$
$Z$ $(71\bar{8}6,\ 1^{\frac{4}{3}})$
$q$ $(31\bar{4}2,\ 1^{2})$
$t$ $(21\bar{3}1,\ 1^{3})$
$u$ $(32\bar{5}1,\ 1^{5})$
$M$ $(4·3·\bar{7}·10,\ \frac{1}{10}^{7})$
$p$ $(15·14·\bar{2}\bar{9}·1,\ 1^{29})$
$x$ $(12\bar{3}2,\ -\frac{1}{2}^{3})$

$\mu$ $(24\bar{6}1,\ -2^{3})$
$\Lambda$ $(23\bar{5}2,\ -\frac{1}{2}^{5})$
$\Upsilon$ $(45\bar{9}2,\ -\frac{1}{2}^{9})$
$v$ $(13\bar{4}1,\ -2^{2})$
$\Phi$ $(27\bar{9}4,\ -\frac{5}{4}^{\frac{9}{5}})$
$X$ $(2·10·\bar{1}\bar{2}·7,\ -\frac{8}{7}^{\frac{3}{2}})$
$\delta$ $(17\bar{8}3,\ -2^{\frac{4}{3}})$
$\Delta$ $(1·11·\bar{1}\bar{2}·5,\ -2^{\frac{6}{5}})$
$\pi$ $(1·26·\bar{2}\bar{7}·14,\ -\frac{35}{14}^{\frac{27}{25}})$

Some of the forms given for the prismatic zone must be regarded as doubtful because of its rounded and striated character.

1.



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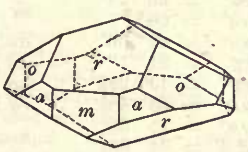

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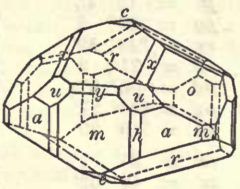
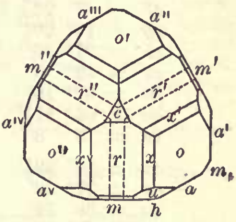


3*a*.



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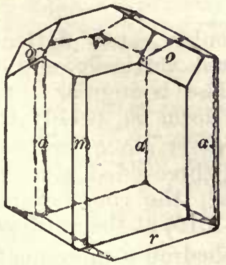

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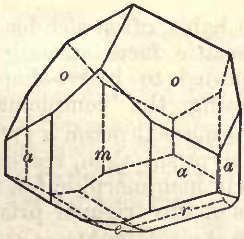

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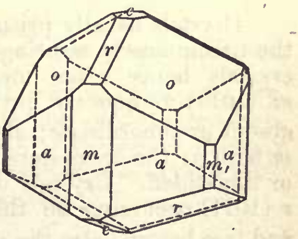
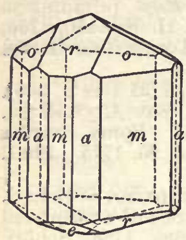


Figs. 1, 4, Common forms. 2, 3, 5, 6, Pierrepont, N. Y.; 3*a*, basal section of 3, J. Stanley-Brown.

7.



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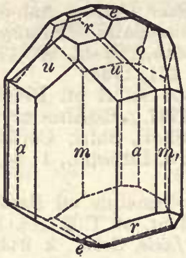

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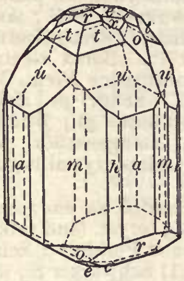
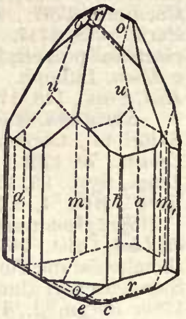
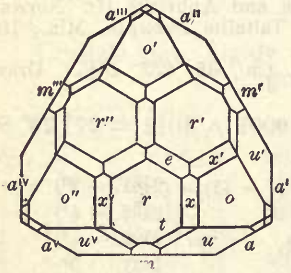


10.

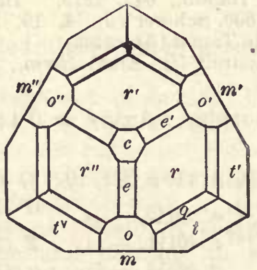


11.

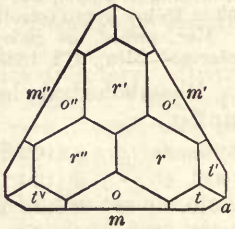


Antilogous Pole.

12.



13.



Analogous Pole.

Fig. 7, Common form. 8, 9, 10, Gouverneur, N. Y., Farrington; the antilogous end above. 11, 12, Gouverneur, N. Y., Rose. 13, Unionville, Pa.

$a\gamma = 26^\circ\ 48'$
$aw = 26^\circ\ 2'$
$a\psi = 23^\circ\ 25'$
$ah = 19^\circ\ 6\frac{1}{2}'$
$a\sigma = 10^\circ\ 53\frac{1}{2}'$
$cf = 7^\circ\ 22'$
$cg = 14^\circ\ 29\frac{1}{2}'$
$cr = 27^\circ\ 20'$
$ck = 42^\circ\ 8'$
$cd = 52^\circ\ 16'$
$cy = 64^\circ\ 11\frac{1}{2}'$
$c\epsilon = 79^\circ\ 3'$

$ce = 14^\circ\ 29\frac{1}{2}'$
$cz = 27^\circ\ 20'$
$c\alpha = 32^\circ\ 52'$
$co = 45^\circ\ 57'$

$c\zeta = 61^\circ\ 4'$
$c\Psi = 62^\circ\ 43'$
$c\beta = 66^\circ\ 44'$
$c\kappa = 68^\circ\ 51'$
$c\Omega = 80^\circ\ 1\frac{1}{2}'$

$ff' = 12^\circ\ 45'$
$gg' = 25^\circ\ 2'$
$rr' = {}^*46^\circ\ 52'$
$kk' = 71^\circ\ 2'$
$dd' = 86^\circ\ 27\frac{1}{2}'$
$yy' = 102^\circ\ 27'$
$\epsilon\epsilon' = 116^\circ\ 29'$

$ee' = 25^\circ\ 2'$
$zz' = 46^\circ\ 52'$
$\alpha\alpha' = 56^\circ\ 4'$

$oo' = 77^\circ\ 0'$
$qq' = 58^\circ\ 51'$
$\kappa\kappa' = 107^\circ\ 44\frac{1}{2}'$
$qq^{\mathrm{v}} = 18^\circ\ 51'$
$tt' = 63^\circ\ 48'$
$tt^{\mathrm{v}} = 30^\circ\ 38\frac{1}{2}'$
$cu = 66^\circ\ 4'$
$uu' = 66^\circ\ 1'$
$uu^{\mathrm{v}} = 42^\circ\ 36'$
$xx' = 21^\circ\ 18'$
$xx^{\mathrm{v}} = 43^\circ\ 22\frac{1}{2}'$
$\mu\mu' = 35^\circ\ 48\frac{1}{2}'$
$\mu\mu^{\mathrm{v}} = 75^\circ\ 53'$
$\Lambda\Lambda = 34^\circ\ 35\frac{1}{3}'$
$\Lambda\Lambda^{\mathrm{v}} = 52^\circ\ 57'$
$\Gamma\Gamma' = 46^\circ\ 50'$

$\Gamma\Gamma^{\mathrm{v}} = 59^\circ\ 35'$
$vv' = 24^\circ\ 26'$
$vv^{\mathrm{v}} = 78^\circ\ 50'$

$au = 24^\circ\ 46'$
$at = 37^\circ\ 34'$
$aq = 49^\circ\ 5'$
$ar = 66^\circ\ 34'$

$av = 32^\circ\ 9'$
$a\delta = 43^\circ\ 19'$
$ao = 51^\circ\ 30'$
$ro = 38^\circ\ 30'$

$mu = 33^\circ\ 0'$
$mo = 68^\circ\ 56'$

Crystals usually prismatic in habit, often slender to acicular; rarely flattened, the prism nearly wanting. Prismatic faces strongly striated vertically, and the crystals hence often much rounded to barrel-shaped. The triangular prism *m* $(10\bar{1}0)$ frequently predominating, the complementary form *m,* $(01\bar{1}0)$ then absent or subordinate; also the hexagonal prism *a* $(11\bar{2}0)$ present alone; or, again, *m* with *a*; the cross-section of the prism then, respectively, three-sided, six-sided, or nine-sided. Crystals commonly hemimorphic (cf. figures); the rhombohedron *r* $(10\bar{1}1)$ occurring on the edges of the trigonal prism *m* $(10\bar{1}0)$ at the antilogous end (see below); also the rhombohedron *o* $(02\bar{2}1)$ and scalenohedron *u* prominent at the antilogous end (Pierrepont, Gouverneur, Pfd., cf. f. 5, 6, 9, 10). Penetration-twins with parallel axes not common; also rare, a cruciform-twin with *r* as tw. pl.[3] Crystals sometimes isolated but more commonly in parallel and radiating groups. Sometimes massive compact; also columnar, coarse or fine, parallel or divergent.

Cleavage: *a*, *r* difficult. Fracture subconchoidal to uneven. Brittle and often rather friable. H. = 7–7·5. G. = 2·98–3·20. Luster vitreous to resinous. Color black, brownish black, bluish black, most common; blue, green, red, and sometimes of rich shades; rarely white or colorless; some specimens red internally and green externally; and others red at one extremity, and green, blue, or black at the other. Streak uncolored. Transparent to opaque.

Strongly dichroic, especially in deep colored varieties; axial colors varying widely.[5] Absorption for the ordinary ray $\omega$ (vibrations $\perp \dot{c}$) much stronger than for the extraordinary ray $\epsilon$ (vibrations $\parallel \dot{c}$); thus sections $\parallel \dot{c}$ transmit sensibly the extraordinary ray only, and hence their use (*e.g.*, in the tourmaline tongs) for giving polarized light. Exhibits idiophanous figures.[6] Optically —. Double refraction strong. Sometimes abnormally biaxial.[7] Refractive indices[4]:

| | | | |
|---|---|---|---|
| *Colorless* | $\omega_y$ = 1·6366 Na | $\epsilon_y$ = 1·6193 | Dx. |
| " | $\omega_y$ = 1·6397 | $\epsilon_y$ = 1·6208 | Miklucho-Maclay |
| *Green* | $\omega_r$ = 1·6408 | $\epsilon_r$ = 1·6203 | Senarmont |
| *Bl. green* | $\omega_r$ = 1·6415 | $\epsilon_r$ = 1·6230 | " |
| *Blue* | $\omega_r$ = 1·6435 | $\epsilon_r$ = 1·6222 | " |
| " | $\omega_y$ = 1·6530 | $\epsilon_y$ = 1·6312 Na | Schwebel |
| " | $\omega_{bl}$ = 1·6564 | $\epsilon_{gr}$ = 1·6343 Tl | " |
| *Green, chrom. var.* | $\omega_r$ = 1·6579 approx. | $\epsilon_r$ = 1·62407 Li | Arzruni |
| | $\omega_{gr}$ = 1·6870 " | $\epsilon_y$ = 1·63733 Na | " |
| | | $\epsilon_{gr}$ = 1·64075 Tl | " |

Erofeyev (l. c.) shows that the refractive indices vary somewhat widely with the color and even in successive layers of the same crystal.

Becomes electric by friction; also strongly pyroelectric as early investigated by Rose, and later by others.[5] The end terminated by the rhombohedron *r* (10$\bar{1}$1) and the corresponding unit prism *m* (10$\bar{1}$0) is, as above noted, with few exceptions the antilogous pole, becoming + electrified with decrease and — electrified with increase of temperature. Cf. also figs. 11, 12 from Rose.

**Var.**—*Ordinary.* In crystals as above described; black much the most common. (*a*) *Rubellite;* the red, sometimes transparent; the Siberian is mostly violet-red (*siberite*), the Brazilian rose-red; that of Chesterfield and Goshen, Mass., pale rose-red and opaque; that of Paris, Me., fine ruby-red and transparent. (*b*) *Indicolite.* or *indigolite;* the blue, either pale or bluish black; named from the indigo-blue color. (*c*) *Brazilian Sapphire* (in jewelry); Berlin-blue and transparent; (*d*) *Brazilian Emerald, Chrysolite* (or *Peridot*) *of Brazil;* green and transparent. (*e*) *Peridot of Ceylon;* honey-yellow. (*f*) *Achroïte;* colorless tourmaline, from Elba. (*g*) *Aphrizite;* black tourmaline, from Kragerö, Norway. (*h*) *Columnar* and *black;* coarse columnar. Resembles somewhat common hornblende, but has a more resinous fracture, and is without distinct cleavage or anything like a fibrous appearance in the texture; it often has the appearance on a broken surface of some kinds of soft coal.

*Dravite* of Tschermak is the brown, greenish black or brownish black magnesium tourmaline from Unterdrauburg in the Drave district in Carinthia.

The varieties based upon composition fall into three prominent groups, between which there are many gradations:

1. ALKALI TOURMALINE. Contains sodium or lithium, or both; also potassium. G. = 3·0–3·1. Color red to green; also colorless.

2. IRON TOURMALINE. G. = 3·1–3·2. Color usually deep black.

3. MAGNESIUM TOURMALINE. G. = 3·0–3·09. Usually yellow-brown to brownish black; also colorless (anal. 54).

A *chromium tourmaline* has also been described (anal. 71, 72). G. = 3·120. Color dark green.

**Comp.**—A complex silicate of boron and aluminium, with also either magnesium, iron, or the alkali metals, prominent. Formula uncertain. According to early investigations of Rammelsberg, recently reviewed and extended, the oxygen ratio of Si : R is in general 2 : 3 and the formula may hence be written:

$$\overset{\text{I}}{\text{R}}_6\text{SiO}_5 = \overset{\text{II}}{\text{R}}_3\text{SiO}_5 = \overset{\text{III}}{\text{R}}_2\text{SiO}_5.$$

Here $\overset{\text{I}}{\text{R}}$ = Na,Li,K; $\overset{\text{II}}{\text{R}}$ = Mg,Fe,Ca; $\overset{\text{III}}{\text{R}}$ = Al,B,Cr,Fe.

| | G. | SiO₂ | B₂O₃ | Al₂O₃ | FeO | MnO | MgO | CaO | Na₂O | K₂O | Li₂O | F | H₂O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Gouverneur, *brown* | 3·049 | 38·85 | [8·35] | 31·32 | 1·14 | — | 14·89 | 1·60 | 1·28 | 0·26 | — | — | 2·31 = 100 |
| 2. Wind. Kappel " | 3·035 | 38·09 | 11·15 | 32·90 | 0·66 | — | 11·79 | 1·25 | 2·37 | 0·47 | — | 0·64 | 2·05 = 101·37 |
| 3. Eibenstock, *greenish* | 3·034 | 37·75 | [9·14] | 30·86 | 4·36 | — | 11·62 | 0·88 | 2·27 | 0·30 | — | — | 2·82 = 100 |
| 4. Zillerthal, *black* | 3·054 | 38·51 | [9·52] | 32·65 | 2·80 | 0·36 | 10·46 | 0·16 | 2·13 | 0·37 | — | 0·36 | 3·04 = 100·36 |
| 5. Orford, N. H., *brownish black* | 3·068 | 38·33 | 9·86 | 33·15 | 2·88 | — | 10·89 | 0·77 | 1·52 | | — | — | 2·81 = 100·21 |
| 6. Texas, Pa., *greenish black* | 3·043 | 38·45 | [8·57] | 34·56 | 2·98 | 0·09 | 9·11 | 0·71 | 2·00 | 0·73 | — | — | 2·80 = 100 |
| 7. Monroe, Conn., *brownish black* | 3·068 | 39·01 | [8·95] | 31·18 | 4·07 | — | 9·90 | 1·81 | 1·82 | 0·44 | — | — | 2·82 = 100 |
| 8. Godhaab, *black* | 3·072 | 37·70 | [7·82] | 34·26 | 4·42 | — | 9·51 | 1·25 | 2·00 | 0·43 | — | — | 2·61 = 100 |
| 9. Havredal, " | 3·107 | 37·11 | [9·29] | 31·26 | 7·58 | — | 9·43 | 0·80 | 1·78 | 0·32 | — | — | 2·43 = 100 |
| 10. St. Gothard, *black* | 3·055 | 38·00 | [10·32] | 31·41 | 7·23 | — | 7·27 | 1·31 | 1·43 | 0·28 | — | — | 2·75 = 100 |
| 11. Haddam, Conn., *black* | 3·136 | 37·50 | [9·02] | 30·87 | 8·54 | — | 8·60 | 1·33 | 1·60 | 0·73 | — | — | 1·81 = 100 |
| 12. Snarum, " | 3·145 | 37·22 | [9·73] | 30·00 | 11·16 | — | 7·94 | 0·65 | 1·13 | 0·53 | — | 0·55 | 1·64 = 100·55 |
| 13. Elba, " | 3·059 | 38·20 | [9·03] | 30·02 | 9·93 | 0·58 | 6·77 | 0·74 | 2·19 | 0·25 | — | 0·15 | 2·29 = 100·15 |
| 14. Unity, N. H., " | 3·192 | 36·29 | [9·04] | 30·44 | 13·23 | — | 6·32 | 1·02 | 1·94 | | — | — | 1·72 = 100 |
| 15. Krummau, " | 3·135 | 36·43 | [9·82] | 34·12 | 11·58 | — | 3·84 | 0·44 | 1·36 | 0·30 | — | — | 2·11 = 100 |
| 16. De Kalb, N. Y. " | 3·195 | 37·07 | [9·70] | 31·86 | 12·55 | 0·51 | 3·49 | — | 2·04 | 0·30 | — | 0·31 | 2·48 = 100·31 |
| 17. Langenbielau, " | 3·152 | 37·24 | [11·02] | 31·63 | 11·64 | — | 3·65 | 0·62 | 1·93 | 0·82 | — | — | 1·45 = 100 |
| 18. Bovey Tracy, " | 3·205 | 37·94 | [10·72] | 30·22 | 13·82 | 0·40 | 2·62 | 0·50 | 1·39 | 0·65 | — | 0·45 | 1·74 = 100·45 |
| 19. Krumbach, " | 3·183 | 36·25 | [10·77] | 32·21 | 12·82 | 1·50 | 2·32 | 0·40 | 1·43 | 0·46 | — | 0·64 | 2·34 = 100·64 |
| 20. Alabashka, " | 3·229 | 36·19 | [12·79] | 30·41 | 15·59 | 0·54 | 1·88 | — | 1·02 | 0·47 | — | 0·76 | 1·11 = 100·76 |
| 21. Andreasberg, " | 3·243 | 36·06 | [11·11] | 30·34 | 17·40 | 0·11 | 0·78 | 0·72 | 1·36 | 0·58 | — | 0·85 | 1·54 = 100·85 |
| 22. Saar, Bohemia, " | 3·181 | 36·11 | 11·64 | 35·46 | 13·17 | 0·28 | 1·52 | — | 0·98 | 0·09 | — | 0·41 | 1·26 = 100·92 |
| 23. Sarapulsk, Ural, *bluish black* | 3·162 | 38·30 | [11·62] | 31·53 | 10·30 | 2·68 | 1·06 | — | 2·37 | 0·33 | — | 0·80 | 1·81 = 100·80 |
| 24. Goshen, Mass., " " | 3·203 | 36·22 | 10·65 | 33·35 | 11·95 | 1·25 | 0·63 | — | 1·75 | 0·40 | 0·84 | 0·82 | 2·21 = 100·07 |
| 25. Elba, *green* | 2·942 | 37·14 | [9·37] | 34·15 | 10·52 | 1·87 | 1·68 | — | 2·30 | 0·75 | 0·32 | 0·47 | 1·90 = 100·47 |
| 26. " " | — | 38·24 | — | 33·19 | 5·43 | 3·59 | 4·30 | 0·30 | — | — | — | 0·98 | |
| 27. " " | 3·112 | 37·74 | [9·99] | 41·89 | 1·38 | 2·51 | 0·41 | — | 2·40 | 0·34 | 0·74 | 0·50 | 2·60 = 100·50 |
| 28. Shaitansk, *red* | 3·082 | 38·26 | [9·29] | 43·97 | — | 1·53 | 1·62 | 0·62 | 1·53 | 0·21 | 0·48 | [0·70] | 2·49 = 100·70 |
| 29. Paris, Me., " | 3·019 | 38·19 | 9·97 | 42·63 | — | 1·94 | 0·39 | 0·45 | 2·60 | 0·68 | 1·17 | 1·18 | 2·00 = 101·20 |
| 30. Rozena, " | 2·998 | 41·16 | [8·93] | 41·83 | — | 0·95 | 0·61 | — | 1·37 | 2·17 | 0·41 | 1·19 | 2·57 = 101·19 |
| 31. Elba, *colorless, reddish* | 3·022 | 38·85 | 9·52 | 44·05 | — | 0·92 | 0·20 | — | 2·00 | 1·30 | 1·22 | 0·70 | 2·41 = 101·17 |
| 32. Brazil, *green* | 3·107 | 38·06 | [10·09] | 37·81 | 5·83 | 1·13 | 0·92 | — | 2·21 | 0·42 | 1·30 | 0·70 | 2·23 = 100·70 |
| 33. Chesterfield, Mass., *green with red* | 3·108 | 38·46 | 9·73 | 36·80 | 6·38 | 0·78 | 1·88 | — | 2·47 | 0·47 | 0·72 | 0·55 | 2·31 = 100·55 |
| 34. Paris, Me., *green with red* | 3·069 | 38·47 | *undet.* | 40·93 | 2·77 | 1·55 | 2·09 | — | 2·36 | 0·36 | 1·47 | — | |
| 35. Pierrepont, *black* | | 36·64 | 9·55 | 27·18 | 9·08 | — | 10·13 | 2·91 | 1·50 | *tr.* | — | — | 3·01 = 100 |

| | G. | $SiO_2$ | $TiO_2$ | $B_2O_3$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $Na_2O$ | $K_2O$ | $Li_2O$ | $H_2O$ | F | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36. Rumford, *A*, *rose* | 2·997 | 38·07 | — | 9·99 | 42·24 | — | 0·26 | 0·35 | 0·56 | 0·07 | 2·18 | 0·44 | 1·59 | 4·26 | 0·28 | | = 100·29 |
| 37. Brazil, *A*, *pink* | 3·028 | 37·19 | ? | 10·06 | 42·43 | — | 0·52 | 0·79 | 0·57 | — | 2·24 | 0·23 | 1·73 | 3·90 | *tr.*? | | = 99·66 |
| 38. Auburn, *A*, *colorless* | 3·07 | 38·14 | — | 10·25 | 39·60 | 0·30 | 1·38 | 1·38 | 0·43 | — | 2·36 | 0·27 | 1·34 | 4·16 | 0·62 | | = 100·23 |
| 39. Brazil, *B*, *pale green* | | 37·39 | ? | 10·29 | 39·65 | 0·15 | 2·29 | 1·47 | 0·49 | — | 2·42 | 0·25 | 1·71 | 3·63 | 0·32 | | = 100·06 |
| 40. Auburn, *B*, *pale green* | | 37·85 | — | 10·55 | 37·73 | 0·42 | 3·89 | 0·51 | 0·49 | 0·04 | 2·16 | 0·62 | 1·34 | 4·18 | 0·62 | | = 100·39 |
| 41. Brazil, *C*, *olive-green* | | 36·91 | ? | 9·87 | 38·13 | 0·31 | 3·19 | 2·22 | 0·38 | 0·04 | 2·70 | 0·28 | 1·61 | 3·64 | 0·14 | $P_2O_5$ 0·11 | = 99·53 |
| 42. Rumford, *B*, *dark green* | | 36·53 | ? | 10·22 | 38·10 | — | 6·43 | 0·32 | 0·34 | — | 2·86 | 0·38 | 0·95 | 3·52 | 0·16 | | = 99·81 |
| 43. Auburn, *C*, *dark green* | | 36·26 | — | 9·94 | 36·68 | 0·15 | 7·07 | 0·72 | 0·17 | 0·16 | 2·88 | 0·44 | 1·05 | 4·05 | 0·71 | | = 100·28 |
| 44. Paris, *black* | | 35·03 | ? | 9·02 | 34·44 | 0·13 | 12·10 | 0·08 | 0·24 | 1·81 | 2·03 | 0·25 | 0·07 | 3·69 | — | | = 99·89 |
| 45. Auburn, *D*, *black* | 3·19 | 34·99 | — | 9·63 | 33·96 | — | 14·23 | 0·06 | 0·15 | 1·01 | 2·01 | 0·34 | *tr.* | 3·62 | — | | = 100·00 |
| 46. Brazil, *D*, " | 3·20 | 34·63 | ? | 9·63 | 32·70 | 0·31 | 13·69 | 0·12 | 0·33 | 2·13 | 2·11 | 0·24 | 0·08 | 3·49 | 0·06 | | = 99·52 |
| 47 Haddam, " | | 34·95 | 0·57 | 9·92 | 31·11 | 0·50 | 11·87 | 0·09 | 0·81 | 4·45 | 2·22 | 0·24 | *tr.* | 3·62 | — | | = 100·35 |
| 48. Stony Pt., " | 3·13 | 35·56 | 0·55 | 10·40 | 33·38 | — | 8·49 | 0·04 | 0·53 | 5·44 | 2·16 | 0·24 | *tr.* | 3·63 | — | | = 100·42 |
| 49. Nautic Gulf, " | 3·095 | 35·34 | 0·40 | 10·45 | 30·49 | — | 8·22 | *tr.* | 2·32 | 7·76 | 1·76 | 0·15 | *tr.* | 3·60 | — | | = 100·49 |
| 50 Pierrepont, " | 3·08 | 35·61 | 0·55 | 10·15 | 25·29 | 0·44 | 8·19 | *tr.* | 3·31 | 11·07 | 1·51 | 0·20 | *tr.* | 3·34 | 0·27 | | = 99·93 |
| 51. Monroe, *dark brown* | | 36·41 | 1·61 | 9·65 | 31·27 | — | 3·80 | *tr.* | 0·98 | 9·47 | 2·68 | 0·21 | — | 3·79 | — | | = 99·87 |
| 52. Orford, " " | | 36·66 | 0·23 | 10·07 | 32·84 | — | 2·50 | *tr.* | 1·35 | 10·35 | 2·42 | 0·22 | *tr.* | 3·78 | *tr.*? | | = 100·42 |
| 53. Gouverneur, *brown* | | 37·39 | 1·19 | 10·73 | 27·79 | 0·10 | 0·64 | — | 2·78 | 14·09 | 1·72 | 0·16 | *tr.* | 3·83 | *tr.*? | | = 100·42 |
| 54. De Kalb, *colorless* | 3·085 | 36·88 | 0·12 | 10·58 | 28·87 | — | 0·52 | — | 3·70 | 14·53 | 1·39 | 0·18 | *tr.* | 3·56 | 0·50 | | = 100·83 |
| 55. Hamburg, *cinnamon brown* | | 35·25 | 0·65 | 10·45 | 28·49 | — | 0·86 | — | 5·09 | 14·58 | 0·94 | 0·18 | *tr.* | 3·10 | 0·78 | | = 100·37 |
| 56. Snarum, *black* | 3·134 | 35·64 | 1·10 | 9·93 | 29·41 | 2·90 | 6·56 | — | 1·65 | 8·00 | 3·03 | 0·16 | — | 2·94 | — | | = 101·32 |
| 57 Alabashka, " | 3·138 | 35·41 | — | 10·14 | 33·75 | — | 13·42 | — | 0·17 | 1·57 | 2·08 | 0·34 | — | 3·41 | 0·28 | | = 100·57 |
| 58 Piedra Blanca, *black* | 3·173 | 34·73 | 0·30 | 9·64 | 31·69 | 3·18 | 10·14 | 0·16 | 0·36 | 3·47 | 2·85 | 0·15 | — | 3·44 | 0·47 | | = 100·58 |
| 59. Tamatawe, " | 3·195 | 35·48 | 1·22 | 9·49 | 25·83 | 6·68 | 7·99 | — | 2·03 | 6·90 | 1·92 | 0·29 | — | 2·58 | 0·33 | | = 100·74 |
| 60. Mursinka, " | 3·210 | 34·88 | 0·27 | 8·94 | 34·58 | — | 14·40 | 0·24 | 0·20 | 1·32 | 2·70 | 0·05 | — | 2·87 | 0·51 | | = 100·96 |
| 61. Oláhpian " | 3·084 | 35·69 | 0·86 | 9·84 | 30·79 | 3·65 | 5·46 | — | 1·54 | 8·12 | 2·53 | 0·27 | — | 3·20 | — | | = 101·95 |
| 62 Buckworth, Australia, *blk.* | 3·173 | 35·50 | — | 8·34 | 34·39 | — | 14·26 | — | — | 0·51 | 3·43 | — | — | 3·34 | 0·77 | | = 100·54 |
| 63. Barrado Perahy, Brazil, *grn.* | 3·029 | 37·40 | — | 10·74 | 39·02 | — | 2·35 | 2·57 | 0·60 | 0·20 | 3·59 | 0·29 | 1·33 | 3·08 | 0·98 | | = 102·15 |
| 64. Brazil, *green* | | 37·05 | — | 9·09 | 40·03 | — | 2·36 | 2·35 | 0·47 | 0·32 | 3·18 | — | 0·60 | 3·23 | 1·15 | | = 99·83 |
| 65. Schüttenhofen, *bl black* | 3·174 | 35·10 | — | [7·09] | 35·10 | — | 13·37 | 1·48 | — | 0·98 | 1·92 | 0·88 | — | 4·01 | — | $SnO_2$ 0·07 | = 100 |
| 66. " *bl. green* | 3·103 | 36·38 | — | [8·12] | 39·77 | — | 4·17 | 2·83 | — | — | 1·93 | 0·93 | 1·54 | 4·29 | — | $SnO_2$ 0·04 | = 100 |
| 67. " *red* | 2·913 | 38·49 | — | [8·25] | 41·49 | — | 0·35 | 0·60 | 0·82 | — | 1·32 | 2·14 | 1·68 | 4·61 | 0·43 | | = 100·18 |
| 68. Waldheim | | 36·65 | — | 4·61 | 35·76 | — | 4·78 | — | 0·47 | 10·01 | 2·89 | 1·22 | — | 2·87 | — | $SnO_2$ 0·41 | = 99·67 |
| 69. Mt. Bischoff, *gray-blue* | 3·042 | 36·86 | — | 10·56 | 36·72 | — | 5·66 | 0·66 | 0·34 | 3·92 | 3·57 | 1·11 | — | 1·16 | 0·61 | | = 101·17 |
| 70. Campolongo, *green* | 2·969 | 39·26 | — | [9·40] | 38·33 | — | 4·51 | 1·12 | — | 1·02 | 2·43 | 0·38 | — | 2·41 | 0·60 | | = 99·46 |
| | | | | | | $Cr_2O_3$ | | | | | | | | | | | |
| 71. Sysersk, Ural, *black-green* | 3·120 | 36·79 | — | 9·51 | 30·56 | 10·86 | 2·91 | *tr.* | 0·72 | 4·47 | 1·36 | *tr.* | — | 2·25 | 0·65 | | = 100·08 |
| 72. Montgomery Co., Md., *grn.* | | 36·56 | 0·09 | 8·90 | 32·58 | 4·32 | 0·79[b] | 0·05[c] | 0·75 | 9·47 | 2·22 | 0·13 | *tr.* | 3·74[d] | 0·06 | $P_2O_5$ 0·04 | = 99·70 |

[a] $Fe_2O_3$.   [b] NiO.   [c] NiO.   [d] At 105° 0·07.

Riggs, as the result of a series of new analyses (anal. 36–55), gives as the general formulas for the three types:

*Lithium T.* $4H_2O.2(Na,Li)_2O.3B_2O_3.8Al_2O_3.12SiO_2$.
*Iron T.* $4H_2O.Na_2O.4FeO.3B_2O_3.7Al_2O_3.12SiO_2$.
*Magnesium T.* $4H_2O.\frac{2}{3}Na_2O.\frac{28}{3}MgO.3B_2O_3.5Al_2O_3.12SiO_2$.

Jannasch and Calb (l. c.) have deduced the general formula $R_9(BO_2)(SiO_4)_2$, and the special formulas:

*Lithium T.* $7H_2O.4(Li,Na)_2O.4FeO.6B_2O_3.15Al_2O_3.24SiO_2$.
*Iron T.* $7H_2O.2Na_2O.9FeO.6B_2O_3.14Al_2O_3.24SiO_2$.
*Magnesium T.* $7H_2O.2Na_2O.12MgO.6B_2O_3.13Al_2O_3.24SiO_2$.

The composition of the differently colored portions of the same crystal has been specially investigated by Scharizer, cf. anals. 65–67.

**Anal.**—1–34, Rg., 1850–1870 (Pogg., **80**, 449, **81**, 1, 1850; **139**, 379, 547, 1870); the analyses are quoted in the form given in Min. Ch., p. 540 *et seq.*, 1875. 35, Id., Abh. Ak. Berl., 1889 (read Feb. 14). Cf. also Jb. Min., **2**, 149, 1890.

36–55, Riggs, Am. J. Sc., **35**, 35, 1888. 56–64, Jannasch and Calb, Ber. Ch. Ges., **22**, 216, 1889, also Calb (or Kalb), Inaug. Diss., Göttingen, 1890. 65–67, Scharizer, Zs. Kr., **15**, 337, 1889. 68, Sauer, Zs. G. Ges., 38, 704, 1886. 69, Sommerlad, Zs. G. Ges., **36**, 649, 1884. 70, Engelmann, Inaug. Diss., Bonn, p. 19, 1877. 71, Cossa and Arzruni, Zs. Kr., **7**, 1, 1882. 72, Chatard, Johns Hopkins Univ. Circular, No. 75, 1889. For analyses see pp. 554, 555.

**Pyr., etc.**—The magnesia varieties fuse rather easily to a white blebby glass or slag; the iron-magnesia var. fuse with a strong heat to a blebby slag or enamel, either white, greenish, or brownish; the iron var. fuse with difficulty, or, in some, only on the edges, to a brownish, brownish red, gray, or black slag; the iron-magnesia-lithia var. fuse on the edges, and often with great difficulty, to a yellowish, grayish, bluish, or whitish slag or enamel, and some are infusible; the lithia var. are infusible, but becoming white or paler, sometimes, as the Paris (Me.) rubellite, affording a fine enamel on the edges (R.). With the fluxes many varieties give reactions for iron and manganese. Fused with a mixture of potassium bisulphate and fluor spar gives a strong reaction for boric acid. By heat alone tourmaline loses weight from the evolution of silicon fluoride and perhaps also boron fluoride, and only after previous ignition is the mineral completely decomposed by hydrofluoric acid. Not decomposed by acids (Rg.). After fusion perfectly decomposed by sulphuric acid (Kbl.), and gelatinizes with hydrochloric acid.

**Obs.**—Tourmaline is usually found in granite, gneiss, syenite, mica schist, chloritic or talcose schist, dolomite, granular limestone; sometimes as a result of contact metamorphism near dikes of igneous rocks, thus adjoining a granite vein at Mt. Willard, N. H. (see Hawes, Am. J. Sc., **21**, 21, 1881). The variety in granular limestone or dolomite is commonly brown; the bluish black var. sometimes associated with tin ores; the brown with titanium.

Many foreign localities are mentioned above. Small brilliant black crystals in decomposed feldspar, at Sonnenberg near Andreasberg in the Harz, are called *aphrizite*. Rubellite and green tourmaline occur near Ekaterinburg in the Ural; beautiful pink crystals are found at Elba; green at Campolongo in Tessin, Switzerland; also from the Binnenthal, green to yellow; red to green, blue and black at Penig, Saxony; red and green varieties at Wolkenburg; also deep green and red in the province Minas Geraes, Brazil; yellow and brown from Ceylon; dark brown varieties from Eibenstock, Saxony; the Zillerthal; black from Arendal, Norway; Snarum; Kragerö. The chrome tourmaline (anal. 71) is from the chromite deposits at Nizhni Isetsk in the Sysersk district in the Ural. Indicolite is found at Utö, Sweden. Pale yellowish brown crystals in talc at Windisch Kappel in Carinthia; white specimens (*achroïte*) come from St. Gothard, Siberia, and Elba. In Great Britain, fine black crystals have been obtained near Bovey Tracey in Devon; also found in Cornwall at different localities; green near Dartmoor in Devon; black near Aberdeen in Scotland, and elsewhere; dark brown at Dalkey in Co. Dublin, Ireland; green near Dunfanaghy, Co. Donegal; green and red at Ox mountain, near Sligo.

In the U. States, in *Maine* at Paris and Hebron, magnificent red and green tourmalines with lepidolite, etc., some crystals over an inch in diameter, transparent, ruby-red within, surrounded by green, or red at one extremity and green at the other; also blue and pink varieties; and at Norway; pink at Rumford, embedded in lepidolite; at Auburn in clear crystals of a delicate pink or lilac with lepidolite, etc.; at Albany, green and black; at Streaked Mtn., black. In *Mass.*, at Chesterfield, red, green, and blue, in a granite vein with albite, uranite and microlite, the crystals small and curved, nearly opaque, and fragile, the green crystals often with distinct prisms of red color inside, especially when in smoky quartz: at Goshen, similar, blue and green, in great perfection; at Norwich, New Braintree, and Carlisle, good black crystals. In *N. Hamp.*, Alstead, Grafton, Sullivan, Acworth, and Saddleback Mt.; at Orford, large brownish black crystals abundant in steatite. In *Vermont*, at Brattleboro, black. In *Conn.*, at Monroe, perfect dark brown crystals in mica-slate near Lane's mine, sometimes two inches in length and breadth; at Haddam, fine black crystals in mica slate with anthophyllite, also in granite with iolite, and also at the gneiss quarries, on the east side of the river; at New Milford, black crystals with beryl and mica; black at Newtown, Bethel, and Waterbury; bluish black at Branchville.

In *N. York*, near Gouverneur, light and dark brown crystals, often highly modified, with tremolite, apatite, and scapolite in granular limestone, at Canton; in simple prisms in the same rock near Port Henry, Essex Co., sometimes as a shell inclosing feldspar; at Schroon, with chondrodite and scapolite; at Newcomb, Essex Co., in brown crystals; at Crown Point, fine brown crystals; at the chrysoberyl locality near Saratoga, N. Y., black; at Alexandria, Jefferson Co.; at Kingsbridge, brown, yellowish or reddish brown crystals in dolomite; near Edenville, gray or bluish gray and green in three-sided prisms occur; short black crystals in the same vicinity, and at Rocky Hill, sometimes 5 inches in diameter; a mile southwest of Amity, yellow and cinnamon-colored crystals with spinel in calcite; also near the same village a clove-brown variety with hornblende and rutile in granular limestone; in splendent black crystals at Pierrepont, St. Lawrence Co.; colorless and glassy at De Kalb; dark brown at McComb. In *N. Jersey*, at Franklin, Hamburg, and Newton, black and brown crystals in limestone, with spinel; also grass-green crystals in crystalline limestone near Franklin. In *Penn.*, at Newlin, Chester Co.; at London Grove and near Unionville, of a light yellow or brownish yellow, in limestone, and rarely *white;* at Parksburg, Chester Co.; in Delaware Co., at Aston; at Chester, fine black; Middletown, black; Marple, of a green color in talc; in New Garden township, Chester Co., in limestone, light brown to yellow and sometimes transparent; near New Hope on the Delaware, large black crystals, in which the prismatic faces are sometimes almost wanting. A chrome-var. from the chromite beds in Montgomery Co., *Maryland.* In *N. Car.*, Alexander Co., in fine black crystals with emerald and hiddenite; green at Silver Creek, Burke Co. In *S. Car.*, in Cheowee valley. In *Georgia*, Habersham Co. In *California*, black crystals, 6–8 in. in diameter, in feldspar veins, in the mountains between San Diego and the Colorado desert, bordering the elevated valley of San Felipe.

In *Canada*, in the province of Quebec, superb greenish yellow or yellowish brown crystals, 1 inch through, in limestone at Calumet Falls, Litchfield, Pontiac Co.; transparent and brown at Hunterstown, with vesuvianite and garnet; fine brown crystals at Clarendon, Pontiac Co.; black at Grenville and Argenteuil, Argenteuil Co.; St. Jérôme, Terrebonne Co. In Ontario, in fine crystals at North Elmsley, N. Burgess and Bathurst, Lanark Co.; Blythfield, Renfrew Co.; Galway and Stoney L. in Dummer, Peterborough Co.; Charleston L. in Leeds Co.

The name *turmalin* from *Turamali* in Cingalese (applied to zircon by jewelers of Ceylon) was introduced into Holland in 1703, with a lot of gems from Ceylon. The property of attracting the ashes of burnt peat, after friction, led to its being very soon named in Holland *Aschentrecker*, or *ash-drawer.* In 1717, Lemery, in his Memoir in the Hist. de l'Acad. des Sc., France, referred the attraction to magnetism; and in 1756 to 1762, appeared the several Memoirs of Æpinus (published in the Mem. Acad. Berlin, vol. **12**, and at St. Petersburg) on the *electrical* properties of tourmaline. The name *tourmaline* was slow of introduction into mineralogical treatises. The first specimens from Ceylon were cut gems, so that the common characteristics of tourmaline and schorl were not apparent. Linnæus, in his Syst. Nat., 1768, suggests the relation between them, but de Lisle was the first to describe Ceylon crystals, and bring the two minerals into one species. On the name *schorl*, see Introduction, p. xliv. Long after the union of tourmaline and schorl, the species continued to bear the latter of these names; and even in 1816, Jameson, in his System of Mineralogy, retains schorl as the name of the species, with *common schorl* and *tourmaline* or *precious schorl* as two subspecies.

**Alt.**—Tourmaline occurs altered to mica, chlorite, cookeite, steatite. The mica is lepidolite, a species which is related in composition to some tourmaline, and is a frequent associate of the red and green varieties. It appears to take place through the addition of alkalies. Some rubellites and green tourmalines at Chesterfield are hollow, evidently from decomposition and removal of the interior; and in the cavities are occasionally observed small crystals of yellow uranite (Teschemacher).

Zeuxite, of Thomson, Min., **1**, 320, 1836, was found in 1814 in acicular interwoven prismatic crystals at Huel Unity, Cornwall; color brown, slightly greenish in some lights; G. = 3·051; H. = 4·25. Greg shows that the mineral is a ferriferous tourmaline (Phil. Mag., **10**, 118, 1855); this is confirmed by Dx. (Min., **2**, xliv, 1874).

**Ref.**—[1] Preisschrift, p. 112, 1825; Kupffer deduces from his measurements $rr' = 46° 47'$ black, $= 46° 52'$ green, $= 46° 58'$ red. The angle 46° 52', which is about the mean of these, has been accepted by Miller, Dx., et al. It is, however, rather variable. Erofeyev gives 46° 54', Vh. Min. Ges., **6**, 81–108, 1871. In the 5th Ed., the rhombohedron with a terminal angle of 77° was taken as the fundamental form because it showed a certain relation to calcite (see Am. J. Sc., **17**, 216, 1854). The probable tetartohedral character was first noted, though with some question, by Erofeyev (l. c.) and confirmed by Ramsay, Vet. Ak. Handl. Bih., **12** (2), No. 1, 1886; cf. also Solly, Min. Mag., **6**, 80, 1884.

[2] For lists of forms, with authorities, critical remarks as to doubtful forms, original observations, etc., see Erofeyev, l. c.; Slg., Zs. Kr., **6**, 217, 1881; Gdt., Index, **3**, 243, 1891. For earlier lists, original observations, etc., see Rose, Pogg., **42**, 580, 1837; Mlr., Min., 341, 1852; Dana, Min., 270, 1854, Am. J. Sc., **18**, 419, 1854; Dx., Min., **1**, 504, 1862; D'Achiardi, Elba, Nuovo Cimento, Feb., 1870 (and Zs. G. Ges., **22**, 663, 1870); Cossa and Arzruni, chrome-tourmaline, Zs. Kr., **7**, 1, 1882; Hidden, N. Carolina, who gives the rhombohedrons $\pm \frac{6}{5}$, ± 6, Am. J. Sc., **32**, 205, 1886; Ramsay, l. c. [3] Bauer, Jb. Min., **1**, 10, 1890. [4] Refractive indices, Dx., Min., l. c. (also Senarmont); Miklucho-Maclay, Rosenb., Mikr. Phys., 364, 1887; Schwebel, Zs. Kr., **7**, 158, 1882; Arzruni, ibid., p. 11.

[5] On *pyroelectricity*, Rose, Pogg., **39**, 291, 1836, **42**, 580, 1837; Rose and Riess, ibid., **59**, 357, 1843, Abh. Ak. Berlin, 65, 1843; Gaugain, Ann. Ch. Phys., **57**, 5, 1859; Schedtler (inves-

tigated by the Kundt method), Jb. Min. Beil., **4**, 519, 1886; Voigt, Nachr. Ges. Göttingen, Dec. 30, 1885. *Piezoelectricity*, J. and P. Curie, C. R., **92**, 186, 1881; Riecke, Wied., **28**, 43, 1886. 31, 889, 1887; Nachr. Ges. Göttingen, 188, 1890. *Elasticity*, Brazil, Voigt, Wied., **41**, 712, 1890. [6] *Light-absorption*, Pulfrich, Zs. Kr., **6**, 151, 1881, Schwebel, ib., **7**, 153, 1882. On dichroism, see Rg., Pogg., **81**, 36, 1850. [7] *Optical anomalies*, Mld., Ann. Mines, **10**, 150, 1876; Madelung, Zs. Kr., **7**, 75, 1882. Change in optical characters by pressure, Bücking, ib., p. 565, 1883. [8] Exhibits idiophanous figures, Btd., Bull. Soc. Min., **2**, 67, 1879. *Conductivity*, heat and electricity, S. P. Thompson and Lodge, Phil. Mag., **8**, 18, 1879, **12**, 112, 1881; Fitzgerald, Sc. Proc. Dubl. Soc., **1**, 370, 1880; Stenger, Wied., **22**, 522, 1884. *Specific heat*, Joly, Proc. R. Soc., **41**, 268, 1887.

A *boro-silicate of uranium* described by W. G. Waring (Eng. Mng. J., **49**, 356, 1890) from Pima Co., Arizona, has been shown by Kunz to be only black tourmaline.

**427. DUMORTIERITE.** *Gonnard*, Bull. Soc. Min., **4**, 2, 1881; *Bertrand*, ib., **3**, 171, 1882; and **4**, 9, 1881.

Orthorhombic. Prismatic angle approximately 60°; 56° Diller[1]. Rarely in distinct crystals with *a* (100) and *m* (110). Usually in fibrous to columnar aggregates. Twins: tw. pl. *m* (110), repeated, forming trillings Lcx.

Cleavage: *a* distinct; also prismatic, imperfect. H. = 7. G. = 3·265 Diller; 3·36 Dmr. Luster vitreous. Color bright smalt-blue to greenish blue. Transparent to translucent.

Pleochroism very strong: 𝔠 colorless, 𝔟 reddish violet, 𝔞 deep ultramarine-blue. Exhibits idiophanous figures, analogous to andalusite. Optically −. Ax. pl. ∥ *b*. Bx ⊥ *c*. Dispersion $\rho < v$ Btd.; $\rho > v$ Lévy-Lcx.

**Comp.**—Essentially a basic aluminium silicate. Perhaps $Al_8Si_3O_{18}$ or $4Al_2O_3.3SiO_2$ = Silica 30·6, alumina 69·4 = 100. Part of the aluminium seems to be replaced by boron.

**Anal.**—1, Damour, Bull. Soc. Min., **4**, 6, 1881. 2–4, J. E. Whitfield, Am. J. Sc., **37**, 216, 1889.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $B_2O_3$ | MgO | ign. | | |
|---|---|---|---|---|---|---|---|---|
| 1. Beaunan | 29·85 | 66·02 | 1·01 | — | 0·45 | 2·25 | | = 99·58 |
| 2. Harlem, N. Y. | 31·44 | 68·91 | — | *tr.* | — | — | | = 100·35 |
| 3. Clip, Arizona | 27·99 | 64·49 | — | 4·94 | *tr.* | 1·72 | $P_2O_5$ 0·20 | = 99·34 |
| 4. " " | 31·52 | 63·66 | — | 2·62 | 0·52 | 1·34 | Alk. 0·48 | = 100·14 |

An earlier analysis by Riggs of the Harlem mineral (Am. J. Sc., **34**, 406, 1887) showed 4·07 $B_2O_3$, but probably from tourmaline which is intimately associated with it.

**Pyr., etc.**—B.B. infusible, loses color on strong ignition; with cobalt solution a beautiful blue, characteristic of aluminium. With salt of phosphorus gives a slightly bluish opaline bead.

**Obs.**—Found in fibrous forms embedded in feldspar in blocks of gneiss at Chaponost, near Lyons, France, the original locality being near Beaunan; also at Brignais.

Also reported from Wolfshau, near Schmiedeberg, Silesia; in the iolite of the gneiss of Tvedestrand, Norway.

In the U. S., it occurs near Harlem, New York Island, in the pegmatoid portion of a biotite-gneiss; in a quartzose rock at Clip, Yuma Co., Arizona.

Named for the palæontologist, M. Eugène Dumortier.

**Ref.**—[1] Cf. Btd., l. c.; Diller, Am. J. Sc., **37**, 216, 1889.

**428. STAUROLITE.** Pierres de croix *de Robien*, N. idées sur la format. d. Foss., 109, 1751 (with figs.). Basaltes crystallisatus pt. *Cronst.* (the specimen a cross of two brown 6-sided crystals, worn as an amulet at baptisms in Basel, and called *Lapis crucifer*, and *Basler Taufstein*), Min., 70, 1758. Schorl cruciforme pt., Pierres de croix, *de Lisle*. Crist., 1772, 1783 (with figs.). Staurolite *Delameth.*, Sciagr., **1**, 298, 1792. Grenatite (fr. St. Gothard), *Saussure*, Voy. Alpes, § 1900, 1796. Granatite. Staurolith *Karst.*, Tab., 22, 1800. Staurotide *H.*, Tr., **3**, 1801. Nordmarkite *Dana*, Min., 389, 1868. Xantholite *Heddle*, Min. Mag., **3**, 59, 1879.

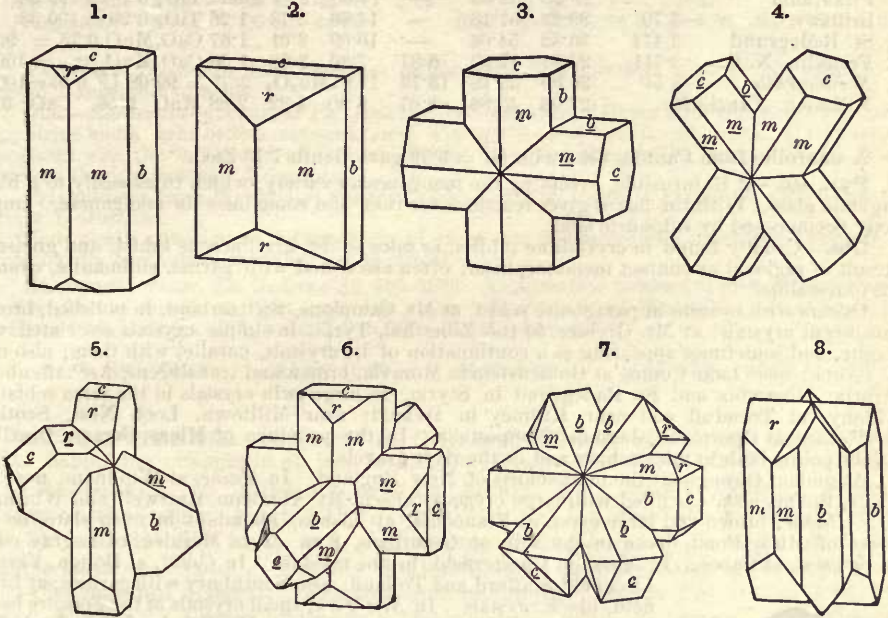
Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·4734 : 1 : 0·6828 Phillips[1].

100 ∧ 110 = 25° 20′, 001 ∧ 101 = 55° 16′, 001 ∧ 011 = 34° 19½′.

**Forms:** *b* (010, *i*-ĭ), *c* (001, *O*); *m* (110, *I*); *r* (101, 1-ī); also only as tw. planes, *y* (230, *i*-$\frac{3}{2}$), *x* (032, $\frac{3}{2}$-ĭ), *z* (232, $\frac{3}{2}$-$\frac{3}{2}$).

Angles: *mm‴* = *50° 40′, *yy‴* = 70° 45½′, *rr′* = 110° 32′, *mr* = *42° 2′, *cx* = 45° 41′, *cz* = 60° 31′.

Twins cruciform: (1) tw. pl. $x$ (032), the two crystals crossing nearly at right angles, since $cx = 45° 41'$. (2) tw. pl. $z$ (232), crossing at an angle of 60° approximately, since $cz = 60° 31'$. (3) tw. pl.[2] $y$ (rare), here $b\underline{b} = 70° 45\frac{1}{2}'$. Crystals commonly prismatic and often flattened ∥ $\bar{b}$; often with rough surfaces.



Figs. 1, 2, Simple forms. 3–5, Common twins. 6–8, Fannin Co., Ga.

Cleavage: $b$ distinct, but interrupted; $m$ in traces. Fracture subconchoidal. Brittle. H. = 7–7·5. G. = 3·65–3·75. Subvitreous, inclining to resinous. Color dark reddish brown to brownish black, and yellowish brown. Streak uncolored to grayish. Translucent to nearly or quite opaque.

Pleochroism distinct: $\mathfrak{c}$ (= $\dot{c}$) hyacinth-red to blood-red, $\mathfrak{a}$, $\mathfrak{b}$ yellowish red, Rosenbusch; or $\mathfrak{c}$ gold-yellow, $\mathfrak{a}$, $\mathfrak{b}$ light yellow to colorless. Optically +. Ax. pl. ∥ $a$. Bx ⊥ $c$. Axial angles:

$2H_{a.r} = 113° 10'$ $\beta_r = 1{\cdot}749$ $\therefore$ $2V_{a.r} = 88° 46'$ Lévy-Lcx.

$2H_{o.r} = 117° 52'$ $2V_{o.r} = 91° 39'$ Dx. $\beta_r = 1{\cdot}7526$, Mlr.

$\alpha = 1{\cdot}736$ $\beta = 1{\cdot}741$ $\gamma = 1{\cdot}746$ Lévy-Lcx.

**Comp., Var.**—Formula doubtful, perhaps $H_4(Fe,Mg)_6(Al,Fe)_{24}Si_{11}O_{66}$ or $2H_2O.6(Fe,Mg)O.12Al_2O_3.11SiO_2$ Friedl.

Coloriano gives $H_2Fe_2Al_{12}Si_5O_{31}$; Groth suggests the simpler form $HFeAl_5Si_2O_{13}$.

Impurities are usually present, especially in the form of inclosed silica, sometimes up to 30 to 40 p. c.; also garnet, mica, and perhaps magneite, brookite, cf. Rg., Lsx., Friedl, l. c. See also analyses, 5th Ed., p. 389, which give $SiO_2$ varying from 27·0 to 51·3.

*Nordmarkite* is a manganesian variety from Nordmark, Sweden, anal. 10.

*Xantholite* is a variety of somewhat anomalous composition, according to the analysis, which is probably to be explained by the presence of impurities (cf. Lcx., Bull. Soc. Min., **9**, 78, 1886).

Anal.—1, Rg., Zs. G. Ges., **25**, 53, 1873. 2, Friedl, Zs. Kr., **10**, 366, 1885. 3, Lsx., Min. Mitth., 173, 1872. 4, Coloriano, Bull. Soc. Ch., **44**, 427, 1885. 5, Friedl, l. c. 6, 7, Rg., l. c. 8, Peters and Maly, Ber. Ak. Wien, **57** (1), 646, 1868. 9, Genth, Am. Phil. Soc., **13**, 383, 1873. 10, Paijkull, Öfv. Ak. Stockh., **23**, 85, 1866. 11, Heddle, l. c.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. St. Gothard | 3·706 | 29·46 | 52·29 | — | 13·42 | 2·29 | 1·42 | $TiO_2$ 0·56 = **99·44** |
| 2. " | | $\frac{3}{3}$ 28·15 | 52·17 | 1·70 | 13·84 | 2·54 | 1·63 | = 100·03 |
| 3. " | 3·71 | 29·81 | 48·26 | 5·31 | 12·03 | 3·25 | 0·86 | = 99·52 |
| 4. " | | 27·38 | 54·20 | 6·83 | 9·13 | — | 1·43 | = 98·97 |
| 5. Tramnitz | 3·74 | $\frac{2}{2}$ 28·19 | 52·15 | 1·59 | 14·12 | 2·42 | 1·59 | = 100·06 |
| 6. Pitkäranta | | 29·23 | 52·85 | — | 14·65 | 2·41 | *undet.* | $TiO_2$ 0·18 = 99·32 |
| 7. Brittany | 3·70 | 30·23 | 51·16 | — | 14·66 | 2·73 | 1·26 | $TiO_2$ 0·29 = 100·33 |
| 8. St. Radegrund | 3·474 | 30·42 | 54·06 | — | 10·09 | 2·01 | 1·67 | CaO,MnO 0 75 = 99·00 |
| 9. Franklin, N. C. | 3·711 | 27·91 | 52·92 | 6·87 | 7·80 | 3·28 | 1·59 | CaO,MnO *tr.* = 100·37 |
| 10. *Nordmarkite* | 3·54 | 36·05 | 35·18 | 13·73 | 11·61 | $Mn_2O_3$ | 2·51 | = 99·08 [F 0·09 = 100·13 |
| 11. Milltown, *Xantholite* | | 27·04 | 45·86 | 8·67 | 6·90 | 4·32 | 2·88 | MnO 0·56, CaO 3·81. |

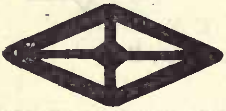
A staurolite from Canton, Ga., with G. = 3·79 gave Genth 7·13 ZnO.

**Pyr., etc.**—B.B. infusible, excepting the manganesian variety, which fuses easily to a black magnetic glass. With the fluxes gives reactions for iron, and sometimes for manganese. Imperfectly decomposed by sulphuric acid.

**Obs.**—Usually found in crystalline schists, as mica schist, argillaceous schist, and gneiss, as a result of regional or contact metamorphism; often associated with garnet, sillimanite, cyanite, and tourmaline.

Occurs with cyanite in paragonite schist, at Mt. Campione, Switzerland, in polished, brown, translucent crystals; at Mt. Greiner, in the Zillerthal, Tyrol, in simple crystals associated with cyanite, and sometimes appearing as a continuation of its crystals, parallel with them; also near Innsbruck; near Lake Como; at Goldenstein in Moravia, brown and translucent; Aschaffenburg, Bavaria; Oberwölz and St. Radegrund in Styria; in large twin crystals in the mica schists of Brittany; at Tornduff and near Killiney in Ireland; near Milltown, Loch Ness, Scotland (*xantholite*); at Oporto, St. Jago de Compostella. In the province of Minas Geraes, Brazil, at various points both in mica schists and in the river gravels.

Abundant throughout the mica schists of New England. In *Maine*, at Windham, near the bridge, the mica slate is filled with large crystals; also at Mt. Abraham, Hartwell, and Winthrop. In *N. Hamp.*, brown and large cryst. at Franconia; at Lisbon, abundant in mica slate; on the shores of Mink Pond, loose in the soil; at Grantham, 2 m. from Meriden, of a gray color. In *Vermont*, at Cabot. In *Mass.*, at Chesterfield, in fine crystals. In *Conn.*, at Bolton, Vernon, Litchfield, Stafford, and Tolland; also Southbury with garnets; at Litchfield, black crystals. In *New York*, small crystals at the Foss ore bed in Dover, Dutchess Co.; also three and a half miles from New York City, on the Hudson; as a result of contact metamorphism in the mica schist near Peekskill, N. Y. (cf. Williams, Am. J. Sc., **36**, 254, 1888). In *Penn.*, reddish brown cryst. abundant on the Wissahickon, 8 m. from Philadelphia. In *N. Carolina*, at the Culsagee corundum mine near Franklin, Macon Co.; large coarse crystals at the Parker mine, Cherokee Co.; also in Madison and Clay counties. In *Georgia*, at the lead mine, Canton, in quartzose mica schist, the gangue of the lead ore; also in Fannin Co., loose in the soil in fine crystals.



Dr. C. T. Jackson has described a variety of staurolite in tessellated crystals like chiastolite, from Charlestown, N. H., as represented in the accompanying figure.

Named from σταυρός, *a cross*. Haüy's change of *staurolite* to *staurotide* was neither necessary nor reasonable.

**Alt.**—Occurs altered to steatite.

**Ref.**—[1] Min., 75. 1837. In some respects it would be more natural to take the twinning planes (see below) as fundamental, 011, 111, 110, when the symbols of the prism would become 320, and the axes 0·7101 : 1 : 1·0242. [2] E. S. D., Am. J. Sc., **11**, 384, 1876; this twinning can be explained as having either 230 or 130 as tw. pl.; the first gives $b\underline{b}$ = 70° 45½′ and 109′ 14½′, the second 109° 42′ and 70° 18′; the measured angle 70° 30′ hardly decides between these, but the former is the more probable as it corresponds to the two other more common laws.

**429. KORNERUPINE.** Kornerupin *J. Lorenzen*, Medd. Grönl., **7**, 19, 1884. Prismatin *A. Sauer*, Zs. G. Ges., **38**, 704, 1886.

Orthorhombic. Axes $\breve{a} : \bar{b}$ = 0·854 : 1. In fibrous to columnar aggregates, resembling sillimanite, showing in the prismatic zones the forms *m* (110), *a* (100), and *b* (010) with $mm'''$ = *81° kornerupine, = 81° 31′ prismatine.

Cleavage: prismatic, rather perfect. H. = 6·5. G. = 3·273 kornerupine; 3·341 prismatine, Ussing. Luster vitreous. White to colorless (K.), yellow-brown (Pr). Optically −. Ax. pl. ∥ 100, $Bx_a \perp$ 001. Axial angle 2E = 32½° K.

*Prismatine* $\alpha_y = 1·6691$ $\beta_y = 1·6805$ $\gamma_y = 1·6818$ ∴ $2V_y = 37° 7$ for Na
$2E_y = 65° 30'$ and from $\beta = 1·6805$ ∴ $2V_y = 37° 34'$.

**Comp.**—$MgAl_2SiO_6$ or $MgO.Al_2O_3.SiO_2$ = Silica 29·7, alumina 50·5, magnesia 19·8 = 100.

**Anal.**—1, Lorenzen, l. c. 2, Sauer, l. c.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | ign. |
|---|---|---|---|---|---|---|---|
| 1. *Kornerupine* | 3·23 | 30·90 | 46·79 | 2·02 | — | 19·46 | 1·30 = 100·47 |
| 2. *Prismatine* | 3·341 | 30·89 | 43·06 | — | 6·28 | 15·08 | 1·36 $Na_2O$ 2·04, $K_2O$ 0·79 = 99·50 |

**Pyr.**—B.B. does not fuse; becomes bright blue if moistened with cobalt solution and ignited. Insoluble in acids.

**Obs.**—*Kornerupine* occurs at Fiskernäs on the west coast of Greenland with green amphibole, sapphirine and a light brown magnesia mica; also gedrite and occasionally iolite. It is intimately associated with the iolite, and sometimes appears in a micropegmatitic form with it. Named after the Danish geologist, Kornerup.

*Prismatine* is from Waldheim, Saxony, where it forms layers in granulyte with albite, also garnet, tourmaline.

Ussing calls attention to the similarity of these two independently described minerals, and it can hardly be doubted that they are identical.

KRYPTOTIL *Sauer*, Zs. G. Ges., **38**, 705, 1886. An alteration product of prismatine, occurring in fine fibrous forms of light greenish color. Composition: $HAlSiO_4 = H_2O.Al_2O_3.SiO_2$ = Silica 50·0, alumina 42·5, water 7·5 = 100. Anal.—Sauer:

$SiO_2$ 48·43 $Al_2O_3$ 41·63 MgO 2·13 $H_2O$ 7·70 = 99·89.

**430. SAPPHIRINE.** Sapphirin (fr. Greenland) *Giesecke*, Stromeyer's Unters., **1**, 391, 1821. Sapphirine. Sapphirin pt. [rest blue Spinel] *Hausm.*, Handb., 427, 1847. Saphirine.

Monoclinic. In indistinct crystals, tabular ∥ *b*; rarely showing prismatic planes on the edges, *bm* = 57° 27′, *mm‴* = 65° 6′; also other prisms inclined 23° 34′ and 31° 36′ to *b*, and a clinodome giving $b \wedge 011 \doteq 47\frac{1}{2}°$; $\beta = 79\frac{1}{2}°$; angles variable, Ussing[1]. Usually in disseminated grains, or aggregations of grains.

Cleavage not distinct. Fracture subconchoidal. H. = 7·5. G. = 3·42–3·48; 3·486 Ussing. Luster vitreous. Color pale blue or green. Translucent. Pleochroic: $\mathfrak{b} = \mathfrak{c}$ blue, $\mathfrak{a}$ colorless. Optically −. Ax. pl. ∥ *b*. $Bx_a \wedge \dot{c} = -71°$ or $\mathfrak{c} \wedge 001 = +8\frac{1}{2}°$. Axial angles, Ussing[1]:

$$2K_{a.y} = 68°\,50' \qquad 2K_{o.y} = 111°\,13' \qquad \therefore\ 2V_{a.y} = 68°\,49' \qquad \beta_y = 1·712$$

$$\alpha_r = 1·7055 \qquad \beta_r = 1·7088 \qquad \nu_r = 1·7112$$

Also, Dx., $2H_{a.r} = 77°\,50'$ $2H_{a.bl} = 79°\,0'$ $\alpha_r = 1·705$ $\beta_r = 1·709$ $\gamma_r = 1·711$

$$2H_{a.r} = 83°\,29' \qquad 2H_{a.y} = 83°\,55' \qquad 2H_{a.gr} = 84°\,34'$$

**Comp.**—$Mg_5Al_{12}Si_2O_{27}$ or $5MgO.6Al_2O_3.2SiO_2$ = Silica 12·9, alumina 65·7, magnesia 21·4 = 100.

**Anal.**—1, Damour, Bull. G. Soc., **6**. 315, 1849. 2, Lorenzen, Medd. Grönl., **7**, 1884. 3, Ussing, Öfv. Ak. Stockh., **46**, 17, 1889. Also Schluttig, Inaug. Diss., Leipzig, 22, 1884, cf. Zs. Kr., **13**, 74.

| | | $SiO_2$ | $Al_2O_3$ | FeO | MgO |
|---|---|---|---|---|---|
| 1. | G. = 3·473 | 14·86 | 63·25 | 2·00 | 19·28 = 99·39 |
| 2. | G. = 3·46 | 12·95 | 64·44 | 1·66 | 19·83 ign. 0·34 = 99·22 |
| 3. | G. = 3·486 | 12·83 | 65·29 | 0·65 | 21·40 $Fe_2O_3$ 0·93 = 100·10 |

**Pyr., etc.**—B.B. alone and with borax infusible, unaltered.

**Obs.**—Associated with mica, anthophyllite, and amphibole at Fiskernäs in south-western Greenland. The name alludes to the sapphire color.

**Ref.**—[1] Öfv. Ak. Stockh., **46**, 17, 1889, and Zs. Kr., **15**, 598, 1889. Dx., Min., **1**, 462, 1862, **2**, xlii, 1874.

## APPENDIX TO ANHYDROUS SILICATES.

**Barylite** *C. W. Blomstrand*, G. För. Förh., 3, 128, 1876. Barylith.

In groups of prismatic crystals, more or less tabular in habit. Two distinct cleavages forming an angle of about 84°. H. = 7. G. = 4·03. Luster greasy. Colorless. Semi-transparent. Composition.—$Ba_4Al_4Si_7O_{24}$ or $4BaO.Al_2O_3.7SiO_2$ = Silica 34·0, alumina 16·5, baryta 49·5 = 100. Analysis:

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | BaO | PbO | CaO | MgO | CuO | $Bi_2O_3$ | ign. |
|---|---|---|---|---|---|---|---|---|---|---|
| $\frac{2}{3}$ | 34·36 | 16·02 | 0·98 | 46·23 | 0·93 | 0·68 | 0·27 | 0·09 | 0·19 | 0·15 = 99·90 |

B.B. infusible; not attacked by acid. Named from βαρύς, *heavy*, and λίθος, *stone*. Occurs with hedyphane in crystalline limestone at Långban, in Wermland, Sweden.

**Hypochlorite.** Sogenannter Grüneisenerde von Schneeberg, Hypochlorit, *Schüler*, Schw. J., **66**, 41, 1832, Dissert. de Ferro ochr., etc., Jena, 1832.

Bismutoferrite *Frenzel*, J. pr. Ch., **4**, 355, 1871, Jb. Min., 516, 1872.

**Hypochlorite** was described as minute crystalline; also earthy. Fracture even to flat conchoidal. Brittle. H. = 6. Luster vitreous, feeble. Color green. Streak light green. Analysis.—Schüler:

$SiO_2$ 50·24 $Al_2O_3$ 14·65 $Bi_2O_3$ 13·03 FeO 10·54 $P_2O_5$ 9·62 Mn *tr.*

In minute crystals and grains, or massive and earthy, with native bismuth and cobalt ores, at Schneeberg, Johanngeorgenstadt, and Bräunsdorf, in Saxony. Also reported from Ullersreuth, Voigtland, in a bed of limonite. Named from ὑπόχλωρος on account of its green chlorite-like color. Beyond doubt a mixture.

**Bismutoferrite** of Frenzel is a supposed bismuth-iron silicate in part mixed with the hypochlorite ("wismuth-hypochlorit") of Schneeberg. G. = 4·47. Two analyses gave:

| $SiO_2$ | $Bi_2O_3$ | $Fe_2O_3$ | |
|---|---|---|---|
| 23·08 | 43·26 | 33·33 | = 99·67 |
| 24·05 | 42·83 | 33·12 | = 100 |

An "antimony-hypochlorite" is also said to occur at Schneeberg.

**Monzonite** *F. v. Kobell*, Ber. Ak. München, 1, 162, 1871.

Compact. Fracture splintery to subconchoidal. H. = 6. G. = 3. Color light grayish green. Translucent on thin edges. Resembles green hornstone. Analysis, Kobell, l. c.:

| $SiO_2$ | $Al_2O_3$ | FeO | MgO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 52·60 | 17·10 | 9·00 | 2·10 | 9·65 | 6·60 | 1·90 | 1·50 = 100·45 |

B.B. fuses at 3 to a lustrous grayish green glass. Not decomposed by acids before or after fusion. Found on Mt. Monzoni in the Fassathal, Tyrol.

**Neociano** *A. Scacchi*, Rend. Accad. Napoli, Jan., 1881. Neocyanite.

In very minute monoclinic crystals, tabular ∥ 010; these are terminated by two orthodomes *m* and *n*, making angles of 71° and 53° with *a* (100), front and back respectively. Color blue. Supposed to be an anhydrous copper silicate. B.B. fuses to a black glass. Easily decomposed by acids, with the separation of pulverulent silica. From fumaroles at Vesuvius, formed by sublimation, together with three other substances. One of these forms a white granular mass, G. = 2·287, probably silica. A second is a white asbestus-like material, containing lime; difficultly fusible, and decomposed only in boiling acid. The other forms yellowish brown crystals in six-sided rhombic plates; insoluble in acid.

**Ramosite** *N. W. Perry*, Eng. Mng. J., **37**, 140, Feb. 23, 1884; Trans. Am. Inst. Mining Eng., **12**, 628, 1884.

In pebbles in alluvium; compact. Fracture conchoidal. H. = 8–9. G. = 3·83. Color deep black. Opaque, translucent on thin edges. Luster vitreous. Analysis:

$SiO_2$ 46·32 $Fe_2O_3$ 13·00 $Al_2O_3$ 19·19 CaO 17·74 MgO 13·13 $MnO_2$ *tr.* = 99·38.

From Ramos, San Luis Potosi, Mexico. The description obviously needs revision; it may prove to be simply a kind of garnet.

**Sphenoclase.** Sphenoklas *F. von Kobell*, J. pr. Ch., **91**, 348, 1864.

Massive, with faint indications of a foliated structure. Fracture splintery. H. = 5·5–6. G. = 3·2. Luster feeble. Color pale grayish yellow. Subtranslucent. Comp.—Perhaps $6RO.Al_2O_3.6SiO_2$ Rg., but needs confirmation. Analysis.—Kbl.:

$SiO_2$ 46·08 $Al_2O_3$ 13·04 FeO 4·77 MnO 3·23 MgO 6·25 CaO 26·50 = 99·87

B.B. fuses at 3 to a greenish glass. Slightly attacked by acids; but after heating, easily decomposed with gelatinization by hydrochloric acid.

From Gjellebäk in Norway, with wollastonite and the so-called edelforsite, forming thin layers of varying thickness in a bluish granular limestone. Named from σφήν, *a wedge*, and κλάσις, *fracture*, it breaking into wedge-shaped pieces.

## B. Hydrous Silicates.

The HYDROUS SILICATES include chiefly the true hydrous compounds, that is, those which contain water of crystallization, like the zeolites; also the hydrous amorphous species, as the clays, etc. There are also included certain species—as the Micas, Talc, Kaolinite—which, while they yield water upon ignition, are without doubt to be taken as acid or basic metasilicates, orthosilicates, etc. Their relation, however, is so close to other true hydrous species that it appears more natural to include them here than to have placed them in the preceding chapter with other acid and basic salts. Finally, some species are referred here about whose chemical constitution and the part played by the water present there is still much doubt.

The divisions of the Hydrous Silicates recognized are as follows:

### I. Zeolite Division.

**1. Introductory Subdivision.**
**2. Zeolites.**

### II. Mica Division.

**1. Mica Group.**
**2. Clintonite Group.**
**3. Chlorite Group.**

### III. Serpentine and Talc Division.

Chiefly hydrous Silicates of Magnesium.

### IV. Kaolin Division.

Chiefly hydrous Silicates of Aluminium; for the most part belonging to the group of the clays.

### V. Concluding Division.

Species not included in the preceding divisions; chiefly silicates of the heavy metals, iron, manganese, etc.

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### I. Zeolite Division.

#### 1. Introductory Subdivision.

Of the species here included, several, while not strictly ZEOLITES, are closely related to them in composition and method of occurrence.

431. **Inesite** $2(\mathrm{Mn},\mathrm{Ca})\mathrm{SiO}_3 + \dot{\mathrm{H}}_2\mathrm{O}$ Triclinic
$\breve{a}:\bar{b}:\acute{c} = 0{\cdot}9753:1:1{\cdot}3208$ $\alpha = 92° 18'$ $\beta = 132° 56'$ $\gamma = 93° 51'$

$\grave{a}:\bar{b}:\acute{c}$ $\beta$
432. **Ganophyllite** $\mathrm{Mn}_7\mathrm{Al}_2\mathrm{Si}_8\mathrm{O}_{26}.6\mathrm{H}_2\mathrm{O}$ Monoclinic $0{\cdot}413:1:1{\cdot}831$ 86° 39'

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433. **Okenite** $\mathrm{H}_2\mathrm{Ca}(\mathrm{SiO}_3)_2 + \mathrm{H}_2\mathrm{O}$ Orthorhombic?
434. **Gyrolite** $\mathrm{H}_2\mathrm{Ca}_2(\mathrm{SiO}_3)_3 + \mathrm{H}_2\mathrm{O}$
435. **Apophyllite** $\mathrm{H}_7\mathrm{KCa}_4(\mathrm{SiO}_3)_8 + 4\tfrac{1}{2}\mathrm{H}_2\mathrm{O}$ Tetragonal $\acute{c} = 1{\cdot}2515$

**431. INESITE.** *A. Schneider*, Jb., Preuss. G. Landesanst. for 1887, p. 472 (1888); Zs. G. Ges., 39, 829, 1888. Rhodotilit *G. Flink*, Öfv. Ak. Stockh., 45, 571, 1888, 46, 12, 1889.

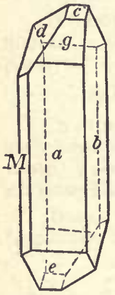
Triclinic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}975266 : 1 : 1{\cdot}32078$; $\alpha = 92° 18' 12''$, $\beta = 132° 55' 54''$, $\gamma = 93° 50' 42''$ Scheibe[1].

$100 \wedge 010 = {}^*82° 35'$, $100 \wedge 001 = 46° 41' 32''$, $010 \wedge 001 = 83° 14' 59''$.

**Forms:** *a* (100, $i\text{-}\bar{i}$), *b* (010, $i\text{-}\breve{i}$), *c* (001, *O*), *M* ($1\bar{1}0$, $'I$), *l* (101, $'1\text{-}\bar{i}'$), *g* (201, $'2\text{-}\bar{i}'$), *e* ($\bar{1}01$, $,1\text{-}\bar{i},$), *d* ($0\bar{1}1$, $'1\text{-}\breve{i}$), *o* (532, $,\tfrac{5}{2}\text{-}\tfrac{5}{3}$), *i* ($\bar{7}47$, $,1\text{-}\tfrac{7}{4}$)?.

$aM = 37° 59'$ $cg = 34° 36\tfrac{1}{2}'$ $ce = 85° 57\tfrac{1}{2}'$ $ad = {}^*64° 37'$
$b'M = 59° 26'$ $al = 19° 36\tfrac{3}{4}'$ $a'e = {}^*47° 21'$ $b'd = {}^*49° 23'$
$cl = 27° 4\tfrac{3}{4}'$ $ag = 12° 5'$ $cd = 47° 22'$ $be = {}^*93° 20'$

Crystals small, prismatic in habit. Usually in fibrous masses; often radiated and spherulitic.



*Inesite*, Scheibe.

Cleavage: *b* perfect; *a* less so. Fracture uneven. Brittle. H.=6. G. = 3·0295 Flink. Luster vitreous. Color rose-red to flesh-red; becoming colorless on exposure. Streak white. Pleochroism distinct but feeble.

Optically —. Extinction-direction on *a* (100) inclined to edge *a/b*, 12° to the left below; on *b* (010) inclined 60½° above behind. $Bx_a$ not quite ⊥ *b*. Axial angles (Adams polariscope, with $n_y = 1{\cdot}7782$ Na for the glass) measured on cleavage fragments ∥ *b*:

$2G_{a.r} = 64° 0'$ Li $2G_{a.y} = 63° 28'$ Na $2G_{a.gr} = 62° 51'$ Tl.

**Comp.**—$2(Mn,Ca)SiO_3 + H_2O$ = Silica 43·8, manganese protoxide 41·4, lime 8·2, water 6·6 = 100. Here Mn : Ca = 4 : 1.

**Anal.**—1, Bärwald, quoted by Schneider. 2, Flink, l. c.

| | $SiO_2$ | MnO | FeO | CaO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. *Inesite* | 43·92 | 37·87 | 0·69 | 8·40 | 0·33 | 9·22 | $Al_2O_3$ 0·29 = 100·72 |
| 2. *Rhodotilite* | 43·67 | 37·04 | 1·11 | 9·38 | 0·15 | 7·17 | PbO 0·77 = 99·29 |

Of the water Bärwald found that 4·54 p. c. was lost at 110°, 0·48 at 200°, 2·23 at 300°, 0·62 at 440°, 1·35 upon ignition; total 9·22.

**Pyr.**—Gives off water in the closed tube and turns brown. Reacts for manganese with the fluxes. Soluble in acids, but not after ignition.

*Inesite* occurs at the manganese mines at Nanzenbach, northeast of Dillenburg, Germany. The manganese ores occur at the contact between clay slate and diabase, and the inesite is found with a manganesian calcite in cavities of a dark brown hydrous manganese silicate, allied to stratopeite (see p. 704). The crystals are embedded in calcite. Named from ἴνες, *flesh fibers*, in allusion to the color and structure.

*Rhodotilite* occurs filling cavities of calcite crystals, with rhodonite, garnet, etc., at the Harstig mine, Pajsberg, Wermland, Sweden. Named from ρόδον, *rose*, τίλος, *fiber*.

As shown by Flink (1889) the two minerals, though independently described, are without doubt identical, and the descriptions agree in almost every particular. The formula provisionally accepted is that of Flink. Schneider suggested $(Mn,Ca)(MnOH)_2Si_3O_8 + H_2O$.

**Ref.**—[1] Quoted by Schneider, l. c.

**432. GANOPHYLLITE.** *A. Hamberg*, G. För. Förh., 12, 586, 1890.

Monoclinic. Axes $\grave{a} : \bar{b} : \dot{c} = 0{\cdot}4130 : 1 : 1{\cdot}8309$; $\beta = 86° 39'$ Hamberg.
$100 \wedge 110 = 22° 24\tfrac{1}{2}'$, $001 \wedge 101 = 74° 7\tfrac{1}{2}'$, $001 \wedge 011 = {}^*61° 19'$.

**Forms:** *b* (010, $i\text{-}\grave{i}$), *c* (001, *O*), *m* (110, *I*), *e* (011, $1\text{-}\grave{i}$).

Angles: $mm''' = {}^*44° 49'$, $ee' = 122° 38'$, $cm = {}^*86° 54'$, $me = 88° 23\tfrac{1}{2}'$. The measurements are only approximate and hence the axial ratio cannot be regarded as highly accurate.

In crystals up to an inch in length, habit short prismatic, terminated by *c* and the acute clinodome *e* (011). Faces *m* and *e* dull, striated ∥ *c*. Also foliated, micaceous.

Cleavage: basal, perfect; resembling mica. Percussion-figure on cleavage fragment a six-rayed star; one ray ∥ edge *b/c*, the others inclined approximately

60° and hence not ‖ edge *c*/*m*. H. = 4–4·5. G. = 2·84. Luster vitreous, brilliant. Color brown.

Pleochroism distinct in sections ‖ ć: $\mathfrak{c}$ (= b̍) and $\mathfrak{b}$ (= à) colorless, $\mathfrak{a}$ (= ć) yellow-brown. Optically –. Ax. pl. ⊥ *b*. $Bx_a \perp c$; hence a cleavage fragment gives the axial figures. Axial angles:

$2E_r = 41° 19'$ Li    $\beta_r = 1·7250$   ∴ $2V_r = 23° 36'$
$2E_y = 41° 53'$ Na    $\beta_y = 1·7287$   ∴ $2V_y = 23° 52'$
Also $\gamma_r = 1·7264$  $\gamma_y = 1·7287$  ∴ (with 2E) $\alpha_r = 1·6941$  $\alpha_y = 1·7046$

**Comp.**—$6H_2O.7MnO.Al_2O_3.8SiO_2$ = Silica 40·5, alumina 8·6, manganese protoxide 41·8, water 9·1 = 100.

**Anal.**—Hamberg, l. c.

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MnO | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| $\frac{2}{2}$ 39·67 | 7·95 | 0·90 | 35·15 | 1·11 | 0·20 | 2·70 | 2·18 | 9·79 $Li_2O$ *tr.*, PbO? 0·20 = 99·85 |

Most of the water goes off at 100° in a vacuum, if sufficient time is allowed, but with diminishing rapidity; it is largely reabsorbed in moist air. Hence it is somewhat analogous in behavior to the zeolites, so that the author calls it a *mangan-zeolite*. Physically it has some resemblance to the micas.

**Pyr.**—Reacts for manganese with the fluxes. Dissolves readily in strong acids, but becomes nearly insoluble after ignition.

**Obs.**—Occurs at the Harstig mine near Pajsberg, Wermland, Sweden, embedded in calcite, also implanted upon rhodonite and sometimes covered with caryophilite, barite, and native lead; again associated with garnet, manganophyllite, and pyrophanite.

Named from γάνος, *luster*, φύλλον, *leaf*, in allusion to the high luster on the cleavage laminæ.

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433. **OKENITE.** Okenit *v. Kobell*, Kastner's Arch., **14**, 333, 1828. Dysclasite *Connel*, Ed. Phil. J., **17**, 198, 1834. Bordite *Adam*, Dufr. Min., **4**, 697, 1859.

Orthorhombic? Prismatic angle 57° 41′ Breith. Composed of a congeries of minute interlacing acicular crystals. Commonly fibrous; also compact.

Cleavage in traces. H. = 4·5–5. G. = 2·28, okenite, Kbl.; 2·362, dysclasite, Connel. Luster subpearly. Color white, with a shade of yellow or blue; often yellow by reflected light, and blue by transmitted. Frequently opalescent. Subtransparent to subtranslucent. Optically –. Ax. pl. ‖ *b* (010), the needles being elongated ‖ ć. Bx ⊥ *a* (100). Axial angle large. $\gamma - \alpha = 0·091$ Lcx.[1]

**Comp.**—$H_2CaSi_2O_6 + H_2O$ or $2H_2O.CaO.2SiO_2$ = Silica 56·6, lime 26·4, water 17·0 = 100.

**Anal.**—1, von Kobell, l. c. 2, Hauer, Jb. G. Reichs., **5**, 190, 1854. 3, Connel, l. c. 4, Adam, l. c. 5, Haughton, J. G. Soc. Ireland, **2**, 114, 1868. 6, Darapsky, Vh. Ver. Santiago, No. 6, p. 248, 1888 (read May 18, 1886).

| | | $SiO_2$ | CaO | $H_2O$ |
|---|---|---|---|---|
| 1. Disco | | 55·64 | 26·59 | 17·00 $Al_2O_3$,$Fe_2O_3$ 0·53, $K_2O$ *tr.* = 99·76 |
| 2. “ | | $\frac{2}{2}$ 54·81 | 27·23 | 18·04 = 100·08 [$Na_2O$ 0·44 = 100·44 |
| 3. Stromö, *Dysclasite* | G. = 2·362 | 57·69 | 26·83 | 14·71 $Fe_2O_3$ 0·32, $Mn_2O_3$ 0·22, $K_2O$ 0·23, |
| 4. Bordö, *Bordite* | G. = 2·33 | 56·92 | 25·14 | 14·19 $Al_2O_3$ 0·67, $Na_2O$ 1·04 = 97·96 |
| 5. Poona | | 54·24 | 27·44 | 17·04 $Na_2O$ 0·07 = 98·79 |
| 6. Rio Putagan, Chili | | 54·60 | 29·52 | 15·03 MgO *tr.*, $Na_2O$ 1·06 = 100·21 |

**Pyr., etc.**—In the closed tube yields water. B.B. alone becomes opaque and white, and fuses to a glass. Effervesces with soda, and fuses to a subtransparent glass, which is milk-white on cooling; with borax forms a transparent colorless glass. Gelatinizes readily in hydrochloric acid.

**Obs.**—Occurs in basalt or related eruptive rocks. Found at the Färöer (*bordite*); in Iceland; on the island of Disco, Greenland; in amygdaloidal basalt at Poona, near Bombay, India. On lava of Rio Putagan, Chili.

**Artif.**—A crystallized silicate near okenite, but containing some alkalies ($Na_2O$ 3·3, $K_2O$ 2·2) replacing the lime, has been obtained by A. de Schulten, Bull. Soc. Min., **5**, 92, 1882. Cf. also Doelter (Jb. Min., **1**, 123, 1890), who obtained okenite by recrystallization in carbonated water in a sealed tube.

**Ref.**—[1] Bull. Soc. Min., **8**, 341, 1885; **10**, 152, 1887.

**434. GYROLITE.** Gurolite *Anderson*, Phil. Mag., 1, 111, 1851.

In concretions, lamellar-radiate in structure.

H. = 3–4. G. not given. Luster vitreous to pearly. Color white. Translucent, becoming opaque. Optically uniaxial, negative. Double refraction rather strong, Dx.[1]

**Comp.**—$H_2Ca_2Si_3O_9 + H_2O$ or $3H_2O.2CaO.3SiO_2$ = Silica 52·1, lime 32·3, water 15·6 = 100.

**Anal.**—1, Anderson, l. c. 2, How, Am. J. Sc., **32**, 13, 1861. 3, Clarke, ib., **38**, 128, 1889.

| | $SiO_2$ | $Al_2O_3$ | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. Skye | 50·70 | 1·48 | 33·24 | 0·18 | — | — | 14·18 = 99·78 |
| 2. N Scotia | 51·90 | 1·27 | 29·95 | 0·08 | 1·60 | — | 15·05 = 99·85 |
| 3. N. Almaden | 52·54 | 0·71[a] | 29·97 | — | 1·56 | 0·27 | 14·60 F 0·65 = 100·30 |

[a] Incl. $Fe_2O_3$.

**Pyr., etc.**—In a closed tube yields water, intumesces, and separates into thin scales. B.B. swells up and fuses with difficulty to an opaque enamel.

**Obs.**—From the Isle of Skye, with stilbite, laumontite, etc. In India from the railway cuttings between Bombay and Poona; also from the Treshinish Islands (Heddle, but cf. okenite, anal. 5). Reported also from the Färöer and from Greenland.

With the apophyllite of New Almaden, California, in fibrous layers between the wall of the vein and the apophyllite. Also N. Scotia, 25 m. S.W. of C. Blomidon, between Margaretville and Port George, on apophyllite.

According to How, gyrolite is formed from apophyllite, with which it often occurs.

**Ref.**—[1] Dx., N. R., 13, 1867, Min., 2, xxi, 1874.

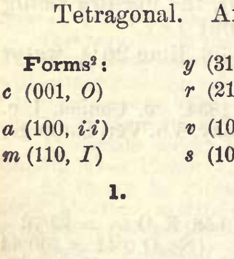
Heddle obtained thin six-sided plates, resembling heulandite, with plane angles 128° 45′ and 128° 55′, and he infers a similar form. Min. Mag., **8**, 272, 1889.

**435. APOPHYLLITE.** Zeolith von Hellesta *C. Rinman*, Ak. H. Stockh., 82, 1784. Zeolithus lamellaris major *Müller*, De Zeolithis Suecicis, 32, 1791. Ichthyophthalmite (fr. Utö) *d'Andrada*, Scheerer's J., **4**, 32, 1800, J. Phys., **51**, 242, 1800. Mesotype épointée (fr. Iceland) *H.*, Tr., **3**, 1801. Apophyllite *H.*, Notes pour servir au Cours de Min. de l'an XIII (1805), Lucas Tabl., **1**, 266, 1806. Fischaugenstein *Wern.*, 1808. Ichthyophthalmit, Albin, *Wern.*, Letzes Min. Syst., 1817. Fish-eye Stone Tesselite (fr Färöer) *Brewster*, Ed. Phil. J., **1**, 5, 1819. Oxhaverite (fr. Iceland) *Brewster*, Ed. J. Sc., **7**, 115, 1827. Xylochlor (fr. Sicily) *v. Walt.*, Vulk. Gest., 1853. Leucocyclite *Herschel*, Trans. Cambridge Phil. Soc., **1**, 21 (read May 1, 1820); Dx. Min., **1**, 126, 1862. Apofillite *Ital.*

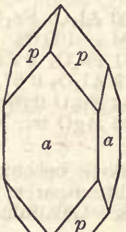
Tetragonal. Axis $\dot{c} = 1·2515$; 001 $\wedge$ 101 = 51° 22½′ Miller[1].

**Forms**[2]:
*c* (001, *O*)
*a* (100, *i-i*)
*m* (110, *I*)
*y* (310, *i*-3)[4]
*r* (210, *i*-2)
*v* (105, $\frac{1}{5}$-*i*)
*s* (102, $\frac{1}{2}$-*i*)
*e* (101, 1-*i*)[5]
*x* (1·1·10, $\frac{1}{10}$)[5]
*d* (115, $\frac{1}{5}$)
*φ* (227, $\frac{2}{7}$)[3]
*z* (113, $\frac{1}{3}$)
*χ* (223, $\frac{2}{3}$)[3]
*p* (111, 1)
*β* (621, 6-3)[6]
*α* (311, 3-3)[5]
*σ* (211, 2-2)
*τ* (533, $\frac{5}{3}$-$\frac{5}{3}$)[3]

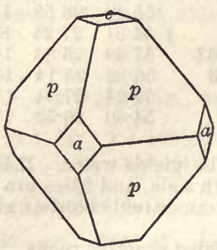
1.



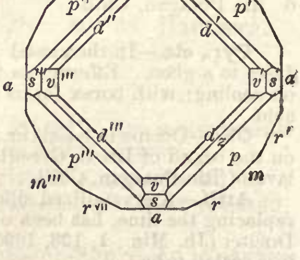
2.



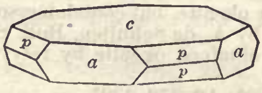
3.



5.



4.



Figs. 1-3, Common forms. 4, L. Superior. 5, Utö, Sweden, after [illegible]auf.

On the apophyllite from the Seisser Alp, Tyrol, Ploner[7] has determined the following forms, many of which, however, are merely vicinal planes. Of these several had been earlier given by Rumpf, viz., 9·9·10, 24·24·25, 51·51·50, 108, 106.

1·0·60, 1·0·40, 1·0·30, 1·0·24, 1·0·20, 1·0·18, 1·0·14, 1·0·13, 1·0·12, 1·0·11, 2·0·21, 1·0·10, 2·0·19, 109, 108, 3·0·22, 107, 2·0·13, 3·0·19, 106, 3·0·17, 2·0·11, 3·0·16, 4·0·21, 3·0·14, 209, 104, 3·0·10, 103, 307, 504, 302.

1·1·54, 1·1·45, 1·1·36, 1·1·27, 1·1·18, 119, 335, 445, 556, 667, 778, 889, 9·9·10, 10·10·11, 11·11·12, 13·13·14, 17·17·18, 24·24·25, 50·50·51, 51·51·50, 25·25·24, 443, 332, 553, 221, 441, 551.

13·4·4, 311, 20·7·7, 522, 12·5·5, 744, 855, 322, 755, 433, 544, 655, 766.

21·7·3, 15·5·3, 12·4·3, 623, 313.

$ay$ = 18° 26′
$vv'$ = 19° 46′
$ss'$ = 44° 3½′
$ee'$ = 67° 4′
$vv''$ = 28° 6′
$ss''$ = 64° 4′
$ee''$ = 102° 45′

$dd'$ = 27° 18′
$zz'$ = 42° 7′
$pp'$ = 76° 0′
$xx''$ = 20° 4′
$dd''$ = 38° 59′
$\phi\phi''$ = 53° 39′

$zz''$ = 61° 5′
$\chi\chi''$ = 99° 26′
$pp''$ = 121° 4′
$cp$ = *60° 32′
$ap$ = 52° 0′
$a\rho$ = 19° 45′

$a\alpha$ = 23° 6′
$a\sigma$ = 32° 37′
$a\tau$ = 87° 31½′
$\rho\rho^{vii}$ = 36° 34′
$\alpha\alpha^{vii}$ = 35° 42½′
$\sigma\sigma^{vii}$ = 49° 49′

Twins: tw. pl. *p*, rare[6]. Habit varied; in square prisms (*a*) usually short and terminated by *c* or by *cp*, and then resembling a cube or cubo-octahedron; also acute pyramidal (*p*) with or without *c* and *a*; less often thin tabular ‖ *c*. Faces *c* often rough; *a* bright but vertically striated; *p* more or less uneven. Also massive and lamellar; rarely concentric radiated.

Cleavage: *c* highly perfect; *m* less so. Fracture uneven. Brittle. H. = 4·5–5. G. = 2·3–2·4. Luster of *c* pearly; of other faces vitreous. Color white, or grayish; occasionally with a greenish, yellowish, or rose-red tint, flesh-red. Transparent; rarely nearly opaque. Double refraction weak; usually +, also −. Often shows anomalous optical characters, cf. Mld.[9] Indices:

$\omega_r = 1·5309$ Li $\epsilon_r = 1·5332$ $\omega_y = 1·5337$ Na $\epsilon_y = 1·5356$ Luedecke[8].

A division of a basal section into biaxial parts with varying optical orientation is common (cf. Mld., Klein, *et al.*); thus there may be a central diagonal square and four lateral sectors bounded by lines parallel to the axes, and sometimes four others between these last, corresponding in position to the planes *e* (101).

Doelter found that apophyllite became uniaxial at about 260° C., the temperature at which it loses its water of crystallization.

**Var.**—1. *Ordinary.* Usually in crystals, as above described; the pearly basal cleavage is a conspicuous character. G. = 2·335, Iceland, Haid.; 2·359, Thomson.

Haüy's *Mesotype épointée* was an Iceland variety; Fuchs and Gehlen in 1816 ascertained its identity with apophyllite.

The name *Oxhaverite* was applied to a pale green crystal found in petrified wood at the Oxhaver Springs, near Husavic in Iceland. *Albine* of Werner (named from *albus, white*) is in small nearly cubic crystals, opaque white in color, from Aussig, Bohemia; it is partly decomposed and consists largely of calcite. *Xylochlore*, from Iceland, is olive-green, and has G. = 2·290; it owes its color to the presence of a little iron.

*Tesselite*, from the Färöer, is a cubical variety, exhibiting a tessellated structure in polarized light.

*Leucocyclite*, when sections parallel to the base are examined in polarized light, shows a black cross with rings that are alternately white and violet-black (whence the name from λευκός, *white*, and κύκλος, *circle*), instead of the ordinary colored rings—a peculiarity observed in crystals from the Seisser Alp, Andreasberg (part of those of this locality), Skye, Färöer, Iceland, Utö, and Poona in India. The above are optically +. Some crystals from Utö and Cziklowa, similarly examined, exhibit a black cross on a deep violet ground, and are optically −. These different optical phenomena may be presented by contiguous plates of the same crystal, cf. Dx.

**Comp.**—$H_7KCa_4(SiO_3)_8 + 4\frac{1}{2}H_2O$ or $K_2O.8CaO.16SiO_2.16H_2O$. = Silica 53·7, lime 25·0, potash 5·2, water 16·1 = 100. A small amount of fluorine replaces part of the oxygen.

The above formula (Rg., Groth) differs but little from $H_2CaSi_2O_6 + H_2O$, in which potassium replaces part of the basic hydrogen. The form often accepted, $H_2(Ca,K)Si_2O_6 + H_2O$, corresponds less well with the analyses.

Rg. writes the formula, accepted above, $4(H_2CaSi_2O_6 + H_2O) + KF$.

**Anal.**—1, Stromeyer, Rg., Min. Ch., 505, 1860. 2, 3, Rg., ibid. 4, Haughton, Phil. Mag., **32**, 223, 1866. 5, J. L. Smith, Dana's Min., 304, 1854. 6, Mattesdorf, Vh. G. Reichs., 32, 1876. 7. Hersch. Inaug. Diss., p. 25, Zürich, 1887. 8, Hillebrand, Am. J. Sc., **24**, 132, 1882. 9, B.

Sadtler, Am. Ch. J., **4**, 357, 1883. 10, Knerr and Schönfeld, ib., **6**, 413, 1885. 11, Eyerman, N. Y. Acad. Sc., Jan. 14, 1889. Also 5th Ed., p. 415.

| | G. | $SiO_2$ | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|---|
| 1. Utö, Sweden | | 51·85 | 25·22 | 5·30 | — | 16·90 | — | = 99·27 |
| 2. Andreasberg | | 51·33 | 25·86 | 4 90 | — | [16·73] | 1·18[a] | = 100 |
| 3. Radauthal | | 52·69 | 25·52 | 4·75 | — | 16·73 | 0·46 | = 100·15 |
| 4. Bombay | | 51·60 | 25·08 | 5·04 | 0·63 | 16·20 | 0·97 | $Al_2O_3$ 0·24, MgO 0·08 |
| 5. L. Superior | 2·37 | 52·08 | 25·30 | 4·93 | — | 15·92 | 0·96 | = 99·19 [= 99·84 |
| 6. Fassathal | | 52·78 | 25·25 | 3·79 | 0·69 | 16·98 | *tr.* | = 99·49 |
| 7. Bergen Hill | 2·360 | 52·24 | 25·03 | 4·88 | — | 16·61 | 2·21 | = 100·97 [= 100·69 |
| 8. Table Mt., Col. | | 51·89 | 24·51 | 3 81 | 0·59 | 16·52 | 1·70 | $Al_2O_3$ 1·54, $Fe_2O_3$ 0·13 |
| 9. Fritz Is., Penn. | 2·5 | 51·02 | 24·40 | 5·87 | — | 16·75 | 0·40 | $Fe_2O_3$ 1·49 = 99·93 |
| 10. French Creek, Penn. | 2·30 | 51·88 | 25·31 | 6·30 | — | 16 80 | — | = 100·29 |
| 11. " " " | 2·35 | 51·63 | 25·42 | 6·27 | — | 16·58 | — | = 99·90 |

[a] Another determination gave 1·65 F.

Rg. found that no water was lost over sulphuric acid, nor at 100°; the first is expelled at 200°, and at 260° the loss corresponds to about 4 p. c. which is reabsorbed and is hence regarded as water of crystallization. Doelter gives, as follows: Loss of water at 240°, after 2 hours, 8·04 p. c.; after 4 hours heating at a red heat 9·20; for Fassathal at 260° after 2 hours, 9·59 p. c., which was gradually absorbed again on exposure to moist air, but only after 3586 hours. These determinations by Unterweissacher, Jb. Min., **1**, 120, 1890. Hersch (l. c.) obtained the following results, after 2 hours heating, in each case:

| Temp. | 100° | 160° | 200° | 240° | 275° | 300° | red ht. | |
|---|---|---|---|---|---|---|---|---|
| $H_2O$ | 0·11 | 0·38 | 0·77 | 2·03 | 9·08 | 9·91 | 16·61 | p. c. |

**Pyr., etc.**—In the closed tube exfoliates, whitens, and yields water, which reacts acid. In the open tube, when fused with salt of phosphorus, gives a fluorine reaction. B.B. exfoliates, colors the flame violet (potash), and fuses to a white vesicular enamel. F. = 1·5 (Kobell). Decomposed by hydrochloric acid, with separation of slimy silica.

**Obs.**—Occurs commonly as a secondary mineral in basalt and related rocks, with various zeolites, also datolite, pectolite, calcite; also occasionally in cavities in granite, gneiss, etc. Greenland, Iceland, the Färöer Islands, and British India afford fine specimens of apophyllite in amygdaloid. The Indian mineral is of unrivaled size and beauty, the crystals sometimes 3 to 4 inches across, often associated with salmon-pink stilbite, etc. It has been found in connection with the Deccan trap area, at Poona near Bombay during the sinking of wells and in the Western Ghâts, obtained abundantly during the construction of the Great Indian Peninsular Railway (Mallet). Also occurs at Andreasberg, sometimes of a delicate pink, in silver veins, traversing slate; Radauthal in the Harz; Montecchio Maggiore, Italy; at Orawitza, Cziklowa, and Szaska in Hungary, associated with wollastonite; in Fifeshire, with magnetic iron; at Puy de la Piquette in Auvergne, in a Tertiary limestone, near intruded basaltic rocks; at Finbo, Utö, and Hällesta, Sweden; in Tyrol, on the Seisser Alp; also the Fassathal; near Nerchinsk, Siberia; in Australia; Guanajuato, Mexico, often of a beautiful pink color implanted upon amethyst.

In the U. S., large crystals occur at Bergen Hill, N. J., associated with analcite, pectolite, stilbite, datolite, etc., some of them 3 inches across. It is also found at Gin Cove, near Perry, Maine, with prehnite and analcite in amygdaloid; in N. York, at the Tilly Foster iron mine, Brewster, but rare; in Penn., at the French Creek mines, Chester Co., also at Fritz Is., in the Schuylkill; at the Cliff mine, Lake Superior region; Table Mt. near Golden, Col.; in California, in large crystals at the mercury mines of New Almaden with bitumen, and often stained brown by it.

It has been found at Peter's Point and Partridge Island, in the Basin of Mines, Nova Scotia, both massive and crystallized, presenting white, reddish, and greenish colors, and associated with laumontite, thomsonite, and other zeolites; also at Chute's cove, Cape d'Or, Isle Haute, Swan's Creek, and Cape Blomidon.

Apophyllite was so named by Haüy in allusion to its tendency to exfoliate under the blowpipe, from ἀπό and φύλλον, *a leaf*. Its whitish pearly aspect, resembling the eye of a fish after boiling, gave rise to the earlier name *Ichthyophthalmite*, from ἰχθύς, *fish*, ὀφθαλμός, *eye*.

**Alt.**—Occurs altered to pectolite near Tiexno on Monte Baldo, along with unchanged crystals. Altered apophyllite from Table Mt., near Golden, Colorado, has been analyzed by Hillebrand (l. c.); it is pearly-white in color with a finely foliated structure and forms the exterior of crystals which within are often perfectly fresh. The material (which lost water over sulphuric acid) after drying at 100° gave:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 67·96 | 8·48 | 1·04 | 5·47 | 0·53 | [0·74] | 1·23 | 14·55 | = 100 |

**Artif.**—Crystals have been obtained by Wöhler from heated waters, and he inferred that a temperature of 180° was necessary to the result. He stated that when heated in water to this temperature under a pressure of 10 to 12 atmospheres, it forms a solution which crystallizes on cooling. Pearly radiated crystals were formed by Becquerel through the action of a solution of potassium silicate on plates of calcium sulphate (gypsum). Daubrée has detected crystals of apophyllite in the Roman works at the hot springs of Plombières.

Also obtained by Doelter (l. c.) by recrystallization, the powdered mineral being digested for 3 weeks in a closed tube at 150°–160° with water containing carbon dioxide; minute tetragonal crystals were the result. Again from okenite by heating with potassium silicate and carbonated water at 200° for 30 days.

By the fusion of apophyllite and slow crystallization the hexagonal $CaSiO_3$ (p. 373) was obtained.

**Ref.**—[2] Min., 436, 1852; also accepted by Dx., Min., **1**, 125, 1862. [2] Cf. Lévy, Min. Heuland, **2**, 271, 1837; Schrauf, Ber. Ak. Wien, **62** (1), 700, 1870, Atlas XXI; Seligmann, Jb. Min., **1**, 140, 1880. Rumpf, who makes the species monoclinic, adds several forms mostly vicinal, Min. Mitth., **2**, 369, 1879; Ploner (ref. below) also adds many forms, chiefly vicinal; all of these are given above. Bgr. notes on the apophyllite from the islands of the Langesund fiord the probable forms: 1·0·12, 503, 326, 321, Zs. Kr., **16**, 644, 1890.

[3] Dx., l. c. [4] J. D. D., L. Superior, Min., 4th Ed., 304, 1854; cf. also Slg., Utö, Sweden, l. c.; Cesàro, Bull. Soc. Min., **12**, 62, 1889. [5] Slg., Utö, l. c. [6] Schrauf, l.c. [7] Ploner, Seisser Alp, Zs. Kr.. **18**, 337, 1890. [8] Luedecke, Andreasberg, Zs. Kr., **4**, 626, 1880.

[9] *Optical anomalies*, see Mld., Ann. Mines, **10**, 121, 1876, also Klocke, Jb. Min., **2**, 11 ref., 1880; Klein, ib., **1**, 253, 1884; Doelter, ib., **1**, 123, 1890; also Rumpf, l. c. On *percussion-figures*, Mgg., Jb. Min., **1**, 59, 1884. *Etching*, Rinne, ib., **2**, 19, 1885. *Pyroelectricity*, Hankel, Pogg., **157**, 163, 1876.

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The following are imperfectly defined hydrous calcium silicates, several of them approximating to okenite and gyrolite.

CENTRALLASSITE *How*, Ed. N. Phil. J., **10**, 84, 1859; Phil. Mag., **1**, 128, 1876. Radiated massive, the fibers or columns lamellar and separable. Brittle. H. = 3·5; G. = 2·45–2·46. Luster pearly. Color white or yellowish white; thin laminæ transparent; graduating into an opaque white variety, subresinous in luster. The mineral was found in a nodule from amygdaloid, near Black Rock, Bay of Fundy, and constituted the portion between a thin outer layer, "*cerinite*," and an inner bluish mass, called "*cyanolite*." How obtained:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. | $\frac{3}{2}$ $SiO_2$ 58·86 | $Al_2O_3$ 1·14 | CaO 27·91 | MgO 0·16 | $K_2O$ 0·59 | $H_2O$ 11·41 | = 100·07 |
| 2. | 54·72 | 2·19 | 31·53 | — | 0·76 | 11·58 | = 100·78 |

B.B. fuses easily, with spirting, to an opaque glass. It is near okenite in composition. Two analyses of the so-called *cyanolite* gave:

| | $SiO_2$ | $Al_2O_3$ | CaO | MgO | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| G. = 2·495 | 74·15 | 0·84 | 17·52 | *tr.* | 0·53 | 7·39 | = 100·43 |
| | 72·52 | 1·24 | 18·19 | *tr.* | 0·61 | 6·91 | = 99·47 |

Probably the same mineral with centrallassite, impure with much more silica; or it is chalcedony, impure with centrallassite. The name alludes to the color.

*Cerinite* gave: $SiO_2$ 58·13, $Al_2O_3$ 12·21, $Fe_2O_3$ 1·01, CaO 9·49, MgO 1·83, $K_2O$ 0·37, $H_2O$ 15·96 = 99·00.

XONOTLITE. Xonaltit *Rammelsberg*, Zs. G. Ges., **18**, 33, 1866. Xonotlit Min. Ch., 380, 1875.

Massive. Fracture splintery. Very hard. G. = 2·71–2·718. Color white to bluish gray; pink. Tough. Optically like okenite, Lcx. Comp.—Perhaps $4CaSiO_3 + H_2O$ = Silica 49·8, lime 46·4, water 3·8 = 100. Anal.—1, 2, Rg., l. c. 3, Heddle, Min. Mag., **5**, 4, 1882.

| | G. | $SiO_2$ | FeO | MnO | CaO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Mexico, *white* | 2·710 | 49·58 | 1·31 | 1·79 | 43·56 | — | 3·70 | = 99·94 |
| 2. " *gray* | 2·718 | 50·25 | 2·28 | | 43·92 | 0·19 | 4·07 | = 100·71 |
| 3. Scotland | 2·605 | 48·91 | 2·97 | 2·27 | 40·39 | 0·56 | 4·17 | $Al_2O_3$ 0·11, $K_2O$ 1·16, $Na_2O$ [0·22 = 100·76 |

Yields water. Decomposed by hydrochloric acid with separation of pulverulent silica. Occurs at Tetela de Xonotla, Mexico, in concentric layers, with apophyllite and bustamite.

Described by Heddle (l. c.) as occurring near Kilfinnichan, Loch Screden, Mull; at Gribon, opposite Oronsay, and on the north shore of Loch na Keal. It resembles a pink chalcedony and is closely associated with gyrolite.

**Tobermorite** *Heddle*, Min. Mag., 4, 119, 1880. Massive, fine granular. G. = 2·423. Color pale pinkish white. Translucent. Anal.—1, Tobermory; 2, north of Tobermory, toward Bloody Bay.

| | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | | 46·51 | 2·40 | 1·14 | 1·85 | 33·40 | 0·47 | 1·45 | 0·36 | 12·61 | = 100·19 |
| 2. | G. = 2·423 | 46·62 | 3·90 | 0·66 | 1·08 | 33·98 | — | 0·57 | 0·89 | 12·11 | = 99·81 |

Occurs filling cavities in the rocks near Tobermory, Island of Mull. Near gyrolite.

**Chalcomorphite.** Chalkomorphit *Rath*, Pogg. Erg., 6, 376, 1873.

Hexagonal. Axis $\dot{c}$ = 1·9091, *cp* = *65° 36′. In minute acicular prisms with *c*, *m*, *p*; *pp′* = 54° 10½′. Cleavage: *c* distinct. H. = 5. G. = 2·54. Luster vitreous. Color white. Anal.—Rath, on 0·26 gr.

$SiO_2$ 25·4 $Al_2O_3$ 4·0 CaO 44·7 $H_2O$ (& $CO_2$) 16·4 loss (incl. $Na_2O$) 9·5 = 100

Gives water in the closed tube, becoming white and lusterless. B.B. fuses with difficulty on the edges, curling up like scolecite. Soluble in hydrochloric acid with the separation of gelatinous silica. From the Laacher See, also from Niedermendig in the Eifel, occurring in cavities in limestone inclusions in the lava.

**Plombierite** *Daubrée*, C. R., 46, 1088, 1858, Ann. Mines, 13, 244, 1858. A gelatinous substance which hardens in the open air, formed from the thermal waters of Plombières. It becomes, on hardening, opaque snow-white. It afforded after drying at 100° C.: $SiO_2$ 40·6, $Al_2O_3$ 1·3, CaO 34·1, $H_2O$ 23·2 = 99·2, corresponding to the hydrated calcium silicate: $CaSiO_3 + 2H_2O$ = Silica 39·5, lime 36·8, water 23·7 = 100.

Chabazite and apophyllite in fine crystals are other results of the action of the waters of Plombières on the brick and mortar of an old Roman aqueduct, besides hyalite, aragonite, and perhaps scolecite and harmotome.

**Louisite** *Honeymann*, Proc. Nova Scotia Inst. Nat. Sc., 5, 15, 1878. A transparent, glassy, leek-green mineral; streak white; fracture splintery. H. = 6·5. G. = 2·41. Gelatinizes with hydrochloric acid. An analysis by H. Louis gave: $SiO_2$ 63·74, $Al_2O_3$ 0·57, FeO 1·25, MnO *tr.*, CaO 17·27, MgO 0·38, $K_2O$ 3·38, $Na_2O$ 0·08, $H_2O$ 12·96 = 99·63. This corresponds, but only approximately, to $CaO.3SiO_2.2H_2O$, which requires Silica 66·2, lime 20·6, water 13·2 = 100.

It needs further examination, especially by the microscope, with reference to the possibility of admixed silica. Named for H. Louis, Esq., of Londonderry, N. S.

## 2. ZEOLITES.

The **Zeolites** form a family of well-defined hydrous silicates, closely related in composition, in conditions of formation, and hence in method of occurrence. They are often with right spoken of as analogous to the Feldspars, like which they are all silicates of aluminium with sodium and calcium chiefly, also rarely barium and strontium; magnesium, iron, etc., are absent or present only through impurity or alteration. Further, the composition in a number of cases corresponds to that of a hydrated feldspar; while fusion and slow recrystallization result in the formation from some of them of anorthite ($CaAl_2Si_2O_8$) or a calcium-albite ($CaAl_2Si_6O_{16}$) as shown by Doelter. The Zeolites do not, however, form a single group of species related in crystallization, like the Feldspars, but include a number of independent groups widely diverse in form and distinct in composition. A transition in composition between certain end compounds has been more or less well established in certain cases, but unlike the Feldspars, with these species calcium and sodium seem to replace one another and an increase in alkali does not go with an increase in silica.

Like other hydrous silicates they are characterized by inferior hardness, chiefly from 3·5 to 5·5, and the specific gravity is also lower than with corresponding anhydrous species, chiefly 2·0 to 2·4. Corresponding to these characters, they are rather readily decomposed by acids, many of them with gelatinization. The intumescence, B.B., which gives the name to the family (from ζεῖν, *to boil*, and λίθος, *stone*) is characteristic of a large part of the species.

The Zeolites are all secondary minerals, occurring most commonly in cavities and veins in basic igneous rocks, as basalt, amygdaloid, diabase, etc.; less frequently in granite, gneiss, etc. In these cases the lime, and in part the soda, has been chiefly yielded by the feldspar, the soda also by elæolite, sodalite, etc., potash by leucite, etc. The different species of the family are often associated together, and also with pectolite and apophyllite (sometimes included with the zeolites), datolite, prehnite and, further, calcite.

The constitution of the Zeolites, particularly with reference to the part played by the water, has been discussed by many authors. See Damour, Ann. Ch. Phys., **53**, 438–459, 1858. Malaguti and Durocher, Ann. Mines, **9**, 325, 1846. Rg., Min. Ch., 1860, 1875. Lemberg (artif.), Zs. G. Ges., **28**, 535 *et seq.*, 1876. Streng (chabazite group), Ber. Oberhess. Ges., **16**, 74–123, 1877. Fresenius (phillipsite group), Zs. Kr., **3**, 42, 1879. Jannasch (heulandite, etc.), Jb. Min., **2**, 269, 1882. Friedel and Sarasin, Bull. Soc. Ch., **42**, 593, 1884. Hersch, Inaug. Diss., Zürich, 1887. Doelter (artif.), Jb. Min., **1**, 118, 1890.

On the effect of loss of water upon the optical properties, see Rinne, Jb. Min., **2**, 17–38, 1887, and Ber. Ak. Berlin, 1163, 1890. Rinne shows that sections after having been heated until they became opaque may be made transparent again and suitable for optical examination by immersion in oil; important molecular changes are thus shown to accompany the loss of water, in some cases they serve to explain the anomalous optical characters often observed in natural crystals (cf. chabazite, analcite, etc.). See also Doelter, l. c., and other authors noted beyond. A summary of the optical relations of the various species, with reference to the means of distinguishing between them by the microscope, is given by Lcx., Bull. Soc. Min., **8**, 321 *et seq.*, 1885.

The species are arranged on the same method as the anhydrous silicates, first the highly acid species, Ptilolite and Mordenite, then the metasilicates, including much the larger part of the family, and finally the normal orthosilicates. For the most part the species fall in definite groups.

## Mordenite Group.

436. **Ptilolite** $(Ca,K_2,Na_2)Al_2Si_{10}O_{24} + 5H_2O$

437. **Mordenite** $(Ca,Na_2,K_2)Al_2Si_{10}O_{24} + 6\frac{2}{3}H_2O$ Monoclinic

$\grave{a} : \overset{|}{b} : \acute{c} = 0{\cdot}4010 : 1 : 0{\cdot}4279 \quad \beta = 88° 30'$

## Heulandite Group. Monoclinic.

| | | | $\grave{a} : \overset{\vert}{b} : \acute{c}$ | $\beta$ |
|---|---|---|---|---|
| 438. | **Heulandite** | $H_4CaAl_2(SiO_3)_6 + 3H_2O$ | 0·4035 : 1 : 0·4293 | 88° 34½′ |
| 439. | **Brewsterite** | $H_4(Sr,Ba,Ca)Al_2(SiO_3)_6 + 3H_2O$ | 0·4049 : 1 : 0·4204 | 86° 20′ |

| | | | | |
|---|---|---|---|---|
| 440. | **Epistilbite** | $H_4CaAl_2(SiO_3)_6 + 3H_2O$ | 0 5043 : 1 : 0·5801 | 54° 53′ |

## Phillipsite Group. Monoclinic.

| | | | $\grave{a} : \overset{\vert}{b} : \acute{c}$ | $\beta$ |
|---|---|---|---|---|
| 441. | **Phillipsite** | $(K_2,Ca)Al_2Si_4O_{12} + 4\frac{1}{2}H_2O$ | 0·7095 : 1 : 1·2563 | 55° 37′ |
| 442. | **Harmotome** | $H_2(K_2,Ba)Al_2Si_5O_{15} + 5H_2O$ | 0·7032 : 1 : 1·2310 | 55° 10′ |
| 443. | **Stilbite** | $(Na_2,Ca)Al_2Si_6O_{16} + 6H_2O$ | 0·7623 : 1 : 1·1940 | 50° 50′ |

444. **Gismondite** $CaAl_2(SiO_3)_4 + 4H_2O$? Monoclinic. Pseudotetragonal.

445. **Laumontite** $H_4CaAl_2Si_4O_{14} + 2H_2O$ Monoclinic.

$\grave{a} : \overset{|}{b} : \acute{c} = 1{\cdot}1451 : 1 : 0{\cdot}5906 \quad \beta = 68° 46'$

446. **Laubanite** $Ca_2Al_2(SiO_3)_5 + 6H_2O$

## Chabazite Group. Rhombohedral.

| | | | $rr'$ | $\dot{c}$ |
|---|---|---|---|---|
| 447. | **Chabazite** | $(Ca,Na_2)Al_2Si_4O_{12} + 6H_2O$, pt. | 85° 14′ | 1·0860 |
| 448. | **Gmelinite** | $(Na_2Ca)Al_2Si_4O_{12} + 6H_2O$ | 68° 8′ | 0·7345 or $\frac{3}{2}\dot{c} = 1·1017$ |
| 449. | **Levynite** | $CaAl_2Si_3O_{10} + 5H_2O$ | 73° 56′ | 0·8357 $\frac{4}{3}\dot{c} = 1·1143$ |

| | | | | |
|---|---|---|---|---|
| 450. | **Analcite** | $NaAl(SiO_3)_2 + H_2O$ | Isometric. | |
| 451. | **Faujasite** | $H_4Na_2CaAl_4(SiO_3)_{10} + 18H_2O$ | Isometric. | |
| 452. | **Edingtonite** | $BaAl_2Si_3O_{10} + 3H_2O$ | Tetragonal. | $\dot{c} = 0·6725$ |

## Natrolite Group. Orthorhombic and Monoclinic.

| | | | | |
|---|---|---|---|---|
| | | | $\breve{a} : \bar{b} : \dot{c}$ | |
| 453. | **Natrolite** | $Na_2Al_2Si_3O_{10} + 2H_2O$ | 0·9785 : 1 : 0·3536 | |
| | | | $\grave{a} : \bar{b} : \dot{c}$ | $\beta$ |
| 454. | **Scolecite** | $Ca(AlOH)_2(SiO_3)_3 + 2H_2O$ | 0·9764 : 1 : 0·3434 | 89° 18 |
| 455. | **Mesolite** | $\left\{\begin{matrix} Na_2Al_2Si_3O_{10} + 2H_2O \\ 2[CaAl_2Si_3O_{10} + 3H_2O] \end{matrix}\right.$ | | |

## Thomsonite Group.

| | | | | |
|---|---|---|---|---|
| | | | | $\breve{a} : \bar{b} : \dot{c}$ |
| 456. | **Thomsonite** | $(Na_2,Ca)Al_2(SiO_4)_2 + 2\frac{1}{2}H_2O$ | Orthorhombic. | 0·9932 : 1 : 1·0066 |
| 457. | **Hydronephelite** | $HNa_2Al_3(SiO_4)_3 + 3H_2O$ | Hexagonal. | |
| | Ranite | $(Na_2,Ca)Al_2(SiO_4)_2 + 2H_2O$ | | |

## Mordenite Group.

**436. PTILOLITE** *W. Cross* and *L. G. Eakins*, Am. J. Sc., **32**, 117, 1886.

In short capillary crystalline needles, aggregated in delicate tufts or forming loose spongy masses.

Cleavage perhaps basal. Luster vitreous. Colorless, white in the mass. Transparent. Extinction parallel.

**Comp.**—$RAl_2Si_{10}O_{24} + 5H_2O$ or $RO.Al_2O_3.10SiO_2.5H_2O$. Here $R = Ca : K_2 : Na_2 = 6 : 2 : 1$ approx., which requires: Silica 70·0, alumina 11·9, lime 4·4, potash 2·4, soda 0·8, water 10·5 = 100.

**Anal.**—Eakins. l. c. on air-dried material:

| $SiO_2$ | $Al_2O_3$ | CaO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|
| 70·35 | 11·90 | 3·87 | 2·83 | 0·77 | 10·18 = 99·90 |

The loss of water beginning at 100° C. goes on steadily up to 300° or 350°, when all is expelled.

**Pyr., etc.**—Fuses B.B. to a clear glass. Gradually decomposed by sulphuric acid, but hardly acted upon by hydrochloric acid, even when boiling.

**Obs.**—Occurs upon a bluish chalcedony in cavities in a vesicular augite-andesyte which is found in fragments in the conglomerate beds of Green and Table mountains, Jefferson Co., Colorado.

Named from *πτίλον, wing, down,* in allusion to the light downy nature of the aggregates.

**437. MORDENITE.** *How*, J. Ch. Soc., **17**, 100, 1864.

Monoclinic. Axes $\grave{a} : \overset{|}{b} : \grave{c} = 0·40099 : 1 : 0·42792$; $\beta = 88° 29\frac{3}{4}' = 001 \wedge 100$ Pirsson[1].

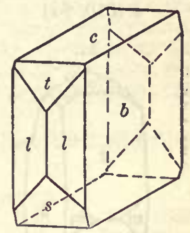
$100 \wedge 110 = 21° 50' 36''$, $001 \wedge 101 = 46° 3' 37''$, $001 \wedge 011 = 23° 9' 35''$.

**Forms:** *b* (010, *i*-ì), *c* (001, *O*), *l* (450, *i*-$\frac{5}{4}$), *t* (201, − 2-ī), *s* ($\bar{2}01$, 2-ī).

Angles: *ll'''* = 53° 14', *bl* = 63° 23' *ct* = *63° 40', *cs* = 66° 8', *ts'* = *50° 12', *lt* = 35° 46', *ls'* = * 36° 7'.

The form approximates very closely to that of heulandite (p. 574), if the occurring prism is made 450, as above.

In minute crystals tabular ∥ *b*, resembling heulandite in habit and angles. Crystals in groups by growth ∥ *b*; also radially arranged. In small hemispherical, reniform, or cylindrical concretions. Structure fibrous.



Wyoming, Pirsson.

Cleavage: *b* perfect. Fracture uneven. Brittle. H. = 3–4. G. = 2·08 How; 2·15 Pirsson. Luster vitreous; on *b* pearly; in fibrous forms highly silky. Color white, yellowish, or pinkish. Translucent on the edges. Ax. pl. and $\mathfrak{a} \perp b$. Double refraction weak. Extinction inclined about 15° to *à*, or $\mathfrak{c} \wedge \grave{c} = -73° 30'$. Axial angle large.

**Comp.**—$3RAl_2Si_{10}O_{24} + 20H_2O$ where $R = K_2 : Na_2 : Ca = 1 : 1 : 1$. Percentage composition: Silica 67·2, alumina 11·4, lime 2·1, soda 2·3, potash 3·5, water 13·5 = 100.

**Anal.**—1, How, l. c. 2, Pirsson, Am. J. Sc., **40**, 232, 1890.

| | | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. | ⅚ | 68·40 | 12·77 | 3·46 | 2·35[a] | — | 13·02 = 100 |
| 2. | | 66·40 | 11·17 | 1·94 | 2·27 | 3·58 | 13·31 $Fe_2O_3$ 0·57, MgO 0·17 = 99·41 |

[a] Incl. 0·09 to 0·23 $K_2O$.

The powdered mineral loses 3 to 6 p. c. after an hour's exposure to a temperature of 100°.

**Pyr.**—B B. fuses with some difficulty and without intumescence to a white enamel. Not perfectly decomposed by acids.

Obs.—Occurs near Morden, King's Co., Nova Scotia, in trap, with apophyllite, barite, and a prehnite-like mineral; at Peter's Point, eight miles west, with gyrolite. Also in western Wyoming near Hoodoo Mt., on the ridge forming the divide between Clark's Fork and the East Fork (Lamar R.) of the Yellowstone river; it occurs in cavities in a decomposed amygdaloidal basalt in crystals and in spherical concretions.

Named after the original locality in Nova Scotia.

Ref.—[1] Wyoming. Am. J. Sc., **40**, 232, 1890.

STEELEITE *How*, Min. Mag., **2**, 134, 1878. A partially altered mordenite, found as red or reddish pink, or chalk-white, balls, varying in size from one to two and a half inches in diameter, embedded in a red clay in cavities in trap. Also in other forms, closely associated with stilbite. In part soft and chalk-like; in part hard and unaltered. Gelatinizes with acids. Locality Cape Split, 13 miles west of Cape Blomidon, N. S. Named after the collector, Mr. Joseph Steele of Scot's Bay, N. S.

PSEUDONATROLITE *Grattarola*, Att. Soc. Tosc., **4**, 229, 1879; Boll. Com. G., 284, 1872. In minute, acicular crystals. H. = 5–6. Luster vitreous to pearly. Colorless, white in the mass. Extinction parallel.

Mean of three analyses:

$SiO_2$ 62·64 $Al_2O_3$ 14·76 CaO 8·54 MgO *tr.* Alk. 1·00 $H_2O$ 14·82 = 101·76.

B.B. fuses less readily than natrolite. Partially soluble in hydrochloric acid. From the granite of San Piero, Elba, where it occurs, associated with stilbite, in slender crystals showing six planes in the prismatic zone; they are not terminated, being attached at both extremities to the walls of the cavities in which they are found. The mineral was originally described by the author (1872) as natrolite, from which, however, he showed it to differ widely in composition; it needs further examination.

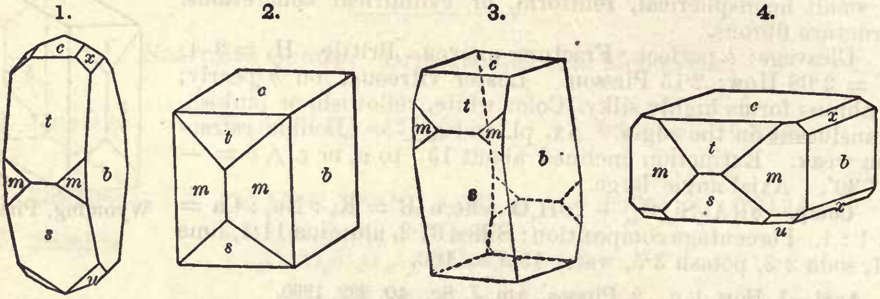
## Heulandite Group. Monoclinic.

**438. HEULANDITE.** Blättriger Zeolith *Meyer*, Beschaft. Ges. N. Fr. Berlin, **4**, 1779, *Hoffm.*, Bergm. J., 430, 1789. Blätter-Zeolith (var. of Z.) *Wern.*, 1800, Ludw. Min., 49, 1803 Stilbite pt., Stilbite anamorphique, *H.*, Tr., **3**, 1801. Euzeolith *Breith.*, Hoffm. Min., **4**, b, 40, 1818. Heulandite *Brooke*, Ed. Phil. J., **6**, 112, 1822. Lincolnite *Hitchcock*, Rep. G. Mass. 1833, 437, 1835, 662, 1841. Beaumontite *Lévy*, Inst., 455, 1839, and Ann. Mines, **17**, 610, 1840.

Monoclinic. Axes: $\grave{a} : \overset{|}{b} : \acute{c} = 0{\cdot}40347 : 1 : 0{\cdot}42929$; $\beta = 88^\circ\ 34\frac{1}{2}' = 001 \wedge 100$ Des Cloizeaux[1].

$100 \wedge 110 = 21^\circ\ 58'$, $001 \wedge 101 = 46^\circ\ 1\frac{1}{6}'$, $001 \wedge 011 = 23^\circ\ 13\frac{1}{3}'$.

**Forms**[2]: *c* (001, *O*) *t* (201, − 2-$\bar{i}$) *x* (021, 2-$\grave{i}$) *u* ($\bar{1}$11, 1)
*a* (100, *i*-$\bar{i}$) *m* (110, *I*) *s* ($\bar{2}$01, 2-$\bar{i}$) *z* (052, $\frac{5}{2}$-$\grave{i}$)? *v* ($\bar{2}$21, 2)[3]
*b* (010, *i*-$\grave{i}$)



Figs. 1, Campsie Hills, after Greg. 2, *Beaumontite*, Jones's Falls. 3, 4, Montecchio Maggiore, Artini.

| | | | |
|---|---|---|---|
| *mm'''* = *43° 56' | *xx'* = 81° 17' | *cu* = 49° 40½' | *vv* = 40° 28' |
| *ct* = *63° 40' | *cx* = 40° 38½' | *cv* = 67° 34 | *mt* = 32° 44' |
| *cs* = *66° 0' | *zz'* = 94° 2' | *uu'* = 33° 9' | *ms'* = 33° 7' |
| *ts* = 129° 40' | *cm* = 88° 41' | | |

Twins: tw. pl. *a*. Crystals sometimes flattened ∥ *b*, the surface of pearly luster; form often suggestive of the orthorhombic system, since the angles *cs* and *ct* differ but little. Crystals often made up of subindividuals in nearly parallel position. Faces usually undulating; *b* often deeply depressed, the orthodomes bright but striated ∥ *b*. Also in globular forms; granular.

Cleavage: *b* perfect. Fracture subconchoidal to uneven. Brittle. H. = 3·5–4. G. = 2·18–2·22. Luster of *b* strong pearly; of other faces vitreous. Color various shades of white, passing into red, gray, and brown. Streak white. Transparent to subtranslucent.

Optically +. Double refraction weak. Ax. pl. and $Bx_a \perp b$. Ax. pl. and $Bx_o$ for some localities nearly ∥ *c*; also for others, nearly ⊥ *c* in white light (Dx.). $Bx_o \wedge \acute{c} = +\ 57\frac{1}{2}^\circ$ Rinne, etc., see below. Dispersion $\rho < v$, when ax. pl. ∥ *c*; $\rho > v$, when ⊥ *c*; also crossed very strong; the ax. planes for red and blue inclined from 7° to 12°. Axial angle variable, from 0° to 92°; usually $2E_r = 52^\circ$, $2E_{bl} = 53^\circ$ Dx[4]. Also, Artini[4]:

| | | | |
|---|---|---|---|
| Montecchio Maggiore | $2E_y = 81^\circ\ 14'$ | $2E_y = 94^\circ\ 27'$ | $2E_y = 89^\circ\ 54'$ |

Also 2E = 92° 46 and at 150° 2E = 103° 50′ in white light.

Indices:

$\alpha = 1{\cdot}498$ $\beta = 1{\cdot}499$ $\gamma = 1{\cdot}505$ Lévy-Lcx.[4]

Rinne found for crystals from Andreasberg the inclination of the ax. pl. to $\grave{a} = +\ 34^\circ$ (i.e. in obtuse angle of $\grave{a}$ and $\acute{c}$); hence $Bx_o \wedge \acute{c} = +\ 57\frac{1}{2}^\circ$; for others from Viesch, these angles were 6° and $85\frac{1}{2}'$ respectively; for Berufiord + 8° and $83\frac{1}{2}'$; Fassathal 32° and $59\frac{1}{2}$. Lévy-Lcx. give $Bx_o \wedge \acute{c} = +\ 85^\circ\ 30'$. For Turkestan crystals, the ax. pl. is inclined 0° 30′ to *c* (001) Erem., and $2E_r = 52^\circ\ 30'$, $2E_{bl} = 53^\circ\ 20'$. For crystals from the Serra de Botucatú, Brazil, the ax. pl. makes an angle of 19° 35′ with *c* (or $\grave{a}$); sections ∥ *b* show tw. lamellæ ∥ *c*, Hussak, l. c.

For Montecchio Maggiore, Negri found the ax. pl. inclined about + 34° to $\grave{a}$, and hence nearly normal to *t* (201) or $Bx_o \wedge \dot{c} = +57\frac{1}{2}°$; Artini made this angle, for the same locality, − 34°, and the ax. pl. nearly normal to *s* ($\bar{2}01$), but obviously by error (cf. Negri).

Sections ‖ *b* are described by Mld. as having a division into four sectors for all of which $Bx_a \perp b$, but the ax. pl. and the ax. angle are variable. Increase of temperature to 150° changes these, but they return to the original condition upon the reassumption of the water. Heated to 180° the sections become opaque and the change is permanent[5].

This subject has been later studied by W. Klein and particularly by Rinne; the latter describes the presence of five sectors, more or less sharply defined in polarized light, in sections ‖ *b*, bounded externally by the usually occurring planes, that bounded by *s* (201) having an hour-glass form. These sectors show a rather wide variation in the position of the ax. plane.

Increase of temperature (Rinne) causes the axial angle to diminish and at 150° the division into sectors no longer exists; further we have ax. pl. ‖ *b*, and $\mathfrak{a} \perp c$ (001); the structure then is that of an orthorhombic crystal. If the heating is carried on till the crystal loses its transparency, further change goes on, the sectors reappear, the ax. pl. is ⊥ *b* and $\mathfrak{c}$ becomes ⊥ ($\bar{2}01$). If strongly heated, the orientation remains the same but the division into sectors disappears and the double refraction before strong becomes weak, and the bright polarization-colors are changed to a bluish gray. Finally by ignition on a platinum foil the double refraction almost entirely disappears. The changes are obviously connected with the loss of the water, two molecules of which go off at 150° and a third at 180°, all being water of crystallization; this water is reabsorbed in moist air.

**Comp.**—$H_4CaAl_2Si_6O_{18} + 3H_2O$ or $5H_2O.CaO.Al_2O_3.6SiO_2$ = Silica 59·2, alumina 16·8, lime 9·2, water 14·8 = 100.

Strontium is usually present, sometimes up to 3·6 p. c. as shown by Jannasch.

**Anal.**—1, 2, Lemberg, Zs. G. Ges., **28**, 558, 1876. 3, Jannasch, Jb. Min., **2**, 275, 1882. 4, 5, Id., ibid., **2**, 39, 1887, and Ber. Ch. Ges., **20**, 346, 1887. 6, Biltz, ibid., p. 44. 7, Igelström, ib., 361, 1871. 8, Hersch, Inaug. Diss., 20, Zürich, 1887. 9, Cohen, ib., 116, 1875. 10, Sansoni, Att. Soc. Tosc., **4**, 175, 1879. 11, L. Gonzaga de Campos, quoted by Hussak, Bol. Comm. Geol. S. Paulo, No. 7, 1890. 12, Knerr & Schoenfeld, Am. Ch. J., **6**, 413, 1884. Also 5th Ed., p. 445.

| | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. Fassathal | | 60·24 | 15·53[a] | 6·39 | 1·91 | 0·39 | 15·54 = 100 |
| 2. Berufiord | | 56·65 | 17·39 | 8·03 | 1·36 | 0·50 | 16·07 = 100 |
| 3. " | 2·20 $\frac{2}{2}$ | 57·71 | 16·42 | 6·96 | 1·50 | 0·35 | 16·86 SrO 0·55, $Li_2O$ 0·05 = [100·40 |
| 4. Andreasberg | 2·247 $\frac{2}{2}$ | 56·10 | 17·65 | 4·26 | 3·32 | 0·27 | 16·28 SrO 3·64, $Li_2O$ *tr.* = 101·02 |
| 5. Fassathal | 2·196 | 60·07 | 15·37[b] | 4·89 | 2·36 | 0·44 | 15·89 SrO 1·60 = 100·62 |
| 6. Teigarhorn | | 58·43 | 16·44 | 7·00 | 1·40 | 0·21 | 16·45 SrO 0·35 = 100·28 |
| 7. Lunddörrsfjäll | | 57·00 | 16·25 | 8·90 | — | — | 17·40 = 99·55 |
| 8. Djupivogur | 2·207 | 58·18 | 16·35 | 7·21 | 2·07 | — | 16·34 = 100·15 |
| 9. Orange Free State | | 59·53 | 16·82 | 6·95 | 1·42 | 0·32 | 15·30 = 100·34 |
| 10. S. Piero, Elba | | 57·15 | 17·72 | 9·53 | *tr.* | *tr.* | 16·80 = 101·20 |
| 11. Botucatú | | 58·10 | 16·67 | 5·90 | 0·61 | 3·26 | 16·16 = 100·70 |
| 12. Adamstown, Pa. | 2·2 | 57·68 | 17·05 | 6·78 | *tr.* | 1·13 | 16·61 MgO 0·69 = 99·94 |

[a] Incl. $Fe_2O_3$. [b] Incl. 0·62 p. c. $Fe_2O_3$.

The red color of the Fassa crystals is due, according to Kenngott, to minute crystalline grains of another mineral, probably iron oxide.

According to Damour, the Färöer mineral loses part of its water in dry air, which it retakes in ordinary air; the loss of the mineral is 2·1 p. c. at 100° C., and 8·7 p. c. between 100° and 150° C.; and this is restored again after 24 hours in the air. At 190° the loss is 12·3 p. c.; and by the end of two months all is regained but 2·1 p. c.

Jannasch found for Berufiord heulandite, Jb. Min., **2**, 269, 1884, also later, ibid., **2**, 39, 1887:

| Temp. | 100°–110° | 150°–160° | 200° | 250° | 300° | 340°–350° | ign.[a] |
|---|---|---|---|---|---|---|---|
| $H_2O$ | 3·33 | 5·97 | 8·05 | 8·89 | 12·66 | 13·45 | 16·82 p. c. |

[a] Over the blast-lamp.

Hersch obtained the following results (see anal. 8) after two hours' heating at each temperature.

| Temp. | 100° | 145° | 195° | 250° | 290° | red ht. |
|---|---|---|---|---|---|---|
| $H_2O$ | 2·64 | 6·14 | 7·47 | 10·97 | 12·06 | 16·34 p. c. |

**Pyr.**—As with stilbite, p. 584.

**Obs.**—Heulandite occurs principally in basaltic rocks, associated with chabazite, stilbite, and other zeolites; also in gneiss, and occasionally in metalliferous veins.

The finest specimens of this species come from Berufiord, and elsewhere in Iceland; the Färöer; in British India, near Bombay, on the islands of Elephanta and Caranja; also in railroad cuttings in the Bhor and Thul Ghâts, and at other points. It also occurs in the Kilpatrick Hills, near Glasgow; on the I. of Skye; in the Fassathal, Tyrol; Andreasberg, Harz; near Semil and Rodisfort, Bohemia; Poremba, Poland; Marschendorf, Moravia; Neudörfel, near Zwickau, Saxony; Siberia, at Nerchinsk, etc.; in the amygdaloid of Abyssinia; in augite porphyrite of Serra de Botucatú, Brazil. Red varieties occur at Campsie in Stirlingshire, with red stilbite; also in Fassathal, Tyrol; also on the southern slope of the Ak-Burchan Mts., Turkestan; brown in ore beds at Arendal.

In the United States, with stilbite and chabazite on gneiss, at Hadlyme, Ct., and Chester, Mass.; with these minerals and datolite, apophyllite, etc., in amygdaloid at Bergen Hill, New Jersey; sparingly at Kipp's Bay, New York Island, on gneiss, along with stilbite; at McKinney's quarry, Rittenhouse Lane, near Philadelphia, sparingly; on north shore of Lake Superior, between Pigeon Bay and Fond du Lac; in minute crystals, seldom over half a line long, with haydenite, at Jones's Falls, near Baltimore, on a syenitic schist (Lévy's *beaumontite*, which is crystallographically and optically identical with heulandite).

At Peter's Point, Nova Scotia, it occurs in amygdaloid, presenting white and flesh-red colors, and associated with laumontite, apophyllite, thomsonite, etc.; also at Cape Blomidon, in crystals an inch and a half in length; at Martial's Cove, Isle Haute, Partridge Island, Swan's Creek, Two Islands, Hall's Harbor, Long Point.

Named after the English mineralogical collector, H. Heuland, whose cabinet was the basis of the classical work (1837) of Lévy.

**Artif.**—Obtained by Doelter by recrystallization after digesting the powdered mineral for 11 days in water containing carbon dioxide at 170° in a closed tube. The crystals were of characteristic form. An analysis gave Unterweissacher: $SiO_2$ 58·90, $Al_2O_3$ 14·02, CaO 8·53, $Na_2O$ 3·36, $H_2O$ 15·19 = 100. Also by digesting pulverized anorthite with fresh precipitated silica in carbonated water for 14 days at 200°. Jb. Min., **1**, 128, 1890.

Lemberg shows that by digestion in a potassium or sodium chloride solution for a week these alkali metals may be made to replace the calcium, forming a potash- or soda-heulandite (Kalistilbit, Natronstilbit). Zs. G. Ges., **28**, 558, 1876.

**Ref.**—[1] Min., p. 425, 1862; the results of Eremeyev agree closely, Vh. Min. Ges., **13**, 389, 1878. The vertical axis has here (as with Mlr.) half the length assumed by Dx. and some authors, with whom *t* = 101, *s* = 1̄01, *u* = 1̄12, etc. With N.-Z., *s* = 1̄01, *t* = 100, *c* = 001, etc. Cf. also Rinne, Jb. Min., **2**, 25, 1887. Breithaupt made it triclinic, Min., **3**, 449, 1847; cf. Rath, Jb Min., 517, 1874.

[2] Cf. Mlr., Min., p. 438, 1852; Greg, Min., 166, 1858; Dx., l. c., who gives Greg's plane, *z*, the symbol 097, or in the position here taken, 0·18·7.

[3] Erem., Turkestan, l. c. [4] Dx., l. c.; Rinne, l. c.; Lévy-Lcx., Min. Roches, 310, 1888; Artini, Rend. Acc. Linc., **4**, 536, 1888; Negri, Riv. Min. Ital., **7**, 90, 1890.

[5] On the effect of heat, Dx., l. c., and N. R., 136, 1867; Mld., Bull. Soc. Min., **5**, 255, 1882; W. Klein, Zs. Kr., **9**, 54, 1884; Rinne, l. c., and Ber. Ak. Berlin, p. 1183, 1890.

ORYZITE. Orizite *Grattarola*, Att. Soc. Tosc., **4**, 226, 1879.

In monoclinic crystals, somewhat resembling rice-grains. Habit prismatic, with *m* (110), *g* (011), and rarely *b* (010). Measured angles (approx.): *mm‴* = 40° 30′, *gg′* = 22° 30′, *mg* = 81° 10′. H. = 6. G. = 2·245. Luster vitreous to pearly. Color white. A triclinic form was earlier suggested. Composition, like heulandite. Analyses, Grattarola, l. c.

| | | | | | | |
|---|---|---|---|---|---|---|
| G. = 2·245 | $SiO_2$ 59·54 | $Al_2O_3$ 16·79[a] | CaO 8·67 | Alk. *tr.* | $H_2O$ 14·84 | = 99·84 |
| | 59·20 | 15·71 | 10·31 | *tr.* | 14·38 | = 99·60 |

[a] With some CaO.

Observed in granite blocks from Fonte del Prete, Elba. Named from ορυζα, *rice*. It was made dimorphous with heulandite, but it may be identical with it (cf. Groth, Zs. Kr., **4**, 641, 1880).

439. **BREWSTERITE.** *Brooke*, Ed. Phil. J., **6**, 112, 1822. Diagonit *Breith.*, Char., 118, 1832.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 0{\cdot}40486 : 1 : 0{\cdot}42042$; $\beta = {}^*86^\circ\ 20' = 001 \wedge 100$ Brooke[1].

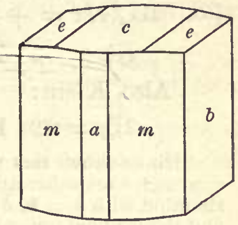
$100 \wedge 110 = 22^\circ\ 0'$, $001 \wedge 101 = 44^\circ\ 29\frac{2}{3}'$, $001 \wedge 011 = 22^\circ\ 45\frac{1}{2}'$.

**Forms**: *a* (100, *i*-ī), *b* (010, *i*-ì), *c* (001, *O*); *m* (110, *I*), *t* (120, *i*-2̀); *e* (016, $\frac{1}{6}$-ì).

Angles: *mm‴* = *44° 0′, *tt′* = 102° 7′, *ee′* = *8° 0′, *cm* = 86° 36′.

Crystals prismatic, flattened ‖ *b*; faces *m*, *t* vertically striated.
Cleavage: *b* perfect; *a* in traces. Fracture uneven. Brittle. H. = 5.

G. = 2·45 Dmr. Luster vitreous; on *b* pearly. Color white, inclining to yellow and gray. Transparent to translucent.



Optically +. Ax. pl. and $Bx_a \perp b$. Extinction-angle or $Bx_{o.r} \wedge \dot{c} = +22°$. Dispersion $\rho > v$ weak; crossed distinct, the ax. planes inclined 1° to 2° for red and blue. Axial angles:

$2E_r = 94°$, $2E_{bl} = 93°$. Again 2E = 102°–103° for white light, Dx.[2]

The axial angle increases somewhat on heating, from $2E_r = 93°\ 43'$ at 8°·8 to 95° 26′ at 105°·5. Further the axial plane for red is turned through an angle of 4° 54′ between 21°·5 and 146°·5.

Sections ‖ *b* show a division into three sectors: a central wedge-shaped portion whose sides make angles of 17° and 13°, respectively, with the front and back prismatic edges; this has also an extinction-angle of + 22°. Further, two triangular lateral sectors in which this angle is 40°, Dx.[2]

**Comp.**—$H_4(Sr,Ba,Ca)Al_2Si_6O_{18} + 3H_2O$ or $(Sr,Ba,Ca)O.Al_2O_3.6SiO_2.5H_2O$. If Sr : Ba : Ca = 4 : 2 : 1, this requires: Silica 54·3, alumina 15·4, strontia 8·9, baryta 6·6, lime 1·2, water 13·6 = 100.

**Anal.**—1, Connel, Ed. N. Phil. J., **10**, 35, 1830. 2, Thomson, Min., **1**, 348, 1836. 3, J. W. Mallet, Phil. Mag., **18**, 218, 1859.

| | $SiO_2$ | $Al_2O_3$ | BaO | SrO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. Strontian | 53·67 | 17·49 | 6·75 | 8·32 | 1·35 | 12·58 | $Fe_2O_3$ 0·29 = 100·45 |
| 2. " | 53·04 | 16·54 | 6·05 | 9·01 | 0·80 | 14·74 | = 100·28 |
| 3. " | $\frac{4}{4}$ 54·42 | 15·25 | 6·80 | 8·99 | 1·19 | 13 22 | = 99·87 |

According to Damour, loses water in unheated dried air, experiencing a loss of weight of 1·65 p. c. in the course of a month. At 100° C., after 2 hours, the loss is 0·2 p. c., but at 130° C. 7·7 p. c., when the mineral while still hot is electric, the crystals mutually attracting; they have become opaque and pearly; by 48 hours' exposure to ordinary air, the loss is reduced to 2·7 p. c. At 190° C., the loss is 8·2 p. c.; this is reduced to zero after 48 hours' exposure; and at 270°, the loss is 10·1 p. c., which is reduced to 1·2 p. c. after 8 days' exposure. At a dull red heat the loss is 12·8 p. c., and at a bright red, 13·3 p. c.

**Pyr., etc.**—B.B. swells up and fuses at 3 to a white enamel. Decomposed by acids without gelatinizing.

**Obs.**—First observed at Strontian in Argyleshire, with calcite. Occurs also at the Giant's Causeway, coating the cavities of amygdaloid; in the lead mines of St. Turpet; near Freiburg in Breisgau; at the Col du Bonhomme, S.W. of Mont Blanc, on a quartz rock; near Barèges, in the Pyrenees, in a calcareous schist; and it has been reported from the department of the Isère in France.

Named after Sir David Brewster (1781–1868).

**Ref.**—[1] Ed. Phil. J., **6**, 112, 1822. Cf. Haid, Min. Mohs, **3**, 80, 1825; Pogg., **5**, 161, 1825. The angle β = 86° 56′ of most recent authors is based upon what is apparently a misprint in Dx., Min., **1**, p. 421, 1862. [2] Dx., l. c., also N. R., 124, 1867.

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**440. EPISTILBITE.** Epistilbit *G. Rose*, Pogg., **6**, 183, 1826. Monophan *Breith.*, Char., 279, 1823. Parastilbite *S. von Waltershausen*, Vulk. Gest., 251, 1853. Reissite *K. v. Fritzsch*, Hbg., Min. Not., **9**, 22, 1870.

Monoclinic. Axes $\grave{a} : \overset{1}{\bar{b}} : \dot{c} = 0·50430 : 1 : 0·58006$; $\beta = 54°\ 53' = 001 \wedge 100$ Rose-Tenne[1].

$100 \wedge 110 = 22°\ 25'$, $001 \wedge 101 = 29°\ 31\frac{1}{6}'$, $001 \wedge 011 = 25°\ 23'$.

**Forms**[2]: *a* (100, *i*-ī) as tw. pl., *b* (010, *i*-ì), *c* (001, *O*); *m* (110, *I*); *e* (1̄01, 1-ī); *u* (011, 1-ì); *s* (1̄12, ½), *p* (1̄11, 1).

| | | | |
|---|---|---|---|
| *mm‴* = *44° 50′ | *cs* = 38° 13′ | *pp′* = 50° 46′? | *mu* = 49° 55′ |
| *uu′* = *50° 46′ | *cp* = 72° 12′ | *ss′* = 32° 21′ | *c*c̲ = *70° 14′ |
| *ce* = 70° 13′ | *cm′* = 122° 7½′ | *bs* = 73° 49½′ | |

Crystals uniformly twins; habit prismatic: (1) tw. pl. *a*, common; also (2) tw. pl. *m*. The crystals sometimes cruciform penetration-twins. Faces *s* rounded, *b* brilliant. In radiated spherical aggregations; also granular.

Cleavage: *b* very perfect. Fracture uneven. Brittle. H. = 4–4·5, on *b* 3·5. G. = 2·25. Colorless to white, yellowish. Luster vitreous. Optically −. Ax. pl. ∥ b. $Bx_a \wedge \acute{c} = +8\frac{1}{2}$ to $9\frac{1}{2}$. Axial angles, Tenne:

$2E_r = 73° 30'$ Li $2E_y = 75° 35'$ Na $2E_{gr} = 76° 40'$ Tl

Also, Klein:

$2E_r = 69° 12'$ $2E_y = 70° 45'$ $2E_{gr} = 71° 55'$

Rinne shows that with increase of temperature the axes $\mathfrak{c}$ (= $Bx_a$) in the twinned crystals approach each other and finally unite, when the twinning disappears and the crystals are orthorhombic with $\breve{a} = \mathfrak{b}$, $\bar{b} = \mathfrak{a}$, $\acute{c} = \mathfrak{c}$. Exposed to the air the water expelled is slowly reabsorbed and the original optical and crystallographic characters reassumed; the orthorhombic characters, however, are retained if the crystals are embedded in Canada balsam. Ber. Ak. Berlin, 1181, 1890.

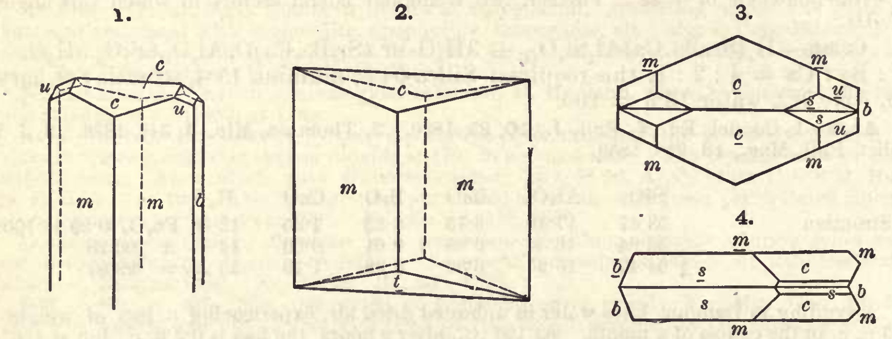

Fig. 1, *Reissite*, Luedecke. 2, Iceland, Hintze. 3, 4, Trechmann.

**Comp.**—Probably like heulandite, $H_4CaAl_2Si_6O_{18} + 3H_2O$ or $CaO.Al_2O_3.6SiO_2.5H_2O$ = Silica 59·2, alumina 16·8, lime 9·2, water 14·8 = 100. A little sodium replaces part of the calcium.

**Anal.**—1, G. Rose, l. c. 2, Hersch, Inaug. Diss., p. 20, Zürich, 1887. 3, 4, Jannasch, Henniges, Jb. Min., **2**, 262, 274, 1882. Also ib., **1**, 50, 1880.

The formula is also written (Groth) $H_6Ca_2Al_4(SiO_3)_{11} + 7H_2O$ which requires: Silica 57·1, alumina 17·6, lime 9·7, water 15·6 = 100.

| | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. Berufiord | 2·250 | 58·59 | 17·52 | 7·56 | 1·78 | 14·48 | = 99·93 |
| 2. Djupivogur | 2·207 | 58·18 | 16·35 | 7·21 | 2·07 | 16·34 | = 100·15 |
| 3. Berufiord | 2·250 | $\frac{2}{2}$ 57·63 | 17·43 | 8·08 | 1·57 | 15·32 | $K_2O,Li_2O$ 0·05 = 100·08 |
| 4. Loc. unknown | 2·247 | $\frac{2}{2}$ 56·65 | 18·68 | 8·68 | 1·47 | 15·60 | = 101·08 |

A zeolite, probably epistilbite, from Lunddörrsfjäll gave Igelström: $SiO_2$ 58·35, $Al_2O_3$ 16·67, CaO 10·63, $H_2O$ 13·76 = 99·41. Jb. Min., 361, 1871.

Jannasch obtained further (anal. 4):

| Temp. | 100°–105° | 150°–160° | 200° | 260°–280° | 300°–350° | Rd. ht. |
|---|---|---|---|---|---|---|
| $H_2O$ | 1·76 | 3·58 | 4·48 | 10·22 | 12·13 | 15·52 |

Cf. also Jannasch, Jb. Min., **2**, 206, 1884; Bodewig, Zs. Kr., **8**, 611, 1884, **10**, 276, 1885.

**Pyr., etc.**—B.B. intumesces and forms a vesicular enamel. Soluble with difficulty or imperfectly in concentrated hydrochloric acid without gelatinizing.

**Obs.**—Occurs with scolecite at the Berufiord in Iceland; the Färöer; at Poona in India; in small flesh-colored crystals at Skye; in small reddish crystals, nearly or quite opaque, with stilbite, at Margaretville, N Scotia, 7 m. E. of Port George. Reported as occurring with stilbite, apophyllite, etc., at Bergen Hill, N. J. With heulandite, stilbite, etc., at Viesch in the Valais, Switzerland.

*Parastilbite* (cf. Tenne, l. c.) is from the Borgarfiord, Iceland. *Reissite* (cf. Luedecke, l. c.) is from Santorin.

**Ref.**—[1] Pogg., **6**, 183, 1826, Jb. Min., **1**, 43, 1880; the angles are quite uncertain as shown later by Trechmann, ib., **2**, 260, 1882, who gives a comparative table for epistilbite, reissite, parastilbite. The monoclinic character was also recognized by Dx , Bull Soc. Min., 2, 161, 1879; it had earlier been regarded as orthorhombic.

[2] Cf. authors noted above. Also on reissite, Hbg., Min Not., **9**, 22, 1870; Luedecke, Jb. Min., **1**, 162, 1881. On parastilbite, Tenne, Jb. Min., **2**, 195, 1881. Also Hintze, Zs. Kr., **8**, 605, 1884.

## Phillipsite Group. Monoclinic.

**441. Phillipsite.** **442. Harmotome.** **443. Stilbite.**

These three species have not only nearly the same axial ratios (p. 571), but they are also closely related in habit and method of twinning, as explained under the description of each. The relation is particularly close between phillipsite and harmotome.

Fresenius has shown that the species of this group may be regarded as forming a series, in which the ratio of $\overset{II}{R} : \overset{III}{R}_2$ is constant (= 1 : 1), while the silica and water both vary between certain limits. The end compounds assumed are:

$$RAl_2Si_6O_{16} + 6H_2O$$
$$R_2Al_4Si_4O_{16} + 6H_2O$$

Here R = Ca chiefly, in phillipsite and stilbite, and Ba in harmotome; also in smaller amounts $Na_2, K_2$. The first of the above compounds may be regarded as a hydrated calcium albite, the second as a hydrated anorthite. The subject, however, requires further study; the formulas given on p. 571 and beyond are those corresponding to reliable analyses of certain typical occurrences.

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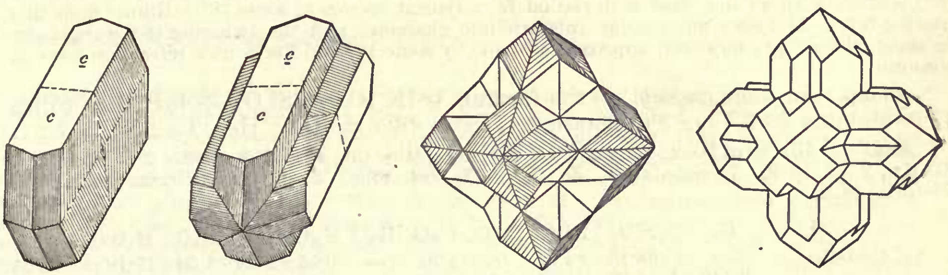
**441. PHILLIPSITE.** *Lévy*, Ann. Phil., **10**, 362, 1825. Lime-Harmotome. Kalk-Harmotom *Germ.* Kalk-Harmotom, Normalin, *Breith.*, Schw. J., **50**, 327, 1827, Uib., 32, 1830, Char., 126, 1832. Christianite *Dx.*, Ann. Mines, **12**, 373, 1847.

Monoclinic. Axes $\grave{a} : \overset{|}{b} : \grave{c} = 0{\cdot}70949 : 1 : 1{\cdot}2563$; $\beta = {}^*55^\circ\ 37' = 001 \wedge 100$ Streng[1].

$100 \wedge 110 = 30^\circ\ 21'$, $001 \wedge \bar{1}01 = {}^*90^\circ\ 0'$, $001 \wedge 011 = 46^\circ\ 2'$.

**Forms:** *a* (100, *i*-ī), *b* (010, *i*-ì), *c* (001, *O*); *m* (110, *I*), *n* (120, *i*-2̀); *d* (501, − 5-ī), *f* (1̄01, 1-ī); *e* (011, 1-ì).

Angles: $mm''' = {}^*60^\circ\ 42'$, $nn' = 80^\circ\ 59\tfrac{1}{2}'$, $af = 34^\circ\ 23'$, $cd = 50^\circ\ 36\tfrac{1}{2}'$, $cm = 60^\circ\ 50'$, $ee' = 92^\circ\ 4'$.


1. 2. 3. 4.

Figs. 1, 2, Sirgwitz, Trippke. 3, 4, After Köhler.

Crystals uniformly penetration-twins, but often simulating orthorhombic or tetragonal forms. Twins sometimes, but rarely, simple (1) with tw. pl. *c*, and then cruciform so that diagonal parts on *b* (f. 1) belong together, hence a fourfold striation, ‖ edge *b*/*m*, may be often observed on *b*. (2) Double twins, the simple twins just noted united with *e* (011) as tw. pl., and, since *ee'* varies but little from 90°, the result is a nearly square prism, terminated by what appear to be pyramidal faces each with a double series of striations away from the medial line (cf. f. 2). These twins may have the prism formed either by *b* with its characteristic striations, with or without the reëntrant angle; or the external faces may belong to *c* (f. 2) when *b* appears in the reëntrant angle only (if this is shown); or still again the reëntrant angle may be absent and the crystals interpenetrate each other irregularly, so that an external face is formed in part by *b*, in part by *c*. Rarely[2] this double twin, showing a square prism formed by the faces *b*, *b*, may be terminated by the unusual form *a* (100) with four reëntrant angles of about 47¾°. Finally (3), three double twins of the ordinary type may be united to a single complex form with *m* as tw. pl. (f. 3, 4). This last may yield forms appearing like a rhombic dodecahedron, with or without a depression at the extremity of the octahedral axes; each rhombic face may then be divided into four fields by striations diverging from the center and parallel to the position that would be occupied by a plane on the octahedral solid angle of the dodecahedron (cf. f. 3).

Faces *b* often finely striated as just noted, but striations sometimes absent and in general not so distinct as with harmotome; also *m* striated ‖ edge *b*/*m*; further, *a*, *c*, and *d* (501) more or less distinctly ‖ edge *a*/*c*. Crystals either isolated, or grouped in tufts or spheres that are radiated within and bristled with angles at surface.

Cleavage: *c*, *b*, rather distinct. Fracture uneven. Brittle. H. = 4–4·5. G. = 2·2. Luster vitreous. Color white, sometimes reddish. Streak uncolored. Translucent to opaque.

Optically +. Ax. pl. and $Bx_o \perp b$. The ax. pl. lies in the obtuse angle of ȧ ċ, and is usually inclined to *c* (that is, to ȧ) about 15° to 20°, or 75° to 70° to the normal to *c*. The position, however, is variable, as also the axial angles. Dx. obtained:

| | Richmond | Dyref. | Oberwinter | C. d. Bove | Somma | Marburg | Annerd. |
|---|---|---|---|---|---|---|---|
| 𝔠 *c* = | + 60° 11′ | 71° 36′ | 72° | 73° 15′ | 73° 21′ | 74° 51½′ | 75° 0′ |
| $Bx_a \wedge \dot{c}$ = | − 85° 26′ | − 74° 1′ | − 73° 37′ | − 72° 26′ | − 72° 17′ | − 70° 45½′ | − 70° 37′ |

| | | | | |
|---|---|---|---|---|
| Richmond | $2H_{a.r} = 84° 8\frac{1}{2}'$ | $2H_{o.r} = 103° 21'$ | $2H_{a.y} = 84° 54\frac{1}{2}'$ | $2H_{o.y} = 103° 5'$ |
| Mte. Somma | $2H_{a.r} = 69° 55'$ | $2H_{o.r} = 112° 33'$ | | |
| Marburg | $2H_{a.r} = 70° 50'$ | $2H_{o.r} = 129° 15'$ | Dyrefiord | $2H_{o.r} = 98° 13'$ |

Fresenius found for Nidda crystals the axial angle inclined about 10° to *c* (hence 𝔞 *c* = 80° and $Bx_a \wedge \dot{c} = -65° 37'$); for yellow this angle is about 1° greater than for red.

According to Langemann[3] the individuals which form the complex twins of phillipsite are strictly triclinic since, for example, sections ‖ *f* (1̄01) show a deviation of the planes of vibration from the *b* axis, amounting in the Nidda phillipsite to 12½°; further, sections ‖ *c* show a division into sectors with in one case a deviation for adjacent sectors of some 18°. Rinne[3] finds that heating (cf. p. 571) does not change this triclinic character and the twinning structure is also retained; the ax. pl., however, approaches *c* (001) by some 10° and the double refraction loses in strength.

**Comp.**—In some cases (Rg.) the formula is $(K_2,Ca)Al_2Si_4O_{12} + 4\frac{1}{2}H_2O$ = Silica 48·8, alumina 20·7, lime 7·6, potash 6·4, water 16·5 = 100. Here Ca : $K_2$ = 2 : 1.

**Anal.**—1. Ricciardi [Gaz. Ch. Ital., **11**, 369] Rg., Min. Ch., Erg., 179, 1886. 2–6, Fresenius, Zs. Kr., **3**, 42, 1878. 7, Schafarzik, Zs. Kr., **17**, 522, 1890. 8, Pittman, Ulrich, Contr. Min. Victoria, 1870.

| | G. | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | BaO | MgO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Aci Castello | | | 48·16 | 23·92 | *tr.* | 2·81 | — | 0·95 | 2·03 | 4·50 | 17·18 = | 99·55 |
| 2. " " | 2·140 | $\frac{2}{2}$ | 46·89 | 21·38 | 0·15 | 3·62 | *tr.* | 0·07 | 7·14 | 2·66 | 18·28 = | 100·19 |
| 3. Nidda | 2·160 | $\frac{2}{2}$ | 47·65 | 21·26 | 0·15 | 8·05 | *tr.* | — | 0·64 | 5·41 | 16·81 = | 99·97 |
| 4 Annerod | 2·152 | | 51·72 | 18·95 | 0·53 | 5·19 | 1·34 | 0·11 | 0·96 | 4·41 | 16·99 = | 100·20 |
| 5. " | | | 51·79 | 19·00 | 0·24 | 7·03 | 0·03 | 0·15 | 0·52 | 3·94 | 17·63 = | 100·33 |
| 6. Limburg | 2·150 | $\frac{2}{2}$ | 51·68 | 18·17 | 0·24 | 5·37 | 0·39 | 0·30 | 0·94 | 4·67 | 18·21 = | 99·97 |
| 7. Somoskö | 2·201 | | 49·65 | 21·88 | — | 6·99 | — | — | *tr.* | 5·28 | 16·16 = | 99·96 |
| 8 Kyneton, Victoria | | | 46·62 | 23·60 | — | 4·48 | — | — | 5·10 | 6·39 | 14·76 = | 100·95 |

According to Damour, the Kaiserstuhl crystals (mixed with a little faujasite) lose 8 p. c. after a month in dried air, and regain all again in ordinary air in 24 hours. Heated to 50° C. for an hour, the mineral loses 12·3 p. c., and recovers nearly all in 24 hours' exposure to ordinary air, but becomes a powder and opaque (the faujasite remaining transparent). Heated to 150° C., the loss is 16 p. c., and only 0·8 p. c. after exposure again to the air for 4 days. At 250° C., the loss is 18·5 p. c., part of which is due to the faujasite; it is reduced to 9 p. c. in the free air.

Fresenius found that phillipsite began to be opaque at 150° and to fall to pieces; the amount of water gradually diminishes with rise in temperature and increases as it falls, each temperature corresponding to a definite amount.

**Pyr., etc.**—B.B. crumbles and fuses at 3 to a white enamel. Gelatinizes with hydrochloric acid.

**Obs.**—In translucent crystals in basalt, at the Giant's Causeway, Ireland; in small colorless crystals, and in spheroidal groups, in leucitophyre, at Capo di Bove, near Rome; in crystals and radiating masses at Aci Castello and elsewhere in Sicily; among the lavas of Mte. Somma; at Stempel, near Marburg; Habichtswald, near Cassel; Annerod, near Giessen; near Eisenach, in Saxe Weimar; Petersberg, in the Siebengebirge; Nidda in Hesse; Laubach; in the basalt of the Limbacher Kopf near Asbach; in the Kaiserstuhl, with faujasite; at Härtlingen, Nassau; Salesl, Bohemia, on the right bank of the Elbe; in the ancient lavas of the Puy-de-Dôme at Cap de Prudelles near Royat, and other points; also at Verrières, Loire; on the west coast of Iceland, the shores of Dyrefiord. Very small transparent crystals, of recent formation, in the masonry at the hot baths of Plombières, France, observed by Daubrée; also at Bourbonne-les-Bains and elsewhere.

Found in minute crystalline aggregates and irregular spherical groups bristling with crystals in the deep-sea dredging by the "Challenger" from the bottom of the central Pacific Ocean, south of the Sandwich Islands. They are embedded in a red clay with ferro-manganesian nodules (cf. p. 259), chondrules of enstatite, etc.; they are believed to have been formed at the ocean bottom by the decomposition of an augitic lava. An analysis by Renard gave:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MnO | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$(125°) | ign. |
|---|---|---|---|---|---|---|---|---|---|
| 48·70 | 17·58 | 6·17 | *tr.* | 1·70 | 1·02 | 4·83 | 3·75 | 7·95 | 9·47 = 101·17 |

The iron is due to impurity. See Rep. Challenger Ex., vol. **1**, 774, 815, 816, 1885; John Murray in Encycl. Brit., **18**, 125, 1885; for the description of the forms, etc., Renard, Bull. Ac. Belg., **19**, 88, 182, 1890; a general account is given in Proc. R. Soc. Edinb., **12**, 474, 1884.

Named after the English mineralogist, W. Phillips (d. 1828). The name *christianite* was given by Des Cloizeaux (after Christian VIII. of Denmark) to the Marburg harmotome and crystals from Iceland; and in his Min., 1862, he places all of phillipsite under his name christianite.

**Ref.**—[1] Jb. Min., 585, 1875. The monoclinic character of the species was first assumed by Groth and definitely proved by Streng. Cf. Köhler, Pogg., **37**, 560, 1836; Streng, Jb. Min., 561, 1874; Groth, Tab. Ueb., pp. 62, 104, 1874; also Trippke, Jb. Min., 681, 1878; Fresenius, Zs. Kr., **3**, 42, 1879; Zeph., Zs. Kr., **5**, 96, 1880; Stadtländer, Jb. Min., **2**, 122, 1885; Langemann, ib., **2**, 110, 1886. [2] Rath, Ber. nied. Ges., p. 234, Nov. 7, 1887. [3] Optical characters, see Dx., Bull Soc. Min., **6**, 305, 1883, **7**, 138, 1884; also Trippke, Fresenius, Langemann, l. c.

SPANGITE *P. Mantovani*. Separate publication dated Rome, April 10, 1872. An imperfectly described zeolite, stated to be a variety of phillipsite from the lava of Capo di Bove near Rome. An analysis of Postempski gave:

| $SiO_2$ | $Al_2O_3$ | CaO | MgO | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|
| 49·00 | 19·50 | 4·85 | 3·70 | 6·33 | 16·75 = 100·13 |

Named after Mr. Norman Spang of Pittsburg.

**442. HARMOTOME.** Spatum calcarium cryst. dodecaedrum album, opacum, et lamellis quatuor erectis, etc. (fr. Zellerfeld), *v. Born*, Lithoph., **2**, 81, Tab. I, f. 1; figura hyacinthica, etc.: hæ crystalli non sunt calcareæ, sed siliceæ, *Bergm.*, Opusc., **2**, 7, 1780. Hyacinte blanche *Démeste*, Lett. 417, var. 5, 1779. Hyacinte blanche cruciforme *de Lisle*, Crist., **2**, 299, pl. IV, f. 119, 1783. Kreuzkristalle *Heyer*, v. Trebra's Erfahrungen, etc., 89; Crell's Ann., **1**, 212, 1789. Kreuzstein *Wern*, *Karsten*, Lempe's Mag., **2**, 58, 59, 1786. Andreasbergolite *Delametherie*, Sciagr., **1**, 267, 1792. Andreolite *Delameth.*, T. T., **2**, 285, 1797. Staurolite *Kirwan*, **1**, 282, 1794. Ercinite *Napione*, Elem. Min., 239, 1797. Harmotome *Haüy*, Tr., **3**, 1801. Pierre cruciforme *Brochant*, **1**, 311, 1808. Morvenite *Thom.*, Min., **1**, 351, 1836. Baryt-Harmotome. Barytkreuzstein *Germ.*

Monoclinic. Axes $\grave{a} : \overset{1}{\bar{b}} : \grave{c} = 0{\cdot}70315 : 1 : 1{\cdot}2310$; $\beta = {}^{*}55^\circ\ 10' = 001 \wedge 100$ Des Cloizeaux[1].

$100 \wedge 110 = 29^\circ\ 59\tfrac{1}{2}'$, $001 \wedge 101 = 35^\circ\ 41\tfrac{5}{6}'$, $001 \wedge 011 = 45^\circ\ 17\tfrac{5}{6}'$.

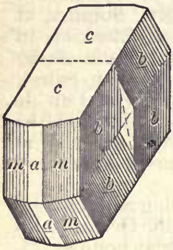
**Forms**[1]:

*a* (100, *i*-ī)
*b* (010, *i*-ì)
*c* (001, *O*)
*v* (410, *i*-$\bar{4}$)
*w* (520, *i*-$\tfrac{5}{2}$)
*m* (110, *I*)
*t* (101, − 1-ī)
*ε* (702, − $\tfrac{7}{2}$-ī)
*f* ($\bar{1}$01, 1-ī)
*e* (011, 1-ì) as tw. pl.

*mm'''* = *59° 59'
*vv'''* = 16° 25'
*ww'''* = 26° 0'
*at* = 19° 28'
*cε* = 48° 11'
*cf* = *90° 0'
*cm* = 60° 21'
*ee'* = 90° 36'

Crystals uniformly cruciform penetration-twins with *c* as tw. pl.; either (1) simple twins (f. 1) or (2) united as fourlings with tw. pl. *e*. These double twins often have the aspect of a square prism with diagonal pyramid, the latter with characteristic feather-like striations from the medial line. Also (3) in more complex groups of three double twins, with *m* as tw. pl. (cf. f. 4, p. 579); see further under phillipsite, where the forms are more fully described.

1.



Morvenite, Dx.

Cleavage: *b* easy, *c* less so. Fracture uneven to subconchoidal. Brittle. H. = 4·5. G. = 2·44–2·50. Luster vitreous. Color white; passing into gray, yellow, red, or brown. Streak white. Subtransparent to translucent. Optically +. Ax. pl. and $Bx_a \perp b$. Ax. pl. in obtuse angle $\grave{a}\ \dot{c}$ and inclined about 65° to $\grave{a}$ and 60° to $\dot{c}$; more exactly (Dx.), $Bx_{o.r} \wedge \dot{c} = +60° 32'$, $Bx_{o.bl} \wedge \dot{c} = +59° 55'$. Axial angle $2H_{a.r} = 87° 2'$, Dx. Indices:

$$\alpha = 1·503 \qquad \gamma = 1·508 \text{ Lévy-Lcx.} \qquad \beta = 1·516 \text{ Dx.}^2$$

According to Langemann[2], harmotome in a manner similar to phillipsite deviates optically from the requirements of the monoclinic system, as shown in sections ⊥ *b* and *c*. Rinne[2] shows that by heating (see p. 571) these optical characters, which refer the simple crystals of harmotome strictly to the triclinic system, are not changed, but the ax. pl. has approached *c* (001) by some 50°, while the double refraction has increased in strength.

**Comp.**—In part $H_2(K_2,Ba)Al_2Si_5O_{15} + 4H_2O$ or $(K_2,Ba)O.Al_2O_3.5SiO_2.5H_2O$ = Silica 47·1, alumina 16·0, baryta 20·6, potash 2·1, water 14·1 = 100.

**Anal.**—1, 3, Rg., Pogg., **110**, 624, 1860. 2, Hersch, Inaug. Diss., 18, Zürich, 1887. 4, Reynolds, Q. J. G. Soc., **27**, 374, 1871. 5, Fresenius, Zs. Kr., **3**, 42, 1878. 6, Dmr., Ann. Mines, **9**, 345, 1846.

| | G. | $SiO_2$ | $Al_2O_3$ | BaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. Andreasberg | | 48·49 | 16·35 | 20·08 | *tr.* | 2·07 | 13·00 = 99·99 |
| 2. " | | 45·72 | 16·79 | 22·34 | — | — | 15·18 = 100·03 |
| 3. Strontian | 2·354 | 47·52 | 16·94 | 20·25 | 1·09 | 1·00 | 13·45 = 100·25 |
| 4. " | | 48·02 | 17·42 | 20·17 | 0·62 | | 13·77 = 100 |
| 5. Oberstein | 2·402 | 47·42 | 15·89[a] | 18·98 | 1·71 | 0·48 | 15·14 MgO 0·13 = 99·75 |
| 6. Strontian, *Morvenite* | 2·498 | 47·60 | 17·04[b] | 20·86 | 0·74 | 0·81 | 14·16 = 101·21 |

[a] Incl. 0·09 $Fe_2O_3$. [b] Incl. 0·65 $Fe_2O_3$.

According to Damour, the Scotch harmotome loses 4·3 p. c. by 6 months' exposure to dried air. Heated to 100° C. it loses 1·8 p. c.; between 100° and 150°, 9 9 p. c.; between 100° and 190°, 13·5 p. c.; and after 24 h. exposure to the ordinary air, what is lost is restored. At a dull red heat the loss is 14·65 p. c., and the mineral is disaggregated; the total loss at a bright red heat is 14·70 p. c.

Hersch (ref. p. 571) obtained for the loss of water, after two hours' heating in each case:

| Temp. | 100° | 150° | 203° | 252° | 295° | red ht. |
|---|---|---|---|---|---|---|
| $H_2O$ | 2·74 | 5·74 | 9·23 | 10·67 | 12·42 | 15·29 p. c. |

**Pyr., etc.**—B.B. whitens, then crumbles and fuses without intumescence at 3·5 to a white translucent glass. Some varieties phosphoresce when heated. Decomposed by hydrochloric acid without gelatinizing.

**Obs.**—Harmotome occurs in basalt and similar eruptive rocks, also phonolyte, trachyte; not infrequently on gneiss, and in some metalliferous veins.

Occurs at Strontian, in Scotland, in fine crystals, some an inch through; in a metalliferous vein at Andreasberg in the Harz; at Rudelstadt in Silesia; at Oberstein, implanted on agate in siliceous geodes; at Kongsberg in Norway; in quartz syenite of Tonsenås near Christiania; with analcite in the amygdaloid of Dumbartonshire.

In the U. S., in small brown crystals with stilbite on the gneiss of New York island (4th Av. tunnel excavations). From a mine near Rabbit Mt., 22 miles W.S.W. of Port Arthur or the north shore of L. Superior, Ontario. The crystals are chiefly implanted upon calcite, which is associated with amethyst, fluorite, etc.

Named from ἀρμός, *joint*, and τέμνειν, *to cut*, alluding to the fact that the pyramid (made by the prismatic planes in twinning position) divides parallel to the plane that passes through the terminal edges.

The name *Andreolite* of Delamétherie (derived from the locality at Andreasberg) has the priority , and also *Ercinite* of Napione; but Haüy substituted *harmotome*, of no better signification, and all subsequent mineralogists have followed him.

**Ref.**—[1] Ann. Mines, **9**, 339, 1846; he unites morvenite and harmotome; also Min., **1**, 412, 1862, Ann. Ch. Phys., **13**, 417, 1868; Rg., Zs. G. Ges., **20**, 589, 1868; Kloos, Jb. Min., **2**, 212, 1885. Also earlier, Köhler, Pogg., **37**, 561, 1836.

[2] On the optical characters see Dx., l. c.; Mld., Ann. Mines, **10**, 153, 1876; Baumhauer, Zs. Kr., **2**, 113, 1878; Fresenius, l. c.; Lcx., Bull. Soc. Min., **8**, 94, 1885; Langemann, Jb. Min., **2**, 83, 1886; Rinne, Abh. Ak. Berlin, 1179, 1890.

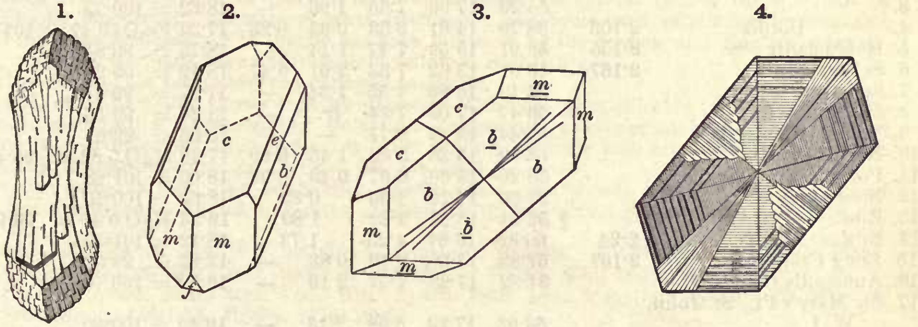
**443. STILBITE.** Zeolit pt. *Cronst.*, Ak. H. Stockh., 1756; Zeolites cryst., crystalli ad centrum tendentes (fr. Gustafsberg, etc.), *Cronst.*, 102, 1758. Z. facie Selenitica lamellaris, Blättricher Zeolit pt., *Wall.*, Min., **1**, 313, 1772. Strahliger Zeolith *Wern.*, Ueb. Cronst., 242, 1780. Strahl-Zeolith (var. of Z.) *Wern.*, 1800, Ludwig., **1**, 49, 1803. Radiated Zeolite. Zeolite nacrée, Stilbite, *Delameth.*, TT., **2**, 305, 1797. Stilbite (Heulandite incl.) *H.*, J Mines, **3**, 66, 1798, Tr., **3**, 1801, 1822; = Strahl-Zeolith *Hoffm.*, Min., **2**, 237, 1812. Desmine [= Stilbite with Heul. excl.] *Breith.*, Hoffm. Min., **4**, b, 40, 1818; = Stilbite *Brooke*, Ed. Phil. J., **6**, 112, 1822. Sphærostilbite *Beud.*, Tr., **2**, 120, 1832. Syhedrite *Shep.*, Am. J. Sc., **40**, 110, 1865. Syhadrite. Puflerit *Bukeisen*, Ber. Ak. Wien, **24**, 286, 1857; Hypostilbite *Dana*, Min., p. 441, 1868.

Monoclinic. Axes: $\grave{a} : \bar{b} : \grave{c} = 0{\cdot}76227 : 1 : 1{\cdot}19401$; $\beta = 50° \, 49\frac{3}{4}' = 001 \wedge 100$ Lasaulx[1].

$100 \wedge 110 = 30° \, 34\frac{5}{6}'$, $001 \wedge \bar{1}01 = 89° \, 30'$, $001 \wedge 011 = 42° \, 47\frac{1}{3}'$.

**Forms**[1]: *a* (100, *i*-$\bar{i}$), *b* (010, *i*-$\breve{i}$), *c* (001, *O*); *m* (110, *I*); *τ* (250, *i*-$\frac{5}{2}$)[3]? *t* (130, *i*-$\dot{3}$)[2]?; *f* ($\bar{1}$01, 1-$\bar{i}$); *e* (011, 1-$\breve{i}$).

Angles: *a'f* = 39° 40', *mm'''* = *61° 9¾', *ττ'* = 68° 11', *tt'* = 58° 51', *cm* = *57° 3½', *ee* = 85° 35'.



1, Sheaf-like crystal. 2–4, Lasaulx: 2, ideal simple crystal; 4, section ‖ *b* in polarized light.

Crystals uniformly cruciform penetration-twins with tw. pl. *c*, analogous to phillipsite and harmotome. The apparent form a rhombic pyramid (f. 2) whose faces are in fact formed by the planes *m* and *m*; the vertical faces being then the pinacoids *b* and *c*. Usually thin tabular ‖ *b*. These compound crystals are often grouped in nearly parallel position, forming sheaf-like aggregates (f. 1) with the side plane (*b*), showing its characteristic pearly luster, often deeply depressed. Also divergent or radiated; sometimes globular and thin lamellar-columnar.

Cleavage: *b* perfect. Fracture uneven. Brittle. H. = 3·5–4. G. = 2·094–2·205; 2·161 Haid. Luster vitreous; of *b* pearly. Color white; occasionally yellow, brown, or red, to brick-red. Streak uncolored. Transparent to translucent.

Optically —. Ax. pl. ‖ *b*. $Bx_a$ inclined 5° to axis *à* in obtuse angle *à ć*; hence $Bx_a \wedge \grave{c} = -55° \, 50'$. Ax. angle approx. 52° to 53° (blue glass) Lsx. Indices:

Kilpatrick $\alpha = 1{\cdot}494$ $\beta = 1{\cdot}498$ $\gamma = 1{\cdot}500$ Lévy-Lcx.[4]

Langemann[4] shows that strictly considered stilbite must be regarded as composed of triclinic individuals. Sections ‖ $\bar{1}$01 show sectors with the extinction inclined 5° to the edge formed with the plane *b*; sections ‖ *b* (f. 4. Lsx.) show four sectors, whose extinction-directions are inclined to one another 10°, separated by radiating portions of variable extinction; sections ‖ *c* show a central portion with parallel extinction and strips at the side in which it is inclined 2½° to the *b* edge.

Rinne[4] found that in sections ‖ *b*, which showed four sectors with the extinction inclined 10° to each other (the axis 𝔞 coinciding with the direction of elongation), after being strongly heated and made transparent in oil (p. 571), the axes 𝔠 and 𝔟 became respectively ‖ and ⊥ to edge *c* (001). The effect of increase of temperature had been to give it the molecular structure of an orthorhombic crystal, the ax. pl. becoming ‖ *c* and $Bx_a$ (= 𝔠) coinciding with the axis *à*.

**Comp.**—For most varieties $H_4(Na_2,Ca)Al_2Si_6O_{18} + 4H_2O$ or $(Na_2,Ca)O.Al_2O_3.6SiO_2.6H_2O$ = Silica 57·4, alumina 16·3, lime 7·7, soda 1·4, water 17·2 = 100. Here $Ca : Na_2 = 6 : 1$.

Some kinds show a lower percentage of silica, and these have been called *hypostilbite*, Dana, Min., p. 441, 1868; cf. anals. 22–25.

**Anal.**—1, 2, E. E. Schmid, Pogg., **142**, 115, 1871. 3, Lemberg, Zs. G. Ges., **28**, 559, 1876. 4, Heddle, Min. Mag., **1**, 91, 1877. 5, Hersch, Inaug. Diss., p. 21, Zürich, 1887. 6, Petersen, Ber. Offenb. Ver., **14**, 102, 1873. 7, Rg., Min. Ch. Erg., 181, 1886. 8, Cossa, Acc. Linc. Trans., **5**, 86, 1881. 9, Brun, Zs. Kr., **7**, 389, 1882. 10. Haughton, Phil. Mag., **13**, 510, 1857. 11. Id., ib., **32**, 224, 1866. 12, Id., J. G. Soc. Ireland, **2**, 113, 1868. 13, Sansoni, Att. Acc. Tosc., **4**, 173, 1879. 14, Hussak, Bol. Comm. S. Paulo, No. 7, 7, 1890. 15, Young, Ch. News, **27**, 56, 1873. 16, How, Phil. Mag., **1**, 134, 1876. 17, Fiebelkorn, Cleve's Geol. W. I. Is., 30, 1873. 18, Hillebrand, U. S. G. Surv., Bull. **20**, 23, 1885. 19, Davidson, Am. Ch. J., **6**, 414, 1884. 20, Hoskinson & Brunner, ibid. 21, Eyerman, N. Y. Acad. Jan. 14, 1889. 22, Haughton, Phil. Mag., **13**, 510, 1837. 23, Id., ibid., **32**, 224, 1866. 24, Bukeisen, l. c. 25, Darapsky, Vh. Ver. Santiago, No. 6, 247, 1888.

| | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Färöer, Stromö | 2·16 | 56·88 | 16·70 | 7·69 | 1·39 | — | 17·24 | MgO 0·03 = 99·93 |
| 2. " Vaagö | | 56·30 | 17·63 | 7·50 | 2·09 | — | 17·36 | MgO 0·05 = 100·93 |
| 3. " | | 55·26 | 17·36 | 7·55 | 1·93 | — | 18·62 | = 100·72 |
| 4. " Bordö | 2·103 | 58·79 | 14·61 | 9·53 | 0·32 | 0·23 | 17·30 | $Fe_2O_3$ 0·47 = 101·25 |
| 5. Helgustadir | 2·155 | 56·91 | 15·59 | 7·47 | 1·14 | — | 18·73 | = 99·84 |
| 6. Seisser Alp | 2·167 | 55·61 | 15·62 | 7·33 | 2·01 | 0·47 | 18·19 | = 99·23 |
| 7. Striegau | | 56·12 | 16·83 | 7·55 | 1·34 | — | 17·57 | = 99·41 |
| 8. Miage Glacier | | 56·47 | 17·09 | 7·74 | *tr.* | — | 18·26 | = 99·56 |
| 9. Viesch Glacier | | 57·44 | 15·43 | 8·71 | — | — | 18·03 | = 99·61 |
| 10. Narbada | | 56·59 | 15·35 | 5·88 | 1·45 | 0·89 | 17·48 | MgO 0·82 = 98·46 |
| 11. Poona | | 58·20 | 15·60 | 8·07 | 0·49 | 0·92 | 18·00 | = 101·28 |
| 12. Bhor Ghát | | 57·00 | 17·10 | 7·95 | 0·32 | | 18·03 | = 100·40 |
| 13. Elba | | 52·34 | 16·94 | 9·22 | 1·80 | | 19·23 | MgO 0·41 = 99·94 |
| 14. Brotas, Brazil | 2·24 | 60·82 | 16·67 | 4·25 | 1·73 | | 18·12 | = 101·59 |
| 15. Long Craig | 2·167 | 57·82 | 15·30[a] | 8·12 | 0·83 | — | 17·85 | = 99·92 |
| 16. Annapolis Co., N. C. | | 57·32 | 17·28 | 7·57 | 2·10 | — | 16·52 | = 100·79 |
| 17. St. Mary's Pt., St. John, W. I. | | 56·02 | 17·23 | 5·68 | 2·15 | — | 19·42 | = 100·50 |
| 18. Table Mt., Col. | | 54·67 | 16·78 | 7·98 | 1·47 | — | 19·16 | = 100·06 |
| 19. Rautenbush, Pa. | | 58·08 | 13·11 | 9·48[b] | *tr.* | 0·42 | 18·53 | = 99·62 |
| 20. Fegley's mine, Pa. | | 57·54 | 12·67 | 7·85 | *tr.* | 1·09 | 18·97 | MgO 1·72 = 99·84 |
| 21. French Creek, Pa. | | 58·00 | 13·40 | 7·80 | *tr.* | 1·03 | 18·30 | MgO 1·40 = 99·93 |
| 22. Skye | | 52·40 | 17·98 | 9·97 | 1·40 | 0·03 | 17·83 | MgO 0·36 = 99·97 |
| 23. Bombay | | 52·80 | 17·12 | 7·89 | 2·35 | 0·07 | 18·52 | = 98·75 |
| 24. *Puflerite* | 2·21 | 52·84 | 16·30 | 11·79 | — | — | 17·16 | = 98·09 |
| 25. Curico | | 52·67 | 19·80 | 11·25 | — | — | 16·29 | = 100·01 |

[a] $Fe_2O_3$ *tr.* [b] Incl. MgO 1·38 p. c.

According to Damour, loses 1·3 p. c. at 100° C.; 13 p. c. between 100° and 150° C.; regaining all lost but 3·1 p. c. after 5 days' exposure to the ordinary air; at 170° C. the loss is 16·2 p. c., which is reduced to 9·2 p. c. after 15 days' exposure.

Hersch (l. c.) obtained for the loss of water, after two hours' heating in each case:

| Temp. | 104° | 150° | 210° | 250° | 290° | red ht. |
|---|---|---|---|---|---|---|
| $H_2O$ | 3·84 | 8·71 | 12·16 | 13·60 | 14·78 | 18·63 p. c. |

**Pyr., etc.**—B.B. exfoliates, swells up, curves into fan-like or vermicular forms, and fuses to a white enamel. F. = 2–2·5. Decomposed by hydrochloric acid, without gelatinizing. The *sphærostilbite* gelatinizes, but Heddle says this is owing to a mixture of *mesolite* with the stilbite.

**Obs.**—Stilbite occurs mostly in cavities in amygdaloidal, basalt, and similar rocks. It is also found in some metalliferous veins, and in granite and gneiss.

Abundant on the Färöer Islands, in Iceland, and on the Isle of Skye, in amygdaloid; also found on the Isle of Arran, Scotland; in Dumbartonshire, at Long Craig and at Kilpatrick, Scotland, in red crystals; at Kincardine, Kilmalcolm, Campsie, Scotland; at the Giant's Causeway and in the Mourne Mts., etc., Ireland; at Andreasberg in the Harz, and Kongsberg and Arendal in Norway, with iron ore; on the Seisser Alp in Tyrol and at the Pufler-loch (*puflerite*); on the granite of Striegau, Silesia; a brown variety on granite, at the copper mines of Gustafsberg, near Falun in Sweden. A common mineral in the Deccan trap area of British India, often in large beautiful sheaf-like forms of a salmon-pink color associated with apophyllite; fine crystals come from the Bhor and Thul Ghâts, also Poona, the island Elephanta, Bombay harbor, etc. (Mallet, Min. India, p. 123, 1887). In augite-porphyrite in the Serra de Brotas, northeast of Botucatú, Brazil.

In North America, sparingly in small crystals at Chester and the Somerville syenite quarries, Mass.; at the gneiss quarry, Thachersville, Conn., in crystals lining cavities in coarse granite; at Hadlyme, in radiated forms on gneiss, associated with epidote, garnet and apatite; at Phillipstown, N. Y., in crystals or fan-like groups; opposite West Point, in a vein of decomposing bluish feldspar, intersecting gneiss, in honey-yellow crystals; in the greenstone of Piermont, in minute crystals; in scopiform crystals of a dull yellow color, near Peekskill, N. Y.; and at Bergen Hill, New Jersey, in small but bright crystals; also at the Michipicoten Islands, Lake Superior.

At Partridge Island, Nova Scotia, forming a perpendicular vein from 3 to 4 inches thick, and from 30 to 50 feet long, intersecting amygdaloid, its colors white and flesh-red; also at Isle Haute, Digby Neck, Gulliver's Hole, Black Rock, Cape Blomidon, Hall's Harbor, Long Point.

The name *stilbite* is from *στίλβη, luster;* and *desmine* from *δέσμη, a bundle.* The species stilbite, as adopted by Haüy, included Strahlzeolith *Wern.* (radiated zeolite, or the above), and Blätterzeolith *Wern.* (foliated zeolite, or the species heulandite, p. 574). The former was the typical part of the species, and is the first mentioned in the description; and the latter (made the variety *stilbite anamorphique*) he added to the species, as he observes, with much hesitation. In 1817 Breithaupt separated the two zeolites, and called the former *desmine* and the latter *euzeolite,* thus throwing aside entirely, contrary to rule and propriety, Haüy's name *stilbite*, which should have been accepted by him in place of desmine, it being the typical part of his species. In 1822 Brooke (apparently unaware of what Breithaupt had done) used *stilbite* for the first, and named the other *heulandite.* In this he has been followed by the French and English mineralogists, while the Germans have unfortunately followed Breithaupt.

**Alt.**—Stilbite has been observed changed to quartz.

**Artif., etc.**—Lemberg shows that by digestion with potassium chloride for 13 days, stilbite is transformed into a corresponding potassium compound (Kalidesmin), while by a calcium chloride it is transformed back again, or with sodium chloride into a corresponding sodium compound (Natrondesmin). Zs. G. Ges., **28**, 559, 1876.

Doelter remarks that, like heulandite, stilbite fused and slowly cooled yields clusters of needles of a pyroxenic mineral, also often anorthite with amorphous ground-mass. Jb. Min., **1**, 132, 1890.

**Ref.**—[1] Zs. Kr., **2** 576, 1878; cf. also Langemann, Jb. Min., **2**, 132, 1886. [2] Heddle, meas. *bt* = 27°–30°, calc. 29° 25½′, Min. Mag., **4**, 44, 1880. [3] Mallet, Min. India, 125, 1887.

[4] On the optical characters, Dx., Min., **1**, 416, 1862; Lsx., l. c.; Langemann, Jb. Min., **2**, 126, 1886; Rinne, Abh. Ak. Berlin, 1175, 1890.

Foresite *Rath*, Pogg., **152**, 31, 1874.

In form and habit like stilbite. In crystalline crusts on tourmaline or lining cavities. Cleavage: *b* distinct, with pearly luster. G. = 2·405. Like stilbite in the position of the ax. pl. and bisectrix (Dx., Jb. Min., 640, 1876).

Anal.—1, Rath, l. c. 2, Bechi, D'Achiardi, Min. Tosc., **2**, 236, 1873. 3, Pulle & Capacci, quoted by D'Achiardi, Boll. Com. G., **5**, 311, 1874. 4, Sansoni, Att. Soc. Tosc., **4**, 317, 1879.

| | $SiO_2$ | $Al_2O_3$ | MnO | CaO | MgO | $Na_2O$ | $Ka_2O$ | BeO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | $\frac{2}{2}$ 49·96 | 27·40 | — | 5·47 | 0·40 | 1·38 | 0·77 | — | 15·07 | = 100·45 |
| 2. | 44·60 | 36·00 | 1·02 | 5·50 | 0·02 | 2·33 | 0·72 | 0·71 | 9·18 | = 100·08 |
| 3. | 44·60 | 38·00 | 1·02 | 5·50 | 0·20 | 3·33 | 0·72 | 0·71 | 6·00 | = 100·08 |
| 4. | $\frac{3}{3}$ 49·97 | 24·12 | — | 8·33 | *tr.* | — | 0·46 | — | 17·06 | = 99·94 |

D'Achiardi calls the mineral analyzed by Bechi cookeite (cuccheite).

B.B. expands and melts. With difficulty decomposed by hydrochloric acid, even after ignition. The water goes off in part at 100° to 110° C., after continued heating at 200° the mineral loses 5 to 5½ p. c., and to drive off the whole amount present (15·06 p. c. and 15·09 in two trials) a strong red heat was required.

Found at San Piero in Campo, Island of Elba, in cavities in the granite, with tourmaline, lepidolite, quartz, feldspar. It occurs, as a secondary product, along with heulandite and stilbite, covering these minerals.

Named after G. F. Forresi of Porto Ferrajo in Elba.

**444. GISMONDITE.** Zeagonite *Gismondi*, Osserv. Min. di Roma, 1816, Tasch. Min., **11**, 164, 1817. Gismondin *Leonh.*, ib., 168. Gismondine. Abrazite *Breislak*, Instit. Geol., **3**, 198. Aricite.

Monoclinic; pseudo-tetragonal by twinning' Apparent form a square octahedron with a terminal angle of 61° 30′ and an angle over the basal edge of 87° 30′ Mgc.; 61° 4′ and 88° 8′ Rath. Crystals twinned somewhat analogous to phillipsite. As explained by Rinne, the pyramid is formed by two sets of clinodomes *e* (011), twinned parallel to a prism of nearly 90°, each set being separately twinned parallel to the basal plane *c* (001). The edge of the pyramid corresponds in position, consequently, to the clino-diagonal axis. Faces rough and composite, often formed of many subindividuals.

Fracture subconchoidal. H. = 4·5. G. = 2·265. Luster vitreous. Colorless or white, bluish white, grayish, reddish. Transparent to translucent.

Optically −. $Bx_a \perp b$ (010) and $Bx_o$ sensibly $\perp a$ (100). Sections ∥ base of pyramid show four sectors, divided by diagonal lines, of which the two opposite have like extinction, while for the two adjacent the extinction-directions are inclined 5°. Sections ∥ pyramidal edge show parts ⊥ to both $Bx_a$ and $Bx_o$. Axial angles, Rinne:

$2H_{a.r} = 86° 58'$ Li $\quad 2H_{o.r} = 104° 11' \quad \therefore 2V_r = 82° 11' \quad \beta_r = 1·5348$
$2H_{a.y} = 87° 34'$ Na $\quad 2H_{o.y} = 103° 38' \quad \therefore 2V_y = 82° 43' \quad \beta_y = 1·5385$
$2H_{a.gr} = 88° 10'$ Tl $\quad 2H_{o.gr} = 102° 54' \quad \therefore 2V_{gr} = 83° 19' \quad \beta_{gr} = 1·5409$

The form was made orthorhombic by Credner; also by Lang, who regarded the crystals as made up of 110 and 011, with 110 ∧ $1\bar{1}0$ = 89° 10′, 011 ∧ $0\bar{1}1$ = 93° 41′, 110 ∧ 011 = 65° 18′. Irregularities of angle led Schrauf, and of optical character Lasaulx, to assume a twinning of triclinic individuals. Des Cloizeaux, however, while proving the forms to be penetration-twins, shows that the directions of extinction vary somewhat widely, probably as caused by the irregular grouping but not so as to confirm Lasaulx's assumption of triclinic individuals. The later observations of Rinne are given above.

Rinne finds that on increase of temperature the variations in the extinction disappear and the crystals become orthorhombic in structure; further the ax. pl. becomes parallel to a diagonal and the bisectrix coincides with $\dot{c}$. Also $2H_{a.gr}$ = 24° 57′. Optically −; double refraction weak.

**Comp.**—Uncertain; corresponds nearly to $CaAl_2Si_4O_{12} + 4H_2O$ = Silica 34·3, alumina 29·1, lime 16·0, water 20·6 = 100. Potash replaces some of the lime.

**Anal.**—1, Marignac, Ann. Ch. Phys., **14**, 46, 1845.

| | | $SiO_2$ | $Al_2O_3$ | CaO | $K_2O$ | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|
| 1. Capo di Bove | G. = 2·265 | 35·88 | 27·23 | 13·12 | 2·85 | 21·10 | = | 100·18 |

The following analyses 2, 3, are referred to phillipsite by Dx.; they have been regarded as mixtures of gismondite and phillipsite, while by some authors they are called *zeagonite* and assigned the formula $(K_2,Ca)Al_2Si_3O_{10}.4H_2O$ = Silica 42·6, alumina 24·1, lime 8 8, potash 7·4, water 17·0 = 100. The mineral of anal. 4 is stated positively to be gismondite.

**Anal.**—2, 3, Mgc., l. c., p. 41. 4, Kbl., J. pr. Ch., **18**, 105, 1839.

| | $SiO_2$ | $Al_2O_3$ | CaO | $K_2O$ | $H_2O$ | | |
|---|---|---|---|---|---|---|---|
| 2. Local | 43·25 | 24·69 | 7·45 | 9·78 | 15·25 | = | 100·42 |
| 3. Vesuvius | 43·95 | 24·34 | 5·31 | 11·09 | 15·31 | = | 100·00 |
| 4. Capo di Bove | 42·72 | 25·77 | 7·60 | 6·80[a] | 17·66 | = | 100·55 |

[a] A single determination.

**Pyr., etc.**—At 100° C. yields one-third of its water, and becomes opaque. B.B. whitens, intumesces much, and melts to a milky glass. Easily dissolves in acids and gelatinizes.

**Obs.**—Occurs in the leucitophyre or leucitic lava, of the region of Mt. Albano, south-east of Rome, at Capo di Bove, and elsewhere, associated with pyroxene, magnetite, mellilite, phillipsite, wollastonite, etc.; on the Gorner glacier, near Zermatt (Kenngott), in cavities in a coarse, granular, reddish brown garnet-rock, with epidote, calcite, chlorite, and genthite; also in the Val di Noto, Sicily (Scacchi), in white mammillary concretions, fibrous within. Other localities are: the Frauenberg near Fulda; Schiffenberg near Giessen in basalt in part altered to a clay-like substance; on the Hohenberg (Hamberg) near Bühne in Westphalia, in a nephelite-basalt in octahedral crystals of relatively large size (¾ cm. on the edge); Schlauroth near Görlitz in Silesia; Salesl, Bohemia.

A mineral near gismondite in form and like it in its complex grouping occurs with other zeolites on Fritz Island in the Schuylkill river, Penn.

*Zeagonite* is from ζεῖν, *to boil*, and ἄγονος, *barren;* and *abrazite*, from ἀ, privative, and βράζειν, *to boil*, has about the same meaning.

**Ref.**—[1] On the form, etc., see Mgc., l. c.; Rath, Pogg., **132**, 549, 1867; Lang, Phil. Mag., **28**, 505, 1864; Streng, Jb. Min., 578, 1874; Slg., Zs. Kr., **1**, 336, 1877; Schrauf, ibid., 596; Lsx., ib., **4**, 172, 1879; Dx., Bull. Soc. Min., **6**, 301, 1883, ib., **7**, 135, 1884; Rinne, Ber. Ak. Berlin, 1027, 1890.

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**445. LAUMONTITE.** Zeolithe efflorescente *H.*, Tr., **4**, 1801. Laumonite *H.*, Tabl. Comp., 1808. Lomonit *Wern.*, *Karst.*, Tab., 1808. Schneiderite *Meneghini*, Am. J. Sc., **14**, 64, 1852. Leonhardite *Blum*, Pogg., **59**, 336, 1843. Caporcianite *Savi*, Mem. cost. fis. Toscana, **2**, 53.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 1{\cdot}1451 : 1 : 0{\cdot}5906$; $\beta = 68° \, 46\tfrac{1}{4}' = 001 \wedge 100$ Miller[1].

$100 \wedge 110 = 46° \, 52'$, $001 \wedge 101 = 22° \, 3\tfrac{1}{6}'$, $001 \wedge 011 = 28° \, 50'$.

**Forms**[2]: *b* (010, *i-ì*) *m* (110, *I*) *e* ($\bar{2}$01, 2-*ì*) *r* (111, – 1)
*a* (100, *i-ī*) *c* (001, *O*) *d* (201, – 2-*ì*)[3] *f* ($\bar{6}$01, 6-*ì*)[3] *u* ($\bar{1}$11, 1)

*mm'''* = *93° 44′ *cf* = 92° 23½′ *br* = 66° 44′ *uu'* = 60° 28′
*cd* = 35° 0′ *cr* = 31° 38′ *bu* = 59° 46′ *md* = 55° 22′
*ce* = 56° 55′ *cm* = *75° 40′ *rr'* = 46° 32′ *m'e* = 66° 30′
*a'e* = *54° 19′ *cu* = 41° 57′

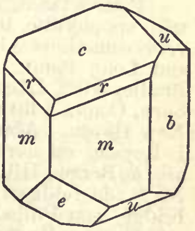
The form of laumontite approximates somewhat closely to that of the pyroxenes.

Twins: tw. pl. *a*. Common form the prism *m* with oblique termination *e*. Also columnar, radiating, and divergent.

Cleavage: *b* and *m* very perfect; *a* imperfect. Fracture uneven. Not very brittle. H. = 3·5–4. G. = 2·25–2·36. Luster vitreous, inclining to pearly upon the faces of cleavage. Color white, passing into yellow or gray, sometimes red. Streak uncolored. Transparent to translucent; becoming opaque and usually pulverulent on exposure.

Optically –. Ax. pl. ∥ *b*. $Bx_a \wedge \grave{c} = +65°$ to 70°. Dispersion large, $\rho < v$; inclined slight. Axial angles, Dx.:

Huelgoet $2E_r = 52° \, 24'$ $2E_{bl} = 56° \, 15'$



Huelgoet, Dx.

**Comp., Var.**—$H_4CaAl_2Si_4O_{14} + 2H_2O = 4H_2O.CaO.Al_2O_3.4SiO_2$ = Silica 51·1, alumina 21·7, lime 11·9, water 15·3 = 100.

*Leonhardite* is a laumontite which has lost part of its water (to one molecule), and the same is probably true of *caporcianite*. The former occurs in white or yellowish crystals like ordinary laumontite, also columnar and granular; caporcianite in pearly flesh-red monoclinic crystals. *Schneiderite* is laumontite from the serpentine of Monte Catini, Italy, which has undergone alteration through the action of magnesian solutions. It occurs with sloanite in the gabbro rosso of Tuscany. Named after Sign. Schneider, director of the mine of Monte Catini. The Ædelforsite of Retzius, or the *Red Zeolite of Ædelfors*, is referred here by N. J. Berlin, who considers it impure from mixed quartz. Bischof has analyzed a pseudomorph of laumontite after orthoclase.

**Anal.**—1. Sjögren, Pogg., **78**, 415, 1849. 2, Traube, Jb. Min., **2**, 67, 1887. 3, 4, Gericke, Lieb. Ann., **99**, 110, 1856, Rg., Min. Ch., 808, 1860. 5, Mallet, Am. J. Sc., **22**, 179, 1856. 6, How, ib., **26**, 34, 1858. 7, Bechi, Trans. Acc. Linc., **3**, 114, 1879. 8, Liversidge, Min. Mag., **1**, 54, 1876. 9, 10, Hillebrand, U. S. G. Surv., Bull. **20**, 16, 1885. 11, Delffs, Pogg., **59**, 339, 1843. 12, Barnes, Am. J. Sc., **15**, 440, 1853. 13, Smita, Min. Mitth., 268, 1877 (material dried over $H_2SO_4$). 14, Bechi, Am. J. Sc., **14**, 62, 1852.

| | G. | $SiO_2$ | $Al_2O_3$ | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|
| 1. Upsala, *red* | | 51·61 | 19·06 | 12·53 | 14·02 | $Fe_2O_3$ 2·96 = 100·18 |
| 2. Striegau, *wh.* | 2·28 | 51·09 | 21·36 | 11·76 | 15·35 = 99·56 | |
| 3. Sarnthal | 2·28 | 51·58 | 20·63 | 11·50 | 15·10 | $Fe_2O_3$ 0·26, $Na_2O$ 1·57 = 100·64 |
| 4. Plauen Grund | 2·310 | 53·16 | 22·76 | 9·33 | 11·90 | $Fe_2O_3$ 0·15, $Na_2O$ 3·32 = 100·62 |

| | | G. | $SiO_2$ | $Al_2O_2$ | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 5. | Skye, *red* | 2·252 | 53·95 | 20·13 | 12·86 | 12·42 | $K_2O,Na_2O$ 0·87, MgO *tr.* = |
| 6. | Port George, N. S. | | 51·43 | 21·64 | 12·07 | 15·26 | = 100·40 [100·23 |
| 7. | Moute Catini | | 53·78 | 19·28 | 8·34 | 15·00 | $Fe_2O_3$ 3·13, MgO 0·52 = 100·05 |
| 8. | Cox R., N. S. W. | | 53·27 | 22·83 | 11·00 | 12·65 | MgO 0·48 = 100·23 [= 100·12 |
| 9. | Table Mt., Col. | | 51·43 | 21·52 | 11·88 | 13·81 | $Fe_2O_3$ 0·94, $Na_2O$ 0·19, $K_2O$ 0·35 |
| 10. | " " " | | 52·07 | 21·30 | 11·24 | 14·58 | $Na_2O$ 0·48, $K_2O$ 0·42 = 100·09 |
| 11. | Schemnitz, *Leonhardite* | 2·25 | 56·13 | 22·98 | 9·25 | [11·64] | = 100 |
| 12. | Copper Falls, " | | $\frac{2}{2}$ 55·50 | 21·69 | 10·57 | 11·93 | = 99·69 |
| 13. | Floitenthal, " | 2·374 | 52·92 | 22·44 | 12·23 | 12·38 | = 99·97 [= 100·17 |
| 14. | *Caporcianite* | 2·47 | 52·02 | 22·83 | 9·68 | 13·17 | MgO 1·11, $Na_2O$ 0·25, $K_2O$ 1·11 |

Laumontite loses its water of crystallization very readily and hence is often found with less than the normal amount. Malaguti and Durocher (ref., p. 571) give the following:

| Temp. | 100° | 200° | 300° | red ht. | Also | *in vac.* | $H_2SO_4$ |
|---|---|---|---|---|---|---|---|
| $H_2O$ | 3·17 p. c. | 6·08 | 7·28 | remainder | | 2·26 p. c. | 3·85 |

Leonhardite loses over sulphuric acid 1·7–1·9 p. c. water, and has then the composition of laumontite dried at 100°, Smita, l. c.

Doelter finds that laumontite, when fused and cooled very slowly, forms a semi-crystalline mass in which anorthite is prominent, also a pyroxenic mineral in acicular forms with an amorphous ground-mass. Jb. Min., **1**, 130, 1890.

**Pyr., etc.**—B.B. swells up and fuses at 2·5–3 to a white enamel. Gelatinizes with hydrochloric acid.

**Obs.**—Occurs in the cavities of basalt and similar eruptive rocks; also in porphyry and syenite, and occasionally in veins traversing clay slate with calcite. It was first observed in 1785, in the lead mines of Huelgoet in Brittany, by Gillet Laumont, after whom it is named.

Its principal localities are the Färöer Islands; Disco in Greenland; in Bohemia, at Eule in clay slate; St. Gothard in Switzerland; the Fassathal, in large masses with radiated structure; Sarnthal, near Botzen, Tyrol; the Plauenscher Grund, near Dresden; Hartfield Moss in Renfrewshire, accompanying analcite; the amygdaloidal rocks in the Kilpatrick hills, near Glasgow; the basaltic rocks of the Hebrides, and the north of Ireland. In India, in the Deccan trap area, at Poona and in the Western Ghâts.

Peter's Point, Nova Scotia, affords fine specimens of this species. It is there associated with apophyllite, thomsonite, and other species of this family; also at Port George, N. S., in veins sometimes 3 in. thick, and at Margaretville, colored green by copper; also at Digby Neck and Long Point. Also found in good specimens at Phippsburg, Maine; also sparingly at Bradleysville, Litchfield Co., Conn., near a paper-mill in narrow seams in gneiss; and at Southbury, Conn., a little east of the village, on the land of Mr. Stiles; also sparingly at West Rock, New Haven. Abundant in many places in the copper veins of Lake Superior in trap, and on I. Royale; on north shore of Lake Superior, between Pigeon Bay and Fond du Lac. Found also at Bergen Hill, N. J., in diabase, with datolite, apophyllite, etc.; sparingly at Phillipstown, N. Y., in feldspar with stilbite; at the Tilly Foster iron mine, Brewster, N. Y.; at Columbia bridge, near Philadelphia.

*Leonhardite* occurs in a trachytic rock at Schemnitz in Hungary; at Pfitsch in an earthy chlorite, and near Predazzo in the Fleimsthal, Tyrol, in a melaphyre; in the Floitenthal. Also at Copper Falls, Lake Superior region, a variety which alters but little on exposure. *Caporcianite* occurs in geodes with calcite in the gabbro rosso of Monte de Caporciano at l'Impruneta, and other places in Tuscany. It is sometimes accompanied by native copper.

**Ref.**—[1] Mlr., Min., p. 452, 1852; he made $x = 102$, $u = 011$, $r = 111$. The position here taken is that of Dx. (Min., **1**, p. 492, 1862), but the vertical axis has half the length assumed by him. [2] Cf. Mlr., Dx., l. c. [3] J. D. D., on schneiderite from Mte. Catini, Min., p. 400, and f. 381, p. 399, 1868.

### 446. LAUBANITE. H. Traube, Jb. Min., 2, 64, 1887.

In fine fibrous, sometimes spherical, bundles with eccentric radiated structure; resembles stilbite.

H. = 4·5–5. G. = 2·23. Luster dull. Color snow-white, superficially pale yellow with iron oxide. Transparent to translucent.

**Comp.**—$Ca_2Al_2Si_5O_{15} + 6H_2O$ or $2CaO.Al_2O_3.5SiO_2 + 6H_2O$ = Silica 48·2, alumina 16·4, lime 18·0, water 17·4 = 100.

**Anal.**—Traube, l. c.

| $SiO_2$ | $Al_2O_3$ | CaO | MgO | $H_2O$ | |
|---|---|---|---|---|---|
| $\frac{2}{2}$ 47·84 | 16·74 | 16·17 | 1·35 | 17·08 | FeO 0·56 = 99·74 |

**Pyr.**—B.B. fuses to a blebby glass. Decomposed by warm concentrated hydrochloric acid with separation of gelatinous silica.

**Obs.**—Occurs implanted upon phillipsite crystals in basalt at Lauban, Silesia.

## Chabazite Group. Rhombohedral.

**447. Chabazite.** **448. Gmelinite.** **449. Levynite.**

The fundamental rhombohedrons of the species of the Chabazite Group have different angles, but, as shown in the axial ratios on p. 572, they are closely related, since, taking the rhombohedron of Chabazite as the basis, that of Gmelinite has the symbol $\frac{2}{3}(20\bar{2}3)$ and of Levynite $\frac{3}{4}(30\bar{3}4)$.

The variation in composition often observed in the first two species has led to the rather plausible hypothesis that they are to be viewed as isomorphous mixtures of the feldspar-like compounds

$$(Ca,Na_2)Al_2Si_2O_8 + 4H_2O$$
$$(Ca,Na_2)Al_2Si_6O_{16} + 8H_2O$$

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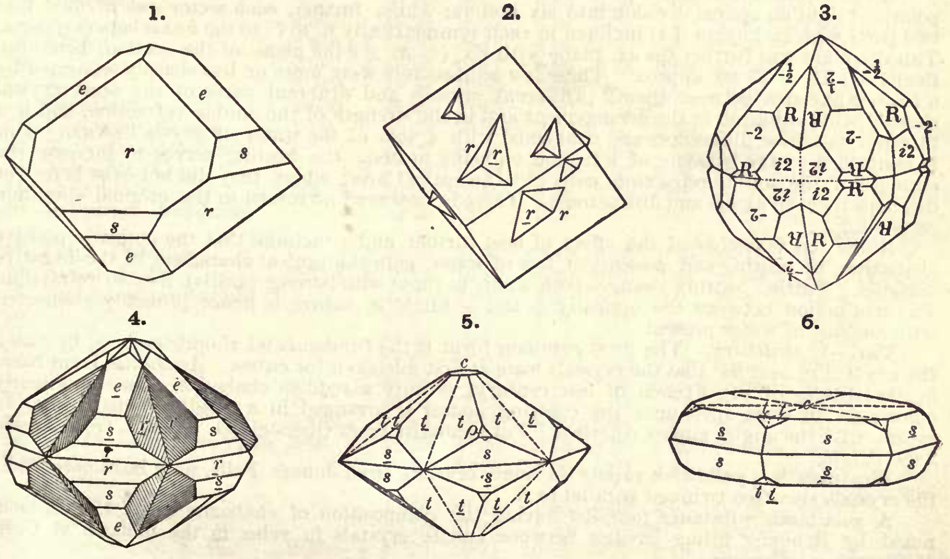
**447. CHABAZITE.** Zeolithus albus cubicus Islandiæ *v. Born*, Lithoph., **1**, 46, 1772. Zeolite en cubes *Faujas*, Volc. Viv., 126, 1778; *de Lisle*, Crist., **2**, 40, 1783. Chabazie (fr. Oberstein) *Bosc d'Antic*, J. d'Hist. N., **2**, 181, 1788. Würfelzeolith pt. (rest analcite) *Wern.*, Emmerling, Min., **1**, 205, 1793. Chabasie (rhombohedral form recognized) *H.*, Tr., **3**, 1801. Chabasin *Karst.*, Tab., 30, 1808. Schabasit *Wern.*, *Hoffm.* Kuboizit *Weiss*, Hoffm. Min., **4**, b, 41, 1818, Mag. Ges. N. Fr., Berlin, **7**, 181, 1816. Adipite *Renevier*, Bull. Soc. Vaud., **16**, 15, 1879. Cabasite *Ital.*

Phakolit *Breith; Tamnau*, Jahrb. Min., 653, 657. 1836. Haydenite *Cleaveland*, Min., 478, 1822. Acadialite *Alger & Jackson* (without publication) = "No Chabasie" *E. Hoffmann*, Am. J. Sc., **30**, 366, 1836; = Acadiolite *Thomson*, Phil. Mag., **22**, 192, 1843; *Hayes*. Am. J. Sc., **1**, 122, 1846. Herschelite *Lévy*, Ann. Phil., **10**, 361, 1825. Seebachite *Bauer*, Zs. G. Ges., **24**, 391, 1872.

Rhombohedral. Axis $\dot{c} = 1{\cdot}0860$; $0001 \wedge 10\bar{1}1 = 51° 25\frac{3}{4}'$ Phillips[1].

**Forms**[2]: *c* (0001, *O*) rare; *a* ($11\bar{2}0$, *i*-2); *r* ($10\bar{1}1$, *R*); *e* ($01\bar{1}2$, $-\frac{1}{2}$), *s* ($02\bar{2}1$, $-2$); *t* ($11\bar{2}3$, $\frac{2}{3}$-2); *o* ($21\bar{3}4$, $\frac{1}{4}^{3}$); *i* ($12{\cdot}1{\cdot}\bar{1}\bar{3}{\cdot}14$, $\frac{11}{14}^{\frac{13}{11}}$)?.

On phacolite also *ρ* ($02\bar{2}3$, $-\frac{2}{3}$) which corresponds in angle to the fundamental rhombohedron of gmelinite.



Figs. 1, 2, Common forms; 2, penetration-twin. 3, Färöer, Tamnau. 4, Bohemia, Sbk.
5, 6, *Phacolite*, Richmond, Victoria, Rath.

*cr* = 51° 26′
*ce* = 32° 5′
*cρ* = 39° 54′

*cs* = 68° 16′
*ct* = 35° 54′
*ee′* = 54° 47′

*rr′* = *85° 14′
*er* = 42° 37′
*ρρ′* = 67° 29′

*ss′* = 107° 7′
*tt′* = 34° 6′
*iiᵛ* = 5° 55′

Twins: (1) tw. axis ć, penetration-twins (f. 2, 3, 4) very common. (2) Tw. pl. *r*, contact-twins, rare. Form commonly the simple rhombohedron varying little in angle from a cube; also *r* and *e*. Faces *r, i, e* striated ‖ intersection-edges; also *a* ‖ edge *a*/*r*. Also amorphous.

Cleavage: *r* rather distinct. Fracture uneven. Brittle. H.=4–5. G.=2·08–2·16. Luster vitreous. Color white, flesh-red; streak uncolored. Transparent to translucent. Optically −; also + (Andreasberg, also haydenite). Double refraction weak. The interference-figure usually confused; sometimes distinctly biaxial; basal sections then divided into sharply defined sectors with different optical orientation. These anomalous optical characters probably secondary and chiefly conditioned by the variation in the amount of water present. Mean refractive index 1·5, Lévy-Lcx.

The optical characters of chabazite have led Becke[3] to a hypothesis of a twinning of triclinic individuals. On this view the chabazite rhombohedron is formed of six or more individuals, each cleavable in three directions, corresponding to the rhombohedral planes, but to be taken as the pinacoids of a triclinic crystal, 100, 010, 001. The angles $\alpha$, $\beta$, $\gamma$, formed on each of these faces, respectively, between the diagonal and the extinction-directions vary for the different localities, but in a typical example (Färöer) were as follows: $\alpha = 22^\circ{\cdot}8$, $\beta = 5^\circ{\cdot}8$, $\gamma = 12^\circ{\cdot}3$. The following angles were also obtained on the cleavage form: $100 \wedge 010 = 83^\circ\ 42'$, $100 \wedge 001 = 85^\circ\ 31\tfrac{1}{2}'$, $010 \wedge 001 = 85^\circ\ 5'$.

These six or more individuals are regarded as united into double twins according to two twinning laws, the tw. planes, 110 and $1\bar{1}0$ (corresponding to faces of the prism of the second series), inclined 118·5° to each other. Three types are distinguished, according as to whether the faces taken as 100, 010, or 001 form the exterior of the pseudo-rhombohedral crystal. These three types are recognized by the angle formed by the extinction-directions in the two halves of a rhombohedral face on either side of the diagonal line. In the first type this angle is about 46°; in the second small, about 11°; in the third about 24°. A basal section shows six sectors with an arrangement of the extinctions in the different parts corresponding to these types, of which, however, the second is rare and not positively identified.

The herschelite of Sicily and seebachite of Richmond differ from chabazite in showing a small axial angle through the terminal plane; moreover, the individuals here are referred to the monoclinic system, twinned in a manner more or less closely analogous to that characterizing the chabazite proper.

Klein has described phacolite from Annerod, a basal section (‖ *c*) of which showed in parallel polarized light an optical division into six sectors; while, further, each sector was divided into two parts with extinction (‖ $\mathfrak{c}$) inclined in each symmetrically 6° to 7° to the *b*-axis between them. This direction was further the ax. plane with $Bx_{\mathfrak{a}}$ ($= \mathfrak{a}$) $\perp$ *c* the plane of the section; hence optically −; $2E = 75$–$80^\circ$ approx. These last semi-sectors were more or less sharply separated by a feather-like area between them. Different crystals and different parts of the same crystal showed wide variation in the arrangement and in the strength of the double refraction, and it is inferred that these differences are connected with a loss of the water of crystallization. This is confirmed by the behavior of a section on being heated: the heating serves to increase the strength of the double refraction, calls out the optical areas where they did not exist before or develops them in extent and distinctness. There is, however, no return to the original condition on cooling.

Rinne has investigated the effect of heat further and concludes that the optically positive chabazites, by heating and consequent loss of water, gain the optical characters of the negative varieties. Further heating changes both kinds to those with strong positive double refraction. The distinction between the optically + and − kinds in nature is hence probably connected with amount of water present.

**Var.**—1. *Ordinary.* The most common form is the fundamental rhombohedron, in which the angle is so near 90° that the crystals were at first mistaken for cubes. *Acadialite*, from Nova Scotia (*Acadia* of the French of last century), is only a reddish chabazite; sometimes nearly colorless. In some specimens the coloring matter is arranged in a tessellated manner, or in layers, with the angles almost colorless. For chabazite from Oberstein G. = 2·092, from Aussig 2·093 Streng.

*Haydenite* is a yellowish variety in small crystals from Jones's Falls, near Baltimore, Md.; the crystals are often twinned parallel to *R*.

A gelatinous substance (*adipite*) having the composition of chabazite (anal. 12) has been noted by Renevier filling cavities between calcite crystals in veins in the molasse at Crêt-Meilloret near Lausanne.

2. *Phacolite* is a colorless variety occurring in twins of mostly a hexagonal form, and often much modified so as to be lenticular in shape (whence the name, from *φακός, a bean*); the original was from Leipa in Bohemia.

Here belongs also herschelite (seebachite) from Richmond, Victoria; the composite twins of great variety and beauty. Probably also the original herschelite from Sicily made orthorhombic by v. Lang (pseudo-hexagonal by twinning). It occurs in flat, almost tabular, hexagonal prisms with rounded terminations divided into six sectors.

**Comp.**—Somewhat uncertain, since a rather wide variation is often noted even among specimens from the same locality. The ratio of $(Ca,Na_2,K_2) : Al$ is nearly constant (= 1 : 1), but of $Al_2 : Si$ varies from 1 : 3 to 1 : 5; the water also increases with the increase in silica. The composition usually corresponds to $(Ca,Na_2)Al_2Si_4O_{12} + 6H_2O$ which, if calcium alone is present, requires: Silica 47·4, alumina 20·2, lime 11·1, water 21·3 = 100. If $Ca : Na_2 = 1 : 1$, the percentage composition is: Silica 47·2, alumina 20·0, lime 5·5, soda 6·1, water 21·2 = 100.

Potassium is also present in small amount, and the Oberstein mineral contains both barium and strontium (0·48 BaO, 0·32 SrO Schröder). Streng (Ber. Oberhess. Ges., **16**, 74, 1877) explains the supposed facts most satisfactorily by the hypothesis that the members of the group are isomorphous mixtures, analogous to the feldspars of

$$\begin{cases} m(Ca,Na_2)Al_2Si_2O_8 + 4H_2O \\ n(Ca,Na_2)Al_2Si_6O_{16} + 8H_2O \end{cases}$$

If $m : n = 1 : 1$, this is equivalent to the formula above given.

**Anal.**—1–3, Burkhardt and Hammerschlag (Streng, l. c.). 4, Lemberg, Zs. G. Ges., **28**, 556, 1876. 5, 6, Rg., Min. Ch. Erg., pp. 57, 61, 1886. 7, 8, Hersch, Inaug. Diss., Zürich, 1887. 9, Mean of three closely agreeing analyses by Holmquist, Steenberg, Ferré, quoted by Widman, G. För. Förh., **12**, 25, 1890. 10, Sansoni, Att. Soc. Tosc., **4**, 316, 1879. 11, Koch, Zs. G. Ges., **28**, 304, 1876. 12, Bischoff, quoted by Renevier, l. c. 13, Hayes, Am. J. Sc., **1**, 122, 1846. 14, Hillebrand, U. S. G. Surv., Bull. **20**, 23, 1885. 15, Sadtler, Am. Ch. J., **4**, 356, 1882. 16, Morse and Bayley, ib., **6**, 24, 1884.

17, Rg., Pogg., **62**, 149, 1844. 18, Burkhardt and Hammerschlag, l. c. 19, Kerl, Zs. G. Ges., **24**, 393, 1872. 20, Lepsius, ib., **25**, 351, 1873. 21–23, Pittman, Ulrich, Contr. Min. Victoria, 65, 1870. 24, Rath, Pogg., **158**, 397, 1876. 25, Hersch, l. c. 26, Dmr., Ann. Ch. Phys., **14**, 97, 1845. 27, Walt., Vulk. Gesteine, 261, 1853. 28, Lemberg, Zs. G. Ges., **28**, 547, 1876. 29, Lsx., Zs. Kr., **5**, 341, 1881. 30, Helms, Liversidge Min. N. S. W., 189, 1888.

| | G. | | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Nidda | 2·133 | $\frac{6}{6}$ | 46·35 | 20·52 | 10·83 | — | 0·21 | 22·09 | = 100 |
| 2. Annerod | | $\frac{8}{8}$ | 48·93 | 18·19 | 6·64 | 0·92 | 2·06 | 22·04 | $Fe_2O_3$ 1·22 = 100 |
| 3. Altenbuseck | | $\frac{4}{4}$ | 50·75 | 16·06 | 6·65 | 1·38 | 2·27 | 21·46 | $Fe_2O_3$ 1·43 = 100 |
| 4. Aussig | | | 47·50 | 20·00 | 10·20 | 0·23 | 1·24 | 21·40 | = 100·57 |
| 5. " | | $\frac{4}{4}$ | 48·32 | 18·81 | 10·24 | — | 1·92 | 21·48 | = 100·77 |
| 6. Oberstein | | | 50·10 | 16·45 | 8·69 | 0·30 | 1·06 | 21·07 | BaO 1·89 = 99·56 |
| 7. " | 2·081 | | 49·28 | 18·52 | 9·36 | 0·72 | — | 22·02 | BaO,SrO *tr.* = 99·90 |
| 8. Färöer | 2 058 | $\frac{2}{2}$ | 47·36 | 20·13 | 8·09 | 1·99 | — | 22·54 | = 100·11 |
| 9. " | 2·092 | $\frac{3}{3}$ | 45·85 | 19·83 | 8·86 | 2·35 | 0·63 | 22·26[a] | = 99·78 |
| 10. Elba | 2·119 | | 49·49 | 20·35 | 7·50 | *tr.* | *tr.* | 20·62 | = 97·96 |
| 11. Csódiberg | 2·056 | | 49·96 | 18·53 | 7·80 | 1·96 | | 20·77 | = 99·02 |
| 12. Lausanne, *Adipite* | 2·09 | | 48·39 | 20·49 | 3·57 | — | 2·79 | 21·62 | MgO 3·14 = 100 |
| 13. N. Scotia, *Acadialite* | | | 52·02 | 17·88 | 4·24 | 4·07 | 3·03 | 18 30 | = 99·54 |
| 14. Table Mt., Col. | | $\frac{2}{2}$ | 47·52 | 19·48 | 10·06[b] | 0·52 | 0·36 | 22·11 | = 100·05 |
| 15. Fritz Is., Pa. | 2·3 | | 50·28 | 17·83 | 6·96 | 2·43 | 2·40 | 20·21 | MgO 0·22 = 100·33 |
| 16. Baltimore, *Haydenite* | | | 49·24 | 18·07 | 5·16 | — | 3·00 | 21·31 | BaO 1·47, $FeO_2O_3$ 0 84, MgO 0·86 = 99·95 |
| 17. Leipa, *Phacolite* | | $\frac{2}{2}$ | 46·33 | 21·87 | 10·40 | 0·95 | 1·29 | [19·16] | = 100 |
| 18. Annerod " | 2·116 | $\frac{6}{6}$ | 46·82 | 19·29 | 10·29 | 0·70 | 0·40 | 22·36 | $Fe_2O_3$ 0·14 = 100 |
| 19. Richmond, *Seebachite* | | | 43·7 | 21·8 | 8·5 | 3·5 | *tr.* | 22·2 | = 99·7 |
| 20. " " | | | 44·77 | 22·10 | 7·51 | 8·18 | — | 22·07 | = 99·63 |
| 21. " " | | | 45·33 | 22·22 | 7·11 | 5·54 | 0·97 | 18·67 | = 99·84 |
| 22. " " | | | 46·05 | 22·07 | 7·06 | 5·48 | 0·72 | 19·25 | = 100·63 |
| 23. " " | | | 46·26 | 23·04 | 7·02 | 5·96 | 0·09 | 18·52 | = 100·89 |
| 24. " " | 2·135 | | 46·08 | 21·09 | 5·75 | 4·52 | 1·77 | 21·08 | = 100·29 |
| 25. " " | 2·162 | | 43·84 | 20·99 | 5·89 | 5·78 | 1·83 | 21 97 | = 100·30 |
| 26. Aci Castello, *Herschelite* | 2·06 | $\frac{2}{2}$ | 47·39 | 20·90 | 0·38 | 8·33 | 4·39 | 17·84 | = 99·23 |
| 27. " " " | | | 47·03 | 20·21 | 4·66 | 4·82 | 2·03 | 17·86 | $Fe_2O_3$ 1·14, MgO 0·50 = 98·25 |
| 28. " " " | | | 46·46 | 20·24 | 1·03 | 8·95 | 3·87 | 19·45 | = 100 |
| 29. " " " | | | 47·15 | 21·42 | 5·34 | [6·69] | | 19·40 | = 100 |
| 30. Invernell, N. S. W. | 2·10 | $\frac{2}{2}$ | 47·70 | 19·31 | 10·85 | 0·39 | 1·18 | 20·67 | MgO 0·43 = 100·53 |

[a] In desiccator 3·64 (= 1 $H_2O$), at red heat 18·62 p. c. [b] Incl. SrO 0·43.

Richmond phacolite loses 2 molecules $H_2O$ over calcium chloride after a week, Hintze, Zs. Kr., **10**, 276, 1885.

According to Damour, crystals from Dyrefiord, Iceland, and Rübendörfel, Bohemia, lost 7·2 p. c. after 5 months in dried air; after some months in the free air again regained this, and also an excess of 0·15 p. c. Heated for 1 hour to 100° C., the loss was 2·75 p. c.; to 180°, 14

p. c.; to 230°, 17 p. c.; to 300°, 19 p. c.; this loss was reduced to zero in 3 days; at a dull red heat, the loss was 21 p. c., and the mineral was no longer hygroscopic; at a bright red, it lost 22·4 p. c., intumesced, and was partially fused.

Phacolite lost 7 p. c. after 7 months in dried air; and 4 months after, in an atmosphere saturated with moisture, it had an excess of 12·5 p. c., which it lost very nearly again in ordinary air. Heated to 100° C., the loss was 3·7 p. c.; to 210°, 15·7 p. c.; to 290°–360°, 18 p. c.; and after 48 hours' exposure to the free air, the amount lost was restored. At a dull red heat, the loss was 22·2 p. c.; at a bright red, 22·8 p. c., and the material was fused to a blebby enamel.

Rg. gives as the loss to 300° 17·1 to 19·5 p. c.

The mean results obtained by Burkhardt and Hammerschlag (quoted by Streng, l. c.) are:

| 100° | 200° | 300° | ign. | strong ign. |
|---|---|---|---|---|
| 4·73 | 9·53 | 14·55 | 21·03 | 22·39 |
| 3·99 | 10·90 | 14·93 | 20·13 | 21·78 |
| 4·06 | 11·31 | 15·02 | 21·24 | 22·50 |
| 4·69 | 11·82 | 15·16 | 21·14 | 22·62 |

Hersch's results after 2 hours' heating in each case are as follows:

For *Chabazite:*

| Temp. | 102° | 125° | 155° | 195° | 240° | 260° | 290° | red ht. |
|---|---|---|---|---|---|---|---|---|
| $H_2O$ | 5·77 | 6·51 | 9·22 | 11·29 | 13·55 | 14·44 | 14·81 | 22·47 p. c. |

For *Phacolite:*

| Temp. | 100° | 150° | 195° | 240° | 285° | 320 | red ht. |
|---|---|---|---|---|---|---|---|
| $H_2O$ | 6·21 | 9·81 | 13·78 | 17·61 | 18·78 | 18·91 | 21·97 p. c. |

**Pyr., etc.**—B.B. intumesces and fuses to a blebby glass, nearly opaque. Decomposed by hydrochloric acid, with separation of slimy silica.

**Obs.**—Chabazite occurs mostly in basaltic rocks, and occasionally in gneiss, syenite, mica schist, hornblendic schist.

Occurs at the Färöer Islands, Greenland, and Iceland, associated with chlorite and stilbite; at Aussig in Bohemia, in a kind of greenstone (the *graustein* of Werner); at Oberstein, with harmotome; at Annerod, near Giessen; at the Giant's Causeway, Antrim, Kilmalcolm, Renfrewshire (some an inch across); Isle of Skye, etc.; Poona, near Bombay, India, but rare.

*Phacolite* occurs at Leipa in Bohemia; also at Salesl and Wannow, in Bohemia; in Antrim, Ireland, at Giant's Causeway.

*Herschelite* accompanies phillipsite in a lava at Aci Castello, near Aci Reale, Sicily; also at Cyclops, Catania; in basalt near Richmond, Victoria, Australia (*seebachite*), the crystals in mode of twinning and in optical properties like the Sicilian.

Both massive and incrusted at the Paugatuck stone-quarry, Stonington, Conn., with scapolite, titanite, and apatite; also yellowish red in North Killingworth, on the Essex turnpike; at Hadlyme, Conn., on gneiss; sparingly at Branchville in a pegmatyte vein with chlorite, etc.; in syenite at Somerville, Mass., also at Chester, Mass., in amygdaloid; at Bergen Hill, N. J., in small crystals; in the same rock at Piermont, N. Y.; in fissures in hornblendic gneiss at Jones's Falls, near Baltimore (*haydenite*), with heulandite. Phacolite has been reported from New York Island.

In Nova Scotia, wine-yellow or flesh-red (the last the *acadialite*), associated with heulandite, analcite, and calcite, at Five Islands, Swan's Creek, Digby Neck, Mink Cove, William's Brook.

At Husavic, Iceland, fossil clam shells (Venus) occur in a recent deposit, lined within with small rhombohedrons of chabazite. Daubrée states that crystals occur at the warm springs of Luxeuil, Dept. of Haute Saône, France, as well as at those of Plombières, under conditions which indicate that they were formed through the agency of the warm waters; the temperature at Luxeuil is 115° F., and at Plombières 163° F. Also a recent formation at Bourbonne-les-Bains and at Oran, Algiers.

The name *Chabazite* is from χαβᾶζιος, an ancient name of a stone. *Herschelite* after Sir John F. W. Herschel (1792–1871). *Seebachite* after Karl von Seebach, a German mineralogist (1839–1878).

**Alt.**—The haydenite is often covered with chlorite, and sometimes chlorite takes the place of the crystal.

Altered crystals from the Vogelsgebirge have been analyzed by Suckow, 5th Ed., p. 436.

*Doranite* of Thomson may be altered chabazite, if the analysis is not an incorrect one of the unaltered mineral. Found in basalt, 2 m. W. of Carrickfergus, Co. Antrim. Cf. 5th Ed., p. 436.

**Artif., etc.**—Obtained by Doelter (1) by recrystallization in water containing carbon dioxide; the powdered mineral was digested in a closed tube for 9 days at 150°, and minute rhombohedral crystals obtained. (2) Also with similar result by direct synthesis of freshly precipitated silica, alumina, also calcium hydrate placed in carbonated water and kept for a long time at 200° in a sealed tube. By the fusion and slow cooling of chabazite, anorthite was obtained. Jb. Min., 1, 124, 1890.

Lemberg describes the conversion of normal chabazite into the corresponding barium and potassium compounds by slow digestion with solutions of barium chloride and potassium chloride; also the resubstitution by the action of calcium chloride, Zs. G. Ges., **28**, 556, 1876.

**Ref.**—[1] Min., 138, 1823, this angle varies somewhat widely, and seldom admits of exact measurement. [2] Cf. Tamnau, Inaug. Diss., Stuttgart, 1836. Also Dx., Min., **1**, 407, 1862; Streng, Oberhess, Ges., **16**, 74, 1877; Becke, Min. Mitth., **2**, 391, 1879; Gdt., Index, **1**, 407, 1886. Gdt. with Streng includes also gmelinite and levynite. The symbol of the striated vicinal scalenohedron *i* (Ph.) is doubtful.

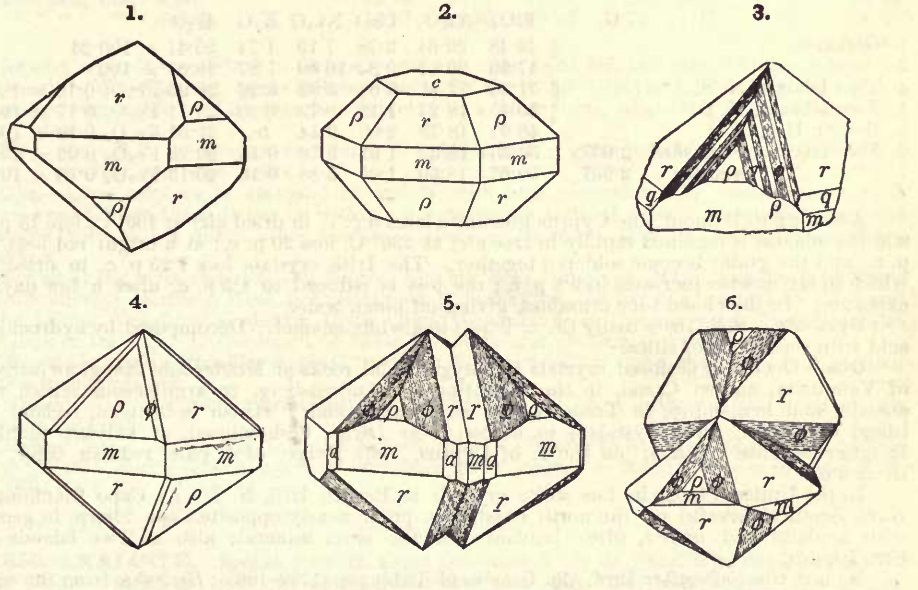
On the form of phacolite, herschelite, seebachite, see: Lang, Phil. Mag., **28**, 506, 1864; Ulrich, Contrib. Min. Victoria, 1870; Rath, Pogg., **158**, 387, 1876; Lsx., l. c.

[3] On the optical phenomena, cf. Brewster, Phil. Trans., p. 93, 1830, Phil. Mag., **9**, 170, 1836, Johnston, ib., p. 166; Dx., l. c.; Streng, l. c., Lang, Rath, l. c.; Becke, Min. Mitth., **2**, 391, 1879. Also Lsx., Sicilian herschelite, Zs. Kr., **5**, 338, 1881; Klein, Ber. Ak. Berlin, 703, 1890, and Jb. Min., **1**, 96, 1891; Rinne, Ber. Ak. Berlin, 1192, 1890.

**448. GMELINITE.** Sarcolite *Vauq.*, Ann. Mus., **9**, 249, 1807, **11**, 42. Hydrolithe *Leman*, Cat. Min. de Drée, 18, 1811. Gmelinite *Brooke*, Ed. J. Sc., **2**, 262, 1825. Ledererite *C. T. Jackson*, Am. J. Sc., **25**, 78, 1834. Natronchabazit *Germ.*

Rhombohedral. Axis $\dot{c} = 0{\cdot}7345$; $0001 \wedge 10\bar{1}1 = 40° \; 18\tfrac{1}{6}'$ Pirsson[1].

**Forms**[2]:
$c$ $(0001, O)$ rare
$m$ $(10\bar{1}0, I)$
$a$ $(11\bar{2}0, i\text{-}2)$
$l$ $(52\bar{7}0, i\text{-}\tfrac{7}{5})^4$
$r$ $(10\bar{1}1, R)$
$\rho$ $(01\bar{1}1, -1)$
$q$ $(30\bar{3}2, \tfrac{3}{2})^4$ tw. pl.
$\xi$ $(11\bar{2}2, 1\text{-}2)$
$\chi$ $(51\bar{6}6, \tfrac{5}{6}\tfrac{6}{5})^3$
$\phi$ $(43\bar{7}7, \tfrac{1}{7}\tfrac{7}{})^4$



Figs. 1, 2, Cape Blomidon, N. Scotia. 3–6, Pinnacle Is., N. Scotia, Pirsson; these are drawn with ρ (01$\bar{1}$1) in front.

$cr = 40° \; 18'$
$mr = 49° \; 42'$
$c\xi = 36° \; 18'$
$c\chi = 38° \; 6'$
$c\phi = 36° \; 23\tfrac{1}{2}'$
$rr' = {}^*68° \; 8'$
$r\rho = 37° \; 44'$
$\xi\xi' = 34° \; 26'$
$\chi\chi^{v} = 11° \; 2'$
$\phi\phi^{v} = 29° \; 21\tfrac{1}{2}'$
$r\phi = 16° \; 4\tfrac{1}{2}'$
$\rho\phi = 21° \; 40'$
$r\chi = 6° \; 2'$
$\rho\chi = 31° \; 42'$
$cq = 51° \; 57\tfrac{1}{2}'$

Twins: (1) tw. pl. *q* (30$\bar{3}$2) which corresponds in angle to the fundamental rhombohedron of the related species chabazite, see f. 6. (2) tw. axis $\dot{c}$, penetration- or contact-twins (f. 5) analogous to those of chabazite.

Crystals usually hexagonal in aspect: sometimes ρ smaller than *r*, and habit rhombohedral; *m* often horizontally striated; ρ often enclosed by the striated or channeled faces of the scalenohedron $\phi$ as in f. 5; sometimes in oscillatory combination with $r$ as in f. 3. Faces $\mathcal{E}$ striated ‖ edge $\mathcal{E}/r$ and often grooved, similarly to $\phi$.

Cleavage: *m* easy; *c* sometimes distinct. Fracture uneven. Brittle. H. = 4·5. G. = 2·04–2·17. Luster vitreous. Colorless, yellowish white, greenish white, reddish white, flesh-red. Transparent to translucent. Optically positive, Cyprus, also negative, Andreasberg, the Vicentine, and Glenarm, N. Scotia. Double refraction very weak. Interference-figure often disturbed, and basal sections divided optically into section analogous to chabazite. Refractive indices, Pirsson [1]:

| | | | |
|---|---|---|---|
| Nova Scotia | $\omega_y = 1{\cdot}4760$ | 1·4646 | 1·4770 Na |
| | $\epsilon_y = 1{\cdot}4674$ | 1·4637 | 1·4765 |

Montecchio Maggiore $\omega_y = 1{\cdot}48031$ $\epsilon_y = 1{\cdot}47852$ Negri.[3]

**Comp.**—In part $(Na_2,Ca)Al_2Si_4O_{12} + 6H_2O$. If sodium alone is present this requires: Silica 46·9, alumina 19·9, soda 12·1, water 21·1 = 100.

The above corresponds to anal. 1 (in which some lime is also present); other analyses show more silica which has been ascribed to the presence of free silica, but, as Pirsson shows, is explained by Streng's hypothesis (p. 591), the albite-like compound being present in relatively large amount.

**Anal.**—1, Rg., Pogg., **49**, 211, 1840. 2, Lemberg, Zs. G. Ges., **28**, 547, 1876. 3–5, Howe, Am. J. Sc., **12**, 270, 1876. 6, 7, Pirsson, ibid., **42**, 62, 1891.

| | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. Glenarm | $\frac{2}{2}$ | 46·48 | 20·64 | 3·78 | 7·19 | 1·74 | 20·41 = 100·24 |
| 2. " | | 47·96 | 20·47 | 0·83 | 10·00 | 1·87 | 18·87 = 100 |
| 3. Two Islands, N. S. | $\frac{2}{2}$ | 51·36 | 17·81 | 5·68 | 3·92 | 0·23 | 20·96 $Fe_2O_3$ 0·15 = 100·11 |
| 4. Five Islands, N. S. | $\frac{2}{2}$ | 50·45 | 18·27 | 1·12 | 9·79 | 0·20 | 20·71 $Fe_2O_3$ 0·17 = 100·71 |
| 5. Bergen Hill, N. J. | | 48·67 | 18·72 | 2·60 | 9·14 | *tr.* | 21·35 $Fe_2O_3$ 0·10 = 100·58 |
| 6. Five Islands, *outer shell* | 2·037 | 50·35 | 18·33 | 1·01 | 9·76 | 0·15 | 20·23 $Fe_2O_2$ 0·26 = 100·09 |
| 7. " " *nucleus* | 2·037 | 50·67 | 18·50 | 1·05 | 9·88 | 0·16 | 20·15 $Fe_2O_3$ 0·15 = 100·56 |

Acording to Damour, the Cyprus gmelinite loses 6 p. c. in dried air; at 100° C. loss 13 p. c., and the amount is regained rapidly in free air; at 230° C. loss 20 p. c.; at a bright red heat 21·5 p. c., and the grains become soldered together. The Irish crystals lose 7·25 p. c. in dried air, which in six months increases to 9·3 p. c.; the loss is reduced to 1·5 p. c. after a few days of exposure. In the closed tube crumbles, giving off much water.

**Pyr., etc.**—B.B. fuses easily (F. = 2·5–3) to a white enamel. Decomposed by hydrochloric acid with separation of silica.

**Obs.**—Occurs in flesh-red crystals in amygdaloidal rocks at Montecchio Maggiore (*sarcolite* of Vauquelin) and at Castel, in the Vicentine; at Andreasberg, in argillaceous schist, with analcite and heulandite; in Transylvania; at Glenarm and Portrush in Antrim, Ireland; the island of Magee, some crystals ½ in. across; near Larne, flesh-colored; at Talisker in Skye, in large colorless crystals; on the I. of Cyprus, near Pyrgo, of a pale reddish color, and G. = 2·07.

In the United States in fine white crystals at Bergen Hill, N. J. At Cape Blomidon in Nova Scotia (*ledererite*) on the north coast, at a point nearly opposite Cape Sharp, in geodes, with analcite and quartz, often implanted on the latter mineral; also at Two Islands and Five Islands.

Named *Gmelinite* after Prof. Ch. Gmelin of Tübingen (1792–1860); *Hydrolite* from the water present; *Ledererite* after Baron Lederer, Austrian Consul at New York (d. 1842). The name hydrolite has the priority, but is objectionable because the mineral is not so eminently hydrous as to make it deserving of the appellation.

**Ref.**—[1] Pirsson, Nova Scotia, Am. J. Sc., **42**, 57, 1891. Des Cloizeaux gives for crystals from Andreasberg $mr = 50° 3'$, $rr = 67° 34'$, Min., **1**, p. 396, 1862. Streng (l. c.) shows that the forms may be referred to the chabazite rhombohedron ($rr' = 85° 16'$), since $\dot{c}$ (chabazite) = $\frac{3}{2}\dot{c}$ gmelinite; $r$ then becomes $20\bar{2}3$ ($\frac{2}{3}R$). Notwithstanding the close relation of the two species it is most unnatural to merge them in one.

[2] Cf. also Tamnau, Inaug. Diss., 1836; Guthe, Hannover Nat. Ges., **20**, 52, 1871. [3] Negri, Montecchio Maggiore, Riv. Min. Ital., **2**, 3, 1887. [4] Pirsson, Five Islands, N. Scotia, l. c.

GRODDECKITE *Arzruni*, Zs. Kr., 8, 343, 1883. Near gmelinite in form and composition. Axis $\dot{c} = 0{\cdot}7252$. In rhombohedral crystals, $mr = 50° 3\frac{1}{2}'$, $rr' = 67° 33'$; showing also a scalenohedron with terminal angles 67° 1' and 4° 30'. Cleavage: *m* indistinct. H. = 3–4. Luster vitreous. Colorless, transparent. An analysis on 0·056 gr. gave Broockmann:

$SiO_2$ 51·2 $Al_2O_3$ 12·0 $Fe_2O_3$ 7·7 CaO 1·1 MgO 3·3 $Na_2O$ [4·5] $H_2O$ 20·2 = 100

Known from a single specimen only, obtained at Andreasberg in the Harz, in 1867; the small crystals cover calcite crystals.

Named after von Groddeck, director of the Bergakademie at Clausthal.

**449. LEVYNITE.** Levyne *Brewster*, Ed. J. Sc., **2**, 332, 1825. Mesolin *Berz.*, Ed. Phil. J., **7**, 6, 1822.

Rhombohedral. Axis $\dot{c}$ = 0·8357; 0001 ∧ $10\bar{1}1$ = 43° 58¾′ Haidinger.[1]

**Forms**[1]: *c* (0001, *O*); *r* ($10\bar{1}1$, *R*); *s* ($02\bar{2}1$, − 2), *h* ($03\bar{3}1$, — 3). *cs* = 62° 37′, *ch* = 70° 57′, *ss′* = *100° 31′, *hh′* = 109° 53′, *rs* = 50° 16′, *rr′* = 73° 56′.

Twins: tw. pl. *c*, as penetration-twins. Faces *r*, *s* striated edge *r*/*s*; *c* uneven and usually rounded. Crystals often in druses.

Cleavage: *s* indistinct. Fracture subconchoidal. Brittle. H. = 4–4·5. G. = 2·09–2·16. Luster vitreous. Colorless, white, grayish, greenish, reddish, yellowish. Transparent to translucent. Optically negative. Double refraction strong.

**Comp.**—$CaAl_2Si_3O_{10} + 5H_2O$ = Silica 49·2, alumina 10·9, lime 11·5, water 18·4 = 100.

**Anal.**—1, Damour, Ann. Mines, **9**, 333, 1846. 2, 3, Hillebrand, U. S. G. Surv., Bull. **20**, 37, 1885.

| | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|
| 1. Iceland | ⅜ 44·48 | 23·77 | 10·71 | 1·38 | 1·61 | 17·41 | = | 99·36 |
| 2. Table Mt., Col., *cryst.* | 46·76 | 21·91 | 11·12 | 1·34 | 0·21 | 18·65 | = | 99·99 |
| 3. " " " *fibrous* | 46·97 | 22·39 | 10·85 | 0·79 | 1·17 | 18·03 | = | 100·20 |

Iceland crystals, according to Damour, lose 4 p. c. in dried air, and regain all again soon in the free air. When heated, begin to lose water at 70° C.; at 225° the loss is 12 to 13 p. c.; remain hygroscopic up to 360°. The loss is completed at a white heat, when the mineral is a white blebby glass.

**Pyr., etc.**—B.B. intumesces and fuses to a white blebby glass, nearly opaque. Gelatinizes with hydrochloric and nitric acids.

**Obs.**—Lines cavities in amygdaloid, and is, with rare exception, the "*sole tenant* of its druses, even though these druses be within a quarter of an inch of others containing chabazite associated with half a dozen other zeolites" (Heddle); it shows thus its distinctiveness from chabazite.

Found at Glenarm and at Island Magee, Antrim; near Dungiven, Magilligan, and elsewhere in Londonderry; Hartfield Moss, near Glasgow; at Dalsnypen, Färöer (the original locality) and on the Island Waagö; at Godhavn, Disco Island, Greenland; at Onundarfiord, Dyrefiord, and elsewhere in Iceland. In the basalt of Table Mountain near Golden, Colorado.

*Mesolin* is a white granular mineral from the Färöer, which may be chabazite; it fills small cavities in amygdaloid.

Named after the mineralogist and crystallographer A. Lévy, author of the work on the Heuland Cabinet.

**Ref.**—[1] Ed. J. Sc., 2, 332, 1828. The form may be referred to the chabazite rhombohedron (*rr′* = 85° 16′), since $\dot{c}$ (chabazite) = $\frac{4}{3}\dot{c}$ levynite approx., then *r* = $30\bar{3}4$ (¾ *R*), *s* = $03\bar{3}2$ (− $\frac{3}{2}$ *R*), *h* = $09\bar{9}4$ (− $\frac{9}{4}$ *R*).

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**450. ANALCITE.** Zeolite dure (fr. Etna) *Dolomieu*, F. de St. Fond Min. des Volcans, 198, 1784. Würfelzeolith pt. [rest Chabazite] *Emmerling*, Min., 205, 1793; Lenz, 1, 241, 1794. [Form, f. 9, described.] Zeolite cubique, Z. leucitique, *Delameth.*, T. T., 2, 307, 308, 1797. Analcime *H.*, Tr., 3, 1801. Analcite *Gallitzin*, Dict. Min., 12, 1801. Kubizit *Wern.*, 1803, Ludwig's Min., 2, 210, 1804. Analzim *Wern.*, Letzt. Min. Syst., 6. Kuboit *Breith.*, Char., 153, 1832 (Analzim, p. 127). Eutalith *Esmark*. Euthalite *Dx.*, Min., **2**, p. xxxix, 1874. Euthallite. Eudnophit *Weibye*, Pogg., **79**, 303, 1850.

Isometric. Observed forms[1]:

*a* (100, *i-i*) *d* (110, *i*) *o* (111, 1) *r* (332, $\frac{3}{2}$)[2] *n* (211, 2-2) *ω* (*hll*, *m-m*)[3].

Usually in trapezohedrons (f. 1); also in cubes with planes *n* (f. 3); again the cubic faces replaced by the vicinal trisoctahedron *ω*. Sometimes in composite groups (f. 2) about a single crystal as nucleus (f. 4). Also massive granular; compact with concentric structure.

Cleavage: cubic, in traces. Fracture subconchoidal. Brittle. H. = 5–5·5.

G. = 2·22–2·29; 2·278 Thomson. Luster vitreous. Colorless, white; occasionally grayish, greenish, yellowish, or reddish white. Transparent to nearly opaque. Often shows weak double refraction which is connected with loss of water and consequent change in molecular structure. Refractive index: $n_r = 1·4874$, Cyclopean Is., Dx.[3]

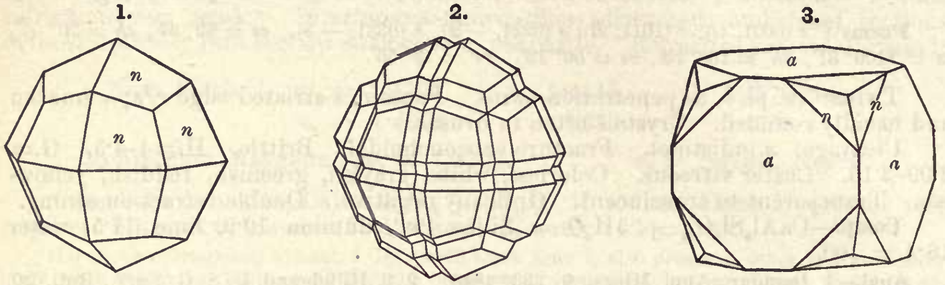
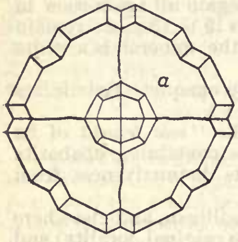


Fig. 1, Common form. 2, 4, Phœnix mine, L. Superior, Penfield. 3, Cyclopean Is., Fassathal.

The question of the optical anomalies of analcite (early noted by Brewster) and the system to which it should be referred, has been discussed by many authors[4]. Schrauf on crystallographic grounds referred crystals from Friedeck, Bohemia, to the orthorhombic system, describing them as complex twins, analogous to leucite. Mallard described in detail the optical anomalies of the species, and explained them by assuming that a crystal was formed by the interpenetration of three pseudo-tetragonal individuals, each one formed of two orthorhombic crystals, with nearly equal axes; these 24 orthorhombic crystals, composing a single pseudo-isometric crystal, would correspond to the 24 planes of a tetrahexahedron.

4.



The whole subject was exhaustively reviewed and further investigated by Ben Saude. He described the results of an optical examination of sections of many crystals cut parallel to the cubic, octahedral, dodecahedral, and trapezohedral planes, and showed that they do not correspond with Mallard's hypothesis, but can be explained on the supposition of internal tension. He found, further, that gelatine cast into moulds corresponding to the crystalline forms acquired on solidifying similar optical characters. He further showed that the effect of heat was to increase the strength of the double refraction or to call it out in parts before isotropic. Klein went far to explain this fact and the double refraction in general by proving that heated in an atmosphere of water vapor or in hot water analcite became isotropic, while dry heat increased the double refraction. The optical anomalies, then, are immediately connected with the loss of water and the change in molecular arrangement resulting from that.

Rinne has also investigated the effect of heat; he calls the form resulting from ignition a triclinic soda-leucite; optically determined, each of the pseudo-quadratic chief sectors, whose axes coincide with the cubic axes, is made up of four sectors with the bisectrix (−) of each inclined about 4° to these axes. An analogy is suggested in optical character and molecular symmetry between ordinary potash-leucite and this soda-leucite on the one hand, and monoclinic potash feldspar and triclinic soda feldspar, albite, on the other.

**Comp.**—$NaAlSi_2O_6 + H_2O = Na_2O.Al_2O_3.4SiO_2.2H_2O$ = Silica 54·5, alumina 23·2, soda 14·1, water 8·2 = 100.

Doelter writes the formula $H_2NaAlSi_2O_7$ or $NaAlSiO_4 + 2H_2SiO_3$, arguing that the water cannot be water of crystallization.

*Picranalcime* of Meneghini and Bechi (Am. J. Sc., **14**, 62, 1852), supposed to contain 10 p. c. MgO, is nothing but ordinary analcite as shown by Bamberger, anal. 7.

**Anal.**—1, Ricciardi & Speciale [Gazz. Ch. Ital., 359, 1881], Zs. Kr., **8**, 309, 1883. 2, 3, Nikolayev [Russ. Berg.-J., **2**, 376, 1881], Zs. Kr., **11**, 392, 1886. 4, Sauer, Zs. Kr., **11**, 412, 1886. 5, Lemberg, Zs. G. Ges., **28**, 539, 1876. 6, Preis & Vrba, Ber. Böhm. Ges., 467, 1879. 7, Bamberger, Zs. Kr., **6**, 32, 1881. 8, Luedecke, Zs. Kr., **7**, 91. 1882. 9, Lorenzen, Medd. Grönl., **7**, 1884. 10, Paijkull, Inaug. Diss., p. 14, Upsala, 1875. 11, Johnsson, quoted by Bgr., Zs. Kr., **16**, 584, 1890. 12, Langlet, ibid. 13, Bgr., l. c. 14, Hersch, Inaug. Diss., p. 19, Zürich, 1887. 15–17, Young, Ch. News, **27**, 56, 1873. 18, Hillebrand, U. S. G. Surv., Bull. **20**, 29, 1885. 19, Harrington, Geol. Canada, 45 G, 1878. 20, Pisani, Dx., Min., **2**, p. xxxix, 1874. 21, Borck, and 22. Berlin, Pogg., **79**, 304, 1850. 23, Damour, Bull. Soc. Min., **4**, 239, 1881.

| | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Etna | 2·21 | 54·39 | 22·86 | 1·67 | 10·56[a] | 2·00 | 8·18 | MgO 0·38 = 100·04 |
| 2. Blagodatsk, *Cuboite* | 2·277 | 54·42 | 22·89 | 0·87 | 13·00 | — | 8·13 | $Fe_2O_3$ 0·40, MgO *tr.* = 99·71 |
| 3. “ *mass.* | 2·481 | 55·28 | 21·21 | 3·70 | 8·93 | 2·73 | 5·01 | $Fe_2O_3$ 0·93, MgO 0·39 = 98·18 |
| 4. Wiesenthal | 2·259 | 54·72 | 23·12 | 0·36 | 12·30 | 0·79 | 8·25 | $Fe_2O_3$ 0·60 = 100·14 |
| 5. Fassathal | | 56·32 | 22·00 | 0·51 | 13·19 | — | 8·80 | = 100·82 |
| 6. Kuchelbad | | 54·76 | 23·64 | 0·33 | 13·52 | — | 8·53 | $CO_2$ 0·12 = 100·90 |
| 7. Mte. Catini | 2·222 | 57·08 | 21·51 | — | 13·63 | 0·32 | 8·32 | = 100·86 |
| 8. Heldburg | 2·343 | 53·92 | 24·60 | — | 12·23 | 1·30 | 8·50 | = 100·55 |
| 9. Kangerdluarsuk | | 54·80 | 23·61 | — | 14·52 | — | 8·25 | = 101·18 |
| 10. “Brevik” | | 53·39 | 23·17 | — | 14·52 | 0·12 | 9·02 | $Fe_2O_3$ 0·35 = 100·57 |
| 11. Lille Arö | | 53·70 | 24·10 | 0·44 | 15·06 | — | 8·35 | = 101·65 |
| 12. “ “ | | 53·00 | 23·59 | 0·02 | 15·22 | — | 8·00 | = 99·83 |
| 13. Eikaholm | | 53·19 | 24·77 | — | 14·63 | — | 8·26 | = 100·85 |
| 14. Cyclopean Is. | 2·311 | 53·58 | 24·07 | 0·85 | 13·60 | — | 8·29 | = 100·39 |
| 15. Crofthead | 2·153 | 54·85 | 22·59 | 0·89 | 12·58 | — | 9·06 | = 99·97 |
| 16. Mugdock | 2·271 | 54·48 | 23·01 | — | 14·00 | — | 8·28 | = 99·77 |
| 17. Barrhead | 2·259 | 55·54 | 22·27 | — | 13·75 | — | 8·55 | = 100·11 |
| 18. Table Mt., Col. | $\frac{2}{2}$ | 55·81 | 22·43 | — | 13·47 | — | 8·37 | = 100·08 |
| 19. Montreal | 2·255 | 53·29 | 23·33 | 0·64 | 14·54 | — | 8·47 | = 100·27 |
| 20. Brevik, *Euthallite* | | 55·8 | 24·1 | — | 12·8 | — | 8·8 | = 101·5 |
| 21. Lamö, *Eudnophite* | | 54·93 | 23·59[b] | — | 14·06 | — | 8·29 | = 100·87 |
| 22. “ “ | | 55·06 | 23·12 | — | 14·06 | — | 8·16 | = 100·40 |
| 23. “ “ | 2·277 | 54·00 | 24·00 | — | 13·51 | — | 8·38 | = 99·89 |

[a] Given as $K_2O$ 10·56, $Na_2O$ 2·00.

[b] In original 25·59, which makes the sum 102·87, while that given is 100·87.

Hersch (l. c.) has determined the loss of water on heating (after two hours in each case) as follows:

| Temp. | 100° | 150° | 195° | 245° | 295° | red ht. |
|---|---|---|---|---|---|---|
| $H_2O$ · | — | 0·20 | 0·75 | 2·13 | 5·61 | 8·29 p. c. |

*Euthallite* of Esmark is a compact analcite, often in nodular form with concentric structure, the successive layers greenish or grayish white in color. It results from the alteration of elæolite. Occurs on the islands Lille Arö, Sigtesö, and at other points on the Langesund fiord, southern Norway. Cf. Dx., l. c., Pisani, anal. 20; also Bgr., Zs. Kr., **16**, 223, 1890. Named from εὖ, *well*, and θαλλός, *a green twig*, in allusion to the color.

*Eudnophite* of Weibye, from the island Låven in the Langesund fiord, Norway, has been regarded as dimorphous with analcite, belonging to the orthorhombic system. The description given is as follows: Crystals in six-sided prisms (*b*, *m*) terminated by a macrodome, *e*, with the angles *mm'''* = 60°, *me* = 50°. ∴ *ee'* = 95° 50'. Commonly massive, cleavable. Cleavage: *c* perfect; *a*, *b*, less so. H. = 5·5. G. = 2·27. Luster weak, a little pearly on the cleavage-faces. Color white, grayish, brownish. Streak white. Translucent; in thin laminæ transparent. Optically biaxial; negative. 2E = 70° approx. Cf. Weibye, l. c.; Dx., Min., **1**, 395, 1862; Btd., Bull. Soc. Min., **4**, 239, 1881; Dx., ibid., **7**, 78, 1884; Lcx., ibid., **8**, 359, 1885.

Brögger (Zs. Kr., **16**, 565 *et seq.*, 1890) has thoroughly investigated this supposed species, especially on the optical side, and concludes that it is nothing but ordinary analcite, characterized by more than usually strong double refraction; cf. above.

**Pyr., etc.**—Yields water in the closed tube. B.B. fuses at 2·5 to a colorless glass. Gelatinizes with hydrochloric acid.

**Obs.**—The Cyclopean Islands, near Catania, Sicily, afford pellucid crystals; also the Fassathal in Tyrol; other localities are, in Scotland, in the Kilpatrick Hills; Bowling, pseudomorphs after laumontite; Glen Farg; near Edinburgh; at Kilmalcolm; the Campsie Hills, etc.; Co. Antrim, etc., in Ireland; the Färöer Islands; Iceland; the Vincentine, with prehnite, chabazite, apophyllite, etc.; Wessela, near Aussig, Bohemia; at Arendal, in Norway, in beds of iron ore; at Andreasberg, in the Harz, in silver mines; Kangerdluarsuk, Greenland; Kerguelen Is. On the islands of the Langesund fiord, Norway, in part as a result of the alteration of elæolite; also of ægirite.

*Euthallite* (see above) is from Lille Arö, Sigtesö, and other points in the Langesund fiord, southern Norway. *Eudnophite* (see above) is from the island Låven (Lamö) in the same region and occurs with catapleiite, leucophanite, mosandrite, etc. Named from εὐδνοφος, *obscurity*, in allusion to the cloudiness of the mineral.

Occurs at Bergen Hill, New Jersey; in gneiss near Yonkers, Westchester Co., N. Y.; at Perry, Maine, with apophyllite, in greenstone; abundant in fine crystals, with prehnite, datolite, and calcite, in the Lake Superior region; in the gangue of the copper, at Copper Falls and Northwestern mines, and at Michipicoton Island, and also at other mines not now worked. At Table Mt. near Golden, Colorado, with other zeolites.

Nova Scotia affords fine specimens at Martial's Cove, Five Islands, Cape d'Or, Swan's Creek, and Cape Blomidon.

The name *Analcime* is from ἀναλκις, *weak*, and alludes to its weak electric power when heated or rubbed. The correct derivative is *analcite*, as here adopted for the species.

**Alt.**—Sauer describes analcite altered from leucite and changed further to feldspathic pseudomorphs. Analcite altered to a mixture of calcite and hydrous silicate of aluminium has been observed by Tschermak. Also occurs altered to prehnite; to lithomarge.

**Artif.**—Obtained by de Schulten in trapezohedral crystals, showing double refraction like the natural mineral; the method employed consisted in heating to 180°–190° in a closed tube sodium silicate, or caustic soda with an aluminous glass. The crystals were trapezohedrons (0·1 mm.) and gave on analysis: $SiO_2$ 54·6, $Al_2O_3$ 21·8, $Na_2O$ [15·0], CaO *tr.*, $H_2O$ 8·6 = 100. Also by heating in a similar manner, sodium silicate and aluminate in proper proportion to form analcite, with lime water; these crystals were sensibly isotropic. The author concludes that a concentrated alkaline solution gives trapezohedrons, under other conditions cubes are formed. Bull. Soc. Min., 3, 150, 1880, **5**, 7, 1882.

Lemberg (l. c.) shows that a soda solution changes leucite (anal. 1) into analcite, while the product so formed (anal. 2) may be altered back again into leucite (anal. 3). A similar result was obtained with natural analcite.

| | $SiO_2$ | $Al_2O_3$ | CaO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. Leucite, *nat.* | 56·04 | 23·38 | 0·20 | 18·90 | 1·41 | 0·32 = 100·25 |
| 2. Analcite, *artif.* | 55·30 | 22·91 | 0·29 | 0·68 | 12·96 | 7·86 = 100 |
| 3. Leucite, " | 55·50 | 23·27 | 0·25 | 19·03 | 0·85 | 1·10 = 100 |

**Ref.**—[1] Mlr., Min., 446, 1852; Schrauf, Atlas, Tf. IX, 1864. [2] Lasp., Kerguelen Is., Zs. Kr., **1**, 204, 1877. [3] Dx., Min., **1**, 392, 1862. [4] On *optical anomalies*, etc., see Brewster, Trans. R. Soc. Edinb., **10**, 187, 1826; Dx., l. c., N. R., 5, 1867; Schrauf, Anz. Ak. Wien, 1876; Mld., Ann. Mines, **10**, 111, 1876; Lsx., Jb. Min., 510, 1878. Zs. Kr., **5**, 330, 1881; Schulten, Bull. Soc. Min., 3, 150, 1880; Arzruni & Koch, Zs. Kr., **5**, 483, 1881; Ben Saude, Jb. Min., **1**, 41, 1882 (Inaug. Diss.); Pfd., Am. J. Sc., **30**, 112, 1885; Klein, Jb. Min., **1**, 250, 1884, **2**, 101, 1885, **1**, 93, 1891; Stadtländer, Jb. Min., **2**, 101, 1885; Brauns, Vh. Ver. Rheinl., **510**, 1887; Brögger, Zs. Kr., **16**, 565 *et seq.*, 1890; Rinne, Ber. Ak. Berlin, 1188, 1890.

The *Cluthalite* of Thomson (Min., **1**, 339, 1836) occurs in flesh-red vitreous crystals in amygdaloid at the Kilpatrick Hills. H. = 3·5. G. = 2·166. Opaque or subtranslucent. Fragile. Analysis afforded:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Na_2O$ | MgO | $H_2O$ |
|---|---|---|---|---|---|
| 51·27 | 23·56 | 7·31 | 5·13 | 1·23 | 10·55 = 99·05. |

It may be altered analcite. From Clutha, a name sometimes given to the valley of the Clyde. Cf. Btd., Bull. Soc. Min., **4**, 239, 1881.

### 451. FAUJASITE. *Damour*, Ann. Mines, **1**, 395, 1842.

Isometric. In octahedrons; also a trisoctahedron perhaps 655 ($\frac{6}{5}$-$\frac{6}{5}$)[1]. Twins: tw. pl. *o*, usually penetration-twins.

Cleavage: *o* distinct. Fracture uneven. Fragile. H. = 5. G. = 1·923. Luster vitreous; sometimes adamantine. Colorless, white; brown externally.

Exhibits anomalous double refraction, which has given rise to doubt as to its true form.

Rinne[2] shows that it is normally isotropic, but a loss of a little water disturbs the molecular structure and the octahedron is then divided into eight uniaxial individuals, optically +. At about 150° C., after losing twelve molecules, it is again isotropic, while a further loss of water makes it uniaxial and negative. On taking up water again it returns to the positive uniaxial condition.

**Comp.**—Perhaps $H_4Na_2CaAl_4Si_{10}O_{38} + 18H_2O = Na_2O.CaO.2Al_2O_3.10SiO.20H_2O$ = Silica 46·8, alumina 15·9, lime 4·4, soda 4·8, water 28·1 = 100.

**Anal.**—1, Damour, l. c.; 2, id., ib., **14**, 67, 1848.

| | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|
| 1. Kaiserstuhl | 49 36 | 16·77 | 5·00 | 4·34 | 22·49 = 97·96 |
| 2. " | 46·12 | 16·81 | 4·79 | 5·09 | 27·02 = 99·83 |

According to Damour, loses 15 p. c. of water when exposed for one month to dry air, but regains almost all of it in ordinary air in 24 hours. Heated at 50°–55° C. for one hour loses 15·2 p. c.; at 60°–65°, 10·4 p. c.: at 70°–75°, 19·5 p. c., which is almost entirely regained by exposure to air for a few weeks.

Jannasch found that the loss over fused $CaCl_2$ was 1·83 p. c. in 24 hours, 1·72 in 48 hours;

over $H_2SO_4$ 4·69 in 54 hours, 6·75 in 78, 6·52 in 100, 5·84 in 106; over $P_2O_5$ 7·44 in 118, 9·04 in 142, 10·19 in 166, 10·88 in 190 hours. From here on the weight became constant. Again, the loss after heating several hours from 105° to 110° was 10·88 p. c.; at 150°, 16·83, corresponding to 12 molecules of water, and this was reabsorbed by the air. Further at 160° the loss was 18·66 p. c.; 200° to 205°, 21·41; 250° to 260°, 22·67; over a gas burner 27·02 and over a blast lamp 27·59. Jb. Min., **2**, 24, 1887.

**Pyr., etc.**—B.B. fuses with intumescence to a white blebby enamel. Decomposed by hydrochloric acid without gelatinization.

**Obs.**—Occurs with augite in the limburgyte of Sasbach in the Kaiserstuhl, Baden. Also stated to occur at Annerod near Giessen; Pflasterkaute near Eisenach; probably also Stempel near Marburg (Koenen). The adamantine luster sometimes observed is attributed to a thin bituminous coating. Named by Damour after Faujas de Saint Fond.

**Ref.**—[1] Knop, Lieb. Ann., **111**, 375, 1859. [2] Jb. Min., **2**, 17, 1887.

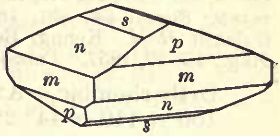
**452. EDINGTONITE.** *Haidinger*, Brewster's Ed. J. Sc., **3**, 316, 1825. Antiedrit *Breith.*, Char., 164, 1832.

Tetragonal, with sphenoidal hemihedrism. Axis $\dot{c} = 0{\cdot}6725$; 001 ∧ 101 = 33° $55\frac{1}{4}'$, Haid[1].

**Forms**[1]: *m* (110, *I*); sphenoids *p* (111, 1), *s* (113, $\frac{1}{3}$)[2], *n* ($1\bar{1}2$, $\frac{1}{2}$).

Angles: *mp* = 46° 26′, *m′n* = 64° 34′, *m′s* = 72° 25′ (meas. 72°), *pp′* 111 ∧ $\bar{1}\bar{1}1$ = 87° $7\frac{1}{2}'$ (meas. 87°19′), *nn′* ($1\bar{1}2$ ∧ $\bar{1}12$) = *50° 52′, *ss′* = 35° $1\frac{1}{2}'$.

Form as in the figure. Crystals minute (not above $\frac{3}{8}$ in. across) and inconspicuous. Faces *s* rare and slightly curved. Also massive.



Haidinger.

Cleavage: *m* perfect. Fracture subconchoidal to uneven. Brittle. H. = 4–4·5. G. = 2·694 Heddle; 2·71 Turner. Luster vitreous. White, grayish white, pink. Translucent to opaque. Optically negative, Dx.

**Comp.**—Perhaps (Rg.) $BaAl_2Si_3O_{10} + 3H_2O$ or $BaO.Al_2O_3.3SiO_2.3H_2O$ = Silica 36·8, alumina 20·9, baryta 31·3, water 11·0 = 100.

**Anal.**—Heddle, Phil. Mag., **9**, 179, 1855.

$SiO_2$ 36·98 $Al_2O_3$ 22·63 BaO 26·84 CaO,$Na_2O$ *tr.* $H_2O$ 12·46 = 98·91.

Turner's original analysis (1825) was incomplete and incorrect; a new investigation is needed.

**Pyr., etc.**—Yields water, and becomes white and opaque. B.B. at a high heat fuses to a colorless mass. Affords a jelly with hydrochloric acid.

**Obs.**—Occurs in the Kilpatrick Hills, near Glasgow, Scotland, associated with harmotome, another barium mineral, and also analcite, prehnite, calcite, etc. Haidinger states that the crystals examined by him occurred on thomsonite, an association not observed by Heddle.

Named after Mr. Edington, who found it in 1823 on Lord Blantyre's estate near Old or West Kilpatrick, Dumbartonshire. It has since been found at several quarries in the neighborhood but, perhaps in part because so inconspicuous, it is a very rare mineral in collections.

**Artif.**—Lemberg mentions a silicate obtained by digesting an artificial natrolite 12 days with barium chloride, which is near edingtonite; it yielded: $SiO_2$ 37·50, $Al_2O_3$ 21·85, BaO 25·38, CaO 1·17, $Na_2O$ 1·04, $H_2O$ 13·06 = 100. Zs. G. Ges., **28**, 553, 1876.

**Ref.**—[1] l. c., also Pogg., **5**, 193, 1825. [2] Greg. Min., 191, 1858.

*Glottalite* of Thomson (Min., **1**, 328, 1836), from Port Glasgow, on the Clyde, Scotland, is described as occurring in white crystals that "seem to be regular octahedrons; at least 4-sided pyramids, the faces of which appear to be equilateral triangles, are visible; other crystals appear to be cubic." H. = 3·5; G. = 2·18; luster vitreous. Thomson obtained, l. c.:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | $H_2O$ | |
|---|---|---|---|---|---|
| 37·01 | 16·31 | 0·50 | 13·93 | 21·25 | = 99·00 |

Heddle states (Phil. Mag., **9**, 181, 1855) that it is probably edingtonite mixed with harmotome, mentioning that Thomson's mineral came from the same locality with the edingtonite, and from the same dealer that furnished him with the edingtonite for his analysis. In the mineralogy of Greg and Lettsom (p. 171, 1858) it is stated to be chabazite occurring in small aggregated and irregular crystals, somewhat resembling phacolite.

## Natrolite Group.

### 453. Natrolite. 454. Scolecite. 455. Mesolite.

The Natrolite Group includes the sodium silicate, Natrolite, with the empirical formula $Na_2Al_2Si_3O_{10}.2H_2O$; the calcium silicate, Scolecite, $CaAl_2Si_3O_{10}.3H_2O$; also Mesolite intermediate between these and corresponding to $\left\{ \begin{array}{l} m Na_2Al_2Si_3O_{10}.2H_2O \\ n CaAl_2Si_3O_{10}.3H_2O \end{array} \right.$.

These three species agree closely in angle, though varying in crystalline system; Natrolite is orthorhombic usually, also rarely monoclinic; Scolecite is monoclinic, perhaps also in part triclinic; Mesolite seems to be both monoclinic and triclinic.

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**453. NATROLITE.** Zeolit pt., Zeolites crystallisatus, prismaticus, capillaris (fr. Gustafsberg), *Cronst.*, Min., 102, 1758; Z. albus fibrosus, capillaris, etc. (fr. Iceland and Gustafsb.), *v. Born*, Lithoph., 46, 1772; *de Lisle*, Crist., 1772, 1783. Mehl-Zeolith, Fasriger-Z., *Wern.*, Ueb. Cronst., 243, 1780; Faserzeolith, Nadelzeolith, *Wern.* Mealy Zeolite, Fibrous Zeolite, Needle Zeolite. Zeolite, Mesotype, pt., *H.*, Tr., **3**, 1801. Natrolith (fr. Högau) *Klapr.*, N. Schrift Nat. Ges. Fr. Berlin, **4**, 243, 1803, Beitr., **5**, 44, 1810. Högauit *Selb.*, Schrift, ib., 395 Natrolite *H.*, Cours de Min., 1804, Lucas Tabl., **1**, 338, 1806. Natron-Mesotype. Soda-Mesotype.

Krokalith (Crocalite) (fr. Felvatza) *Estner*, Min., **2**, pt. 2, 559, 1797. Bergmannit (fr. Fredriksvärn) *Schumacher*, Verz. dän. Foss., 46, 1801. Spreustein *Wern.*, 1811, Hoffm. Min., **2**, b, 303, 1812. Radiolith *Esmark*, Hunefeld, Schw. J., **52**, 361, 1828. Brevicit (fr. Brevik) *P. Ström*, Jahresb., **14**, 176, 1834. Lehuntite *Thomson*, Min., **1**, 338, 1836. Eisen-Natrolith *C. Bergemann*, Pogg., **84**, 491, 1851; Iron-Natrolite. Savite *Meneghini*, Am. J. Sc., **14**, 64, 1852. Galaktit *Haid.*, Kenng. Ber. Ak. Wien, **12**, 290, 1854, **16**, 157, 1855. Fargite *Heddle*, Phil. Mag., **13**, 50, 1857. Palæo-Natrolith *Scheerer*, Pogg., **108**, 416, 1859.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}97852 : 1 : 0{\cdot}35362$ Brögger[1].
$100 \wedge 110 = 44^\circ\ 22\frac{2}{3}'$, $001 \wedge 101 = 19^\circ\ 52\frac{1}{6}'$, $001 \wedge 011 = 19^\circ\ 28\frac{1}{2}'$.

**Forms**[2]:
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)
*c* (001, *O*)[3]
*l* (610, *i*-6̄)[4]

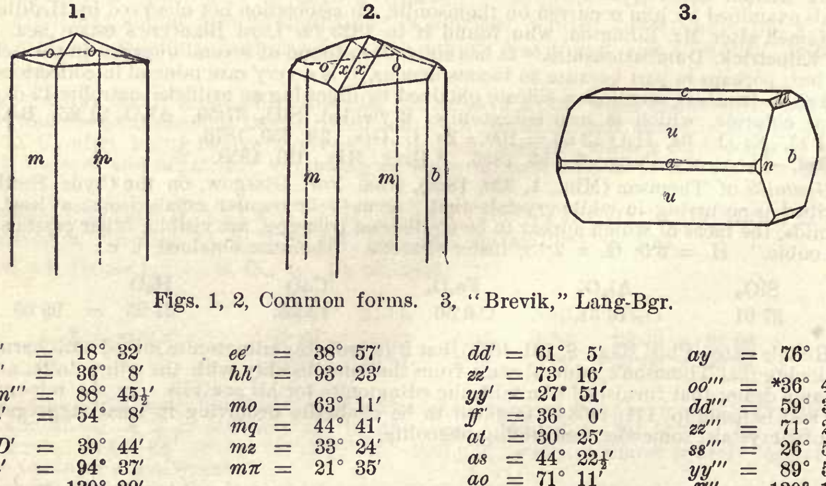
δ (310, *i*-3̄)[6]
ν (740, *i*-$\frac{\bar{7}}{4}$)[7]
*m* (110, *I*)
λ (590, *i*-$\frac{\breve{9}}{5}$)[7]
*n* (120, *i*-2̆)[3]

*D* (101, 1-ī)[6]
*u* (301, 3-ī)[3]
*v* (601, 6-ī)[2]
*e* (011, 1-ĭ)

*h* (031, 3-ĭ)[3]
*o* (111, 1)
*d* (221, 2)
*z* (331, 3)[3]
π (551, 5)[4,6]

*t* (511, 5-5̄)[4,6]
*s* (311, 3-3̄)[4]
*y* (131, 3-3̆)
*f* (391, 9-3̆)[3]

Also the following vicinal planes: μ (31·30·0)[5]; ω (12·12·5)[5]; σ (31·31·30)[5]; τ (44·40·43)[5]; φ (54·50·54)[5]; *x* (11·10·11); ζ (21·20·21); Π (34·36·1).



Figs. 1, 2, Common forms. 3, "Brevik," Lang-Bgr.

*ll'''* = 18° 32′
*δδ'* = 36° 8′
*mm'''* = 88° 45½′
*nn'* = 54° 8′
*DD'* = 39° 44′
*uu'* = 94° 37′
*vv'* = 130° 29′

*ee'* = 38° 57′
*hh'* = 93° 23′
*mo* = 63° 11′
*mq* = 44° 41′
*mz* = 33° 24′
*mπ* = 21° 35′
*oo'* = *37° 37¾′

*dd'* = 61° 5′
*zz'* = 73° 16′
*yy'* = 27° 51′
*ff'* = 36° 0′
*at* = 30° 25′
*as* = 44° 22½′
*ao* = 71° 11′
*oo''* = 53° 39′

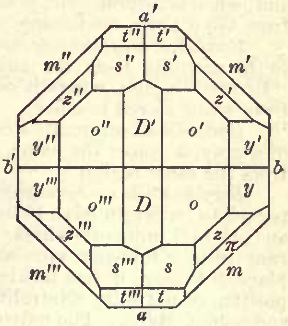
*ay* = 76° 4½′
*oo'''* = *36° 47½′
*dd'''* = 59° 39′
*zz'''* = 71° 27′
*ss'''* = 26° 58′
*yy'''* = 89° 52′
*ff'''* = 130° 16′

Also in part monoclinic with the axial ratio $\grave{a} : \overset{+}{b} : \dot{c} = 1{\cdot}0165 : 1 : 0{\cdot}35991$; $\beta = 89° \ 54\frac{5}{8}'$ Brögger[7].

Forms: *a* (100, *i-ī*), *b* (010, *i-ì*), *n* (210, *i-2̄*), *m* (110, *I*), *e* (1̄01, 1-ī), *D* (011, 1-ì), *o* (111, −1), *o′* (1̄11, 1), *d* (2̄21, 2), *z* (3̄31, 3), *y* (3̄11, 3-3), *s* (1̄31, 3-3̀), *t* (1̄51, 5-5̀), *Π* ($\bar{3}\bar{6}{\cdot}34{\cdot}1$, 36-$\frac{18}{17}$).

The crystals are regarded as monoclinic twins with *a* as tw. plane; the axes $\grave{a}$ and $\overset{+}{b}$ correspond respectively to $\bar{b}$ and $\breve{a}$ of the orthorhombic type. The optical orientation is sensibly the same for both types.

4.



Monte Baldo, after Artini.

Stadtländer[8] has described complex natrolite crystals from Marburg whose grouping may be explained by assuming a twinning with the prism as tw. pl. and *c* as comp. face, the horizontal axes thus crossing at angles of nearly 90°. Further a twinning about the front pinacoid is also suggested, but with some question. Luedecke[8] notes a variation in extinction of 5°–7° with the prismatic edge in natrolite of Aussig and Salesl.

Twins: tw. pl.[3] *u* (301), cruciform twins, rare; the crystals crossing nearly at right angles—this may perhaps have been an accidental association. Crystals prismatic, usually very slender to acicular and terminated by the pyramid *o* (111), then closely resembling tetragonal forms; often with more or less distinct vicinal planes; the faces in the prismatic zone vertically striated. Crystals frequently interlacing, divergent, or in stellate group. Also fibrous, radiating, massive, granular, or compact.

Cleavage: *m* perfect; *b* imperfect, perhaps only a plane of parting (Bgr.). Fracture uneven. H. = 5–5·5. G. = 2·20–2·25; 2·249, Bergen Hill, Brush. Luster vitreous, sometimes inclining to pearly, especially in fibrous varieties. Color white, or colorless; to grayish, yellowish, reddish to red. Transparent to translucent.

Optically +. Ax. pl. ∥ *b*. Bx ⊥ *c*. Indices and axial angles:

Auvergne $\alpha_r = 1{\cdot}4768$ $\beta_r = 1{\cdot}4797$ $\gamma_r = 1{\cdot}4887$ $\therefore 2V_r = 59° \ 29'$ $2E_r = 94° \ 27'$ Dx.
Also $2E_r = 93° \ 28'$ $2E_{bl} = 95° \ 41'$

Bombiano $2H_{a.y} = 62° \ 32'$ $2H_{o.y} = 119° \ 28'$ $\therefore 2V_y = 62° \ 0'$ Artini
*Savite* $2H_{a.y} = 62° \ 44'$ $2H_{o.y} = 119° \ 38'$ $\therefore 2V_y = 62° \ 6'$ "

Stokö $2H_{a.r} = 62° \ 31'$ $2H_{o.r} = 119° \ 35\frac{1}{2}'$ $\therefore 2V_r = 61° \ 56'$ Bgr.
$2H_{a.y} = 62° \ 44'$ $2H_{o.y} = 119° \ 4'$ $\therefore 2V_y = 62° \ 15'$
$2H_{a.gr} = 63° \ 0\frac{1}{2}'$ $2H_{o.gr} = 118° \ 37'$ $\therefore 2V_{gr} = 62° \ 34'$

$\alpha_r = 1{\cdot}47287$ $\beta_r = 1{\cdot}47631$ $\gamma_r = 1{\cdot}48534$ (calc.)
$\alpha_y = 1{\cdot}47543$ $\beta_y = 1{\cdot}47897$ $\gamma_y = 1{\cdot}48866$
$\alpha_{gr} = 1{\cdot}47801$ $\beta_{gr} = 1{\cdot}48172$ $\gamma_{gr} = 1{\cdot}49181$
Also calc. ($\alpha$, $\beta$, $\gamma$) $2V_r = 61° \ 3'$ $2V_y = 62° \ 10'$ $2V_{gr} = 62° \ 19'$

Sections of crystals, regarded as monoclinic, gave:

$2H_{a.r} = 61° \ 29'$ $2H_{o.r} = 121° \ 1'$ $2V_r = 60° \ 51'$ Bgr.
$2H_{a.y} = 61° \ 37'$ $2H_{o.y} = 120° \ 47'$ $2V_y = 61° \ 0\frac{1}{2}'$
$2H_{a.gr} = 61° \ 46'$ $2H_{o.gr} = 120° \ 24'$ $2V_{gr} = 61° \ 13\frac{1}{2}'$

Dispersion horizontal, probably shown in sections ⊥ $Bx_a$ ($Bx_a \parallel \dot{c}$ approx.); but crossed dispersion not observed in sections ⊥ $Bx_o$.

Other determinations of indices and axial angles are given by Brögger, quoted from Lorenzen; further the latter found: 2E = 98° 58′ at 15°, 97° 6′ at 108°, 96° 13′ at 150°, 93° 21′ at 229½°, 90° 55′ at 308°. Cf. also Dx., N. R., 74, 1867.

Rinne (cf. p. 571) shows that with increase of temperature and the accompanying loss of water, natrolite is converted into a monoclinic substance, called by him *metanatrolite*. A section ∥ *c* with extinction parallel the diagonals (𝔞 ∥ $\breve{a}$ and 𝔟 ∥ $\bar{b}$) showed, after heating, fields with the extinction (𝔞) inclined to each other 15° in adjacent parts about the lateral axis; further, to correspond with the new molecular structure, the former vertical axis must be made the axis of symmetry, and the prismatic faces orthodomes 101 and $\bar{1}01$, with twinning about 100 (or 001). No change in geometrical form accompanied the change in molecular structure.

**Var.**—*Ordinary.* Commonly either (*a*) in groups of slender colorless prismatic crystals, varying but little in angle from square prisms, often acicular, or (*b*) in fibrous divergent or radiated masses, vitreous in luster, or but slightly pearly (these radiated forms often resemble those of thomsonite and pectolite); often also (*c*) solid amygdules, usually radiated fibrous, and somewhat silky in luster within; (*d*) rarely compact massive.

*Galactite* is ordinary natrolite, occurring in colorless acicular crystallizations in southern Scotland, instituted as a species on an erroneous analysis. It may contain a few per cent of lime and hence is intermediate between pure natrolite and mesolite (p. 605). *Fargite* is a red natrolite from Glen Farg, containing, like galactite, about 4 p. c. of lime.

*Radiolite, bergmannite, spreustein, brevicite, palæo-natrolite,* are names which have been given to the natrolite from the augite-syenite of southern Norway, on the Langesund fiord, in the "Brevik" region, where it occurs fibrous, massive, and in long prismatic crystallizations, and from white to red in color.

*Radiolite* as originally described occurred in radiated masses, and compact fibrous nodules, of a grayish color; the name, however, is often used to include also the well crystallized forms from the same region.

*Bergmannite* or *Spreustein* is a secondary mineral in the augite-syenite. Various views in regard to its origin have been expressed; for example Scheerer regarded it as a paramorph after an original mineral which he called *palæo-natrolite;* other authors have suggested elæolite, cancrinite, a feldspar, etc., as the parent mineral. Brögger, however, shows that, in the first place, it is more or less lacking in homogeneity and, further, includes kinds which have the composition of natrolite (Natrolith-spreustein, Bgr.) and others of hydronephelite (Hydronephelit-spreustein, Bgr.). The natrolite spreustein has arisen chiefly from the alteration of sodalite, also in less extent from cancrinite. A similar change of sodalite to natrolite (spreustein) has also been noted in connection with the sodalite-syenite of Kangerdluarsuk, Greenland.

*Brevicite* is the same as spreustein, though the name has also been used as synonymous with radiolite. The original analysis (anal. 27), showing nearly 7 p. c. CaO, was probably not made on homogeneous material, cf. anals. 19, 28. *Crocalite,* from the Ural, is a red zeolite, like the bergmannite of Laurvik; occurs in small amygdules, and is fibrous or compact.

*Savite,* according to Sella (N. Cimento, 1858) is natrolite, occurring in slender colorless prisms. It comes from a serpentine rock at Mte. Caporciano, Italy, and specimens are ordinarily not pure from serpentine. Its identity with natrolite has been confirmed by Dx. (N. R., 75, 1867); also more fully by Artini[6]. Cf. anal. 5.

*Iron-natrolite* (Eisennatrolith *Bergm.*, Jernnatrolith *Swed.*) is a dark green opaque variety, either crystalline or amorphous, from the Brevik region; probably from the islands Lövö and Sigtesö. It was supposed to have the alumina to a considerable extent replaced by iron sesquioxide, cf. anal. 31. Brögger shows, however, that the iron is due to the presence of inclusions of a mineral probably related to stilpnomelane.

**Comp.**—$Na_2Al_2Si_3O_{10} + 2H_2O$ or $Na_2O.Al_2O_3.3SiO_2 + 2H_2O$ = Silica 47·4, alumina 26·8, $Na_2O$ 16·3, water 9·5 = 100.

Groth writes the formula as a basic metasilicate, $Na_2(AlO)Al(SiO_3)_3 + 2H_2O$.

**Anal.**—1, Lemberg, Zs. G. Ges., **28**, 550, 1876. 2, Hersch, Inaug. Diss., p. 13, Zürich, 1887. 3, Kleppert, Jb. Min., 88, 1875. 4, Fuchs, Schw. J., **18**, 8, 1816, also other anals. 5, Mattirolo, Att. Acc. Torino, **21**, 848, 1886. 6, Luzzatto, Riv. Min. Ital., **4**, 54, 1889. 7–10, Negri, ibid., **7**, 16, 1890. 11, G. J. Brush, Am. J. Sc., **31**, 365, 1861. 12, O. C. Marsh, Dana Min., 428, 1878. 13, Genth, priv. contr. 14, Young, Ch. News, **27**, 56, 1873. 15, 17, Heddle, Phil. Mag., **11**, 272, 1856. 16, Hyland. Sc. Proc. R. Dublin Soc., 411, 1890 (read Feb. 10). 18, Eckenbrecher, Min. Mitth., **3**, 30, 1880. 19, G. Lindström, G. För. Förh., **9**, 436, 1887. 20–22, Paijkull, Inaug. Diss., Upsala, 1877. 23–26, Quoted by Bgr., Zs. Kr., **16**, 619, 1890 (Fr. A. v. Hall, E. Wickström, E. Knutsen, etc.). 27, Sondén, Berzelius, Jahresb., **14**, 176, 1834, Pogg., **33**, 112, 1834. 28, Paijkull, quoted by Bgr., l. c., p. 640. 29, 30, Lorenzen, Medd. Grönl., **7**, p. 11 (sep.), 1884. 31, Bergemann, l. c.

| | G. | | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 1. Hohentwiel | | | 47·61 | 27·31 | — | 15·88 | — | 9·96 = 100·76 |
| 2. Jakuben | 2·283 | $\frac{2}{3}$ | 46·12 | 28·22 | — | 15·87 | — | 9·91 = 100·12 |
| 3. Stempel | | | 47·59 | 25·23 | 0·26 | 13·87 | 1·12 | 10·50 $Fe_2O_3$ 0·39, [MgO 0·24 = 99·20 |
| 4. Fassathal | | | 48·63 | 24·82 | — | 15·69 | — | 9·60 $Fe_2O_3$ 0·21 [= 98·95 |
| 5. Monte Catini, *Savite* | | | 48·07 | 27·05 | — | 16·56 | — | 9·62 = 101·30 |
| 6. Mte. Baldo | | | 47·16 | 26·76 | 0·28 | 16·18 | — | 9·57 = 99·95 |
| 7. Salcedo | | $\frac{3}{3}$ | 47·21 | 27·01 | — | 15·99 | — | 9·55 = 99·76 |
| 8. Montecchio Maggiore | | $\frac{2}{2}$ | 46·97 | 27·12 | — | 15·95 | 0·40 | 9·42 = 99·86 |
| 9. Lugo | | $\frac{2}{2}$ | 47·23 | 27·21 | — | 14·80 | 0·41 | 9·70 = 99·35 |
| 10. Alta Villa | | | 47·71 | 27·89 | — | 16·99 | — | 9·69 = 102·28 |
| 11. Bergen Hill | 2·249 | | 47·31 | 26·77 | 0·41 | 15·44 | 0·35 | 9·84 = 100·12 |

| | | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 12. | C. Blomidon | | 45·74 | 28·38 | 0·27 | 14·23 | 1·16 | 10·11 = 99·89 |
| 13. | Magnet Cove | 2·243 | 47·97 | 26·51 | — | 15·98 | — | 9·81 = 100·27 |
| 14. | Loch Thom | | 46·29 | 27·10 | 0·72 | 15·37 | — | 10·43 = 99·91 |
| 15. | Bishopton, *Galactite, white* | | 47·60 | 26·60 | 0·16 | 15·86 | — | 9·56 = 99·78 |
| 16. | Kenbane Head, " | 2·26 | $\frac{2}{2}$ 46·50 | 27·55 | 2·59 | 13·28 | — | 10·10 = 100·02 |
| 17. | Glen Farg, *Fargite, red* | | 47·84 | 27·11 | 4·31 | 11·30 | — | 10·24 = 100·80 |
| 18. | Brevik, *Spreustein* | 2·39 | 46·81 | 27·33 | *tr.* | 15·69 | — | 10·20 = 100·03 |
| 19. | " *Brevicite* | | 47·92 | 26·80 | — | 16·25 | 0·26 | 9·51 = 100·74 |
| 20. | *Bergmannite* | | 47·34 | 26·92 | 1·19 | 14·41 | — | 10·48 $Fe_2O_3$ 0·62 [= 100·96 |
| 21. | Lamansskär, *light red, radiated* | | 48·34 | 25·27 | *tr.* | [16·48] | — | 8·89 $Fe_2O_3$ 0·75, [MgO 0·27 = 100 |
| 22. | Stokö, *white* | | $\frac{2}{2}$ 47·16 | 26·84 | 0·04 | 15·41 | — | 9·48 $Fe_2O_3$ 0·10 [= 99·03 |
| 23. | L. Arö, *Radiolite, monoclinic* | | 47·29 | 27·00 | 0·18 | 15·39 | 0·90 | 9·44 = 100·20 |
| 24. | " " " | | 47·33 | 26·82 | 0·15 | 15·41 | 1·17 | 9·43 = 100·31 |
| 25. | " " *orthorhombic* | | 47·60 | 27·12 | — | 15·68 | — | 9·50 = 99·90 |
| 26. | Ovr. Arö " " | | 47·92 | 26·80 | — | 16·25 | 0·26 | 9·51 = 100 74 |
| 27. | *Brevicite* | | 43·88 | 28·39 | 6·88 | 10·32 | — | 9·63 MgO 0·21 [= 99·31 |
| 28. | " | | 46·72 | 26·59 | *tr.* | 16·82 | — | 9·73 = 99 86 |
| 29. | Kangerdluarsuk, *pseud., red rad.* | | 46·54 | 27·16 | 0·89 | 15·52 | — | 9·65 FeO 1·17, [Cl. *tr.* = 100·93 |
| 30. | " " *cryst. rad.* | | 47·07 | 27·02 | 0·11 | 16·05 | *tr.* | 9·56 FeO 0·58= [100·39 |

| | | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| 31. | *Eisennatrolith* | 2·353 | 46·54 | 18·94 | 7·49 | 2·40 | 0·55 | 14·04 | 9·37 = 99·33 |

The Auvergne natrolite undergoes, according to Damour (ref., p. 571), no loss in dried air. At 240° C. it loses nearly all its water and becomes milky and opaque; and if afterward exposed to the free air, it regains all it had lost, excepting its transparency and firm texture; if again heated, it loses its water at about 90° C.

Hersch (l. c.) obtained, after heating two hours at each temperature:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Temp. | 105° | 130° | 160° | 195° | 225° | 240° | 265° | 290° | red. ht. |
| $H_2O$ | 0·14 | 0·17 | 0·19 | 0·27 | 0·37 | 0·64 | 0·77 | 2·51 | 9·81 p. c. |

**Pyr., etc.**—In the closed tube whitens and becomes opaque. B.B. fuses quietly at 2 to a colorless glass. Fusible in the flame of an ordinary stearine or wax candle. Gelatinizes with acids.

**Obs.**—Occurs in cavities in amygdaloidal basalt, and other related igneous rocks; sometimes in seams in granite, gneiss, and syenite.

It is found in the *graustein* of Aussig and Teplitz in Bohemia; in fine crystals at Puy de Marman and Puy de la Piquette in Auvergne; at Alpstein, near Sontra in Hesse; Fassathal, Tyrol; Monte Baldo on Lago di Garda, Montecchio Maggiore, and other points in Venetian Italy; Kapnik in Hungary; Dellys in Algeria; Högau in Würtemberg (the Faserzeolith *W.*), in yellowish radiated masses; etc. In red amygdules (*crocalite*) in amygdaloid of Ireland, Scotland, and Tyrol; the amygdaloid of Bishopton (*galactite*), acicular crystals, several inches long; at Glen Farg in Fifeshire; in Dumbartonshire; at Glenarm in the county of Antrim; at Portrush; and at Magee Island, near Larne, Ireland. Common in the augite-syenite of the Langesund fiord, near Brevik, southern Norway, in fine crystallizations, also in radiated forms and as the secondary spreustein (see further above).

In North America, natrolite occurs in the trap of Nova Scotia, at Gates's mountain, Cape d'Or, Swan's Creek, Cape Blomidon, Two Islands. At Bergen Hill, N. J.; sparingly at Chester, Ct.; at Copper Falls, Lake Superior, in crystals, sometimes on native copper; also on New York Island; at Magnet Cove, Arkansas (anal. 13).

Named *Mesotype* by Haüy, from *μέσος, middle*, and *τυπος, type*, because the form of the crystal—in his view a square prism—was intermediate between the forms of stilbite and analcite. *Natrolite*, of Klaproth, is from *natron, soda;* it alludes to the presence of soda, whence also the name *soda-mesotype*, in contrast with scolecite, or *lime-mesotype*. Schumacher's name *bergmannite*, after Bergmann (1735–1784), dates from the same year (1801) with Haüy's *mesotype*.

**Artif.**—Obtained by Doelter by recrystallization of the powdered mineral in water containing carbon dioxide in a closed tube at 160°. Further by digesting nephelite in a closed tube at 200° with alkaline carbonates and carbonated water, analcite was obtained in distinct crystals, and also prismatic crystals which were inferred to be natrolite. Jb. Min., 1, 134, 1890.

Lemberg shows that the slow (5 months) action of potassium carbonate on natrolite causes an exchange of potassium for sodium, which action is reversed by sodium carbonate. The action of calcium chloride brought about a partial change toward scolecite in natural natrolite, but complete in the artificial substance. Zs. G. Ges., **28**, 551, 1876.

**Ref.**—[1] Arö, Langesund fiord (?), Zs. Kr. **3**, 478, 1879, also [7] below; cf. Luedecke, Jb. Min., **2**, 7, 1881. Artini and Brögger also obtained the axial ratios:

| | $\breve{a}$ | $\bar{b}$ | $\grave{c}$ | |
|---|---|---|---|---|
| Mte. Baldo | 0·97962 : | 1 : | 0·34991 | Artini. |
| Norway | 0·98194 : | 1 : | 0·35345 | Bgr. |

[2] See Seligmann, Zs. Kr., **1**, 338, 1877, for early authorities, list of forms, etc. [3] Lang, Phil. Mag., **25**, 43, 1863. [4] Bgr., l. c., 1877. [5] Palla, Salesl, Zs. Kr., **9**, 386, 1884; some of these are very doubtful. [6] Artini, Rend. Acc. Linc., Mte. Baldo, **3***b*, 245, 1887. Also *savite*, Bombiano, **4***a*, 51, 1888, Bombiano, **5***a*, 37, 1889. [7] Bgr., G. För. Förh., **9**, 266, 1887, Zs. Kr., **16**, 596 *et seq.*, 1890. [8] Stadtländer, Jb. Min., **2**, 113, 1885; Luedecke, ib., 2, 7, 1881.

ELLAGITE *A. Nordenskiöld*, Beskrifn., etc., 118, 1855. H. = 2·5–3·0. Occurs in yellow, brownish, or reddish yellow crystalline masses, cleavable in two directions with the intersections near 90°; subtranslucent to opaque; luster pearly on a cleavage surface. Igelström, l. c., obtained: $SiO_2$ 47·73, $Al_2O_3$ 25·20, FeO 5·92, CaO 8·72, $H_2O$ 12·81 = 100·38. B.B. fuses and forms a white enamel. Occurs with fine crystals of epidote at Åland, Finland.

**454. SCOLECITE.** Skolezit *Gehlen & Fuchs*, Schw. J., 8, 361, 1813. Mesotype pt. Fibrous Zeolite pt. Lime-Mesotype. Poonahlite *Brooke*, Phil. Mag., **10**, 110, 1831. Punahlit *Germ.*

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 0·97636 : 1 : 0·34338$; $\beta = 89° 18' = 001 \wedge 100$ Flink[1].

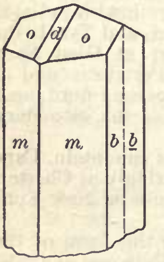
$100 \wedge 110 = 44° 18\tfrac{3}{4}'$, $001 \wedge 101 = 19° 18'$, $001 \wedge 011 = 18° 57'$.

| | | | | |
|---|---|---|---|---|
| **Forms**[2]: | *l* (210, $i$-$\bar{2}$) | *o* (111, − 1) | *w* (551, − 5)[3] | *t* (531, − 5-$\tfrac{5}{3}$)[3] |
| *a* (100, $i$-$\bar{i}$) | *m* (110, *I*) | *z* (332, − $\tfrac{3}{2}$)[4] | *e* ($\bar{1}$11, 1) | *u* (13·11·1, − 13-$\tfrac{13}{11}$)[3] |
| *b* (010, $i$-$\grave{i}$) | *k* (120, $i$-$\grave{2}$)[3] | *y* (12·12·5, − $\tfrac{12}{5}$)[4] | *r* ($\bar{5}$51, 5)[4] | *p* (131, − 3-$\grave{3}$) |
| *c* (001. *O*) | *h* (470, $i$-$\tfrac{7}{4}$)[4] | *v* (331, − 3) | *s* (311, − 3-$\bar{3}$)[3] | *q* (474, − $\tfrac{7}{4}$-$\tfrac{7}{4}$)[4] |
| *n* (510, $i$-$\bar{5}$)[4] | *d* (101, − 1-$\bar{i}$) | *x* (441, − 4)[4] | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *ll'''* | = 52° 2' | *mv* | = 33° 59' | *a'e* | = 72° 12' | *ss'* | = 26° 25½' |
| *mm'''* | = *88° 37½' | *m'e* | = 64° 14' | *oo'* | = *35° 46' | *pp'* | = 88° 8' |
| *kk'* | = 54° 14' | *oe'* | = 52° 21' | *vv'* | = 70° 19' | *ee'* | = 36° 1½' |
| *mo* | = 63° 25' | *ao* | = 71° 20' | | | | |

It is shown by Luedecke that part of the scolecite deviates optically from the requirements of the monoclinic system; here belongs the mineral from the Schattige Wichel, etc.

Crystals slender prismatic, twins with *a* as tw. pl., showing a feather-like striation on *b*, diverging upward at 15°–22° Zeph. (24°–26° Dx.); also as penetration-twins. Faces *m* often delicately striated horizontally. Crystals in divergent groups. Also massive, fibrous and radiated, and in nodules.



Iceland, Flink.

Cleavage: *m* nearly perfect. H. = 5–5·5. G. = 2·16–2·4. Luster vitreous, or silky when fibrous. Transparent to subtranslucent. Pyroelectric: on heating, the end with *oc* +, also *a* +, prisms and *b* —.

Optically —. Double refraction weak. Ax. pl. and $Bx_o \perp b$. $Bx_a \wedge \grave{c} = 15°–16°$. Axial angles, Schmidt[5]:

| | | | | |
|---|---|---|---|---|
| Iceland | $2H_{a.r} = 32° 26'$ Li | $2H_{o.r} = 124° 1'$ | ∴ | $2V_{a.r} = 35° 22'$ |
| | $2H_{a.y} = 33° 48'$ Na | $2H_{o.y} = 123° 0'$ | ∴ | $2V_{a.y} = 36° 26'$ |
| | $2H_{a.gr} = 34° 10'$ Tl | $2H_{o.gr} = 121° 26'$ | ∴ | $2V_{a.gr} = 37° 14'$ |
| Also measured | $2E_y = 55° 44'$ | ∴ $\beta = 1·4952$ | | |

**Comp.**—$CaAl_2Si_3O_{10} + 3H_2O$ or $CaO.Al_2O_3.3SiO_2.3H_2O$ = Silica 45·9, alumina 26·0, lime 14·3, water 13·8 = 100.

**Anal.**—1, Igelström, Jb. Min., 361, 1871. 2, Hersch, Inaug. Diss., p. 12, Zürich, 1887. 3, Lemberg, Zs. G. Ges., 28, 551, 1876. 4, Petersen, Jb. Min., 852, 1873. 5, E. E. Schmid, Ber. Ges. Jena, **14**, p. 62, June 9, 1880. 6, Luedecke, Jb. Min., **2**, 19, 1882. 7, Bechi, Boll. Com. G., 541, 1879. 8, Hillebrand, U. S. G. Surv., Bull. **20**, 36, 1885. 9, J. T. Donald, Eng. Mng. J., **51**, 474, April, 1891. 10, Darapsky, Jb. Min., **1**, 66, 1888. 11, Hussak, Bol. Comm. Geol., S. Paulo, No. 7, p. 8, 180.

| | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. Lunddörrsfjäll | | 46·56 | 25·75 | 15·00 | — | 13·30 = 100·61 |
| 2. Bulandstindr | 2·256 | $\frac{2}{2}$ 46·12 | 26·25 | 14·37 | — | 13·89 = 100·63 |
| 3. Iceland | | 46·27 | 26·16 | 13·70 | 0·43 | 13·89 = 100·45 |
| 4. *Poonahlite* | 2·296 | 46·91 | 26·03 | 13·33 | 0·22 | 13·83 $K_2O$ 0·08 = 100·40 |
| 5. Etzlithal | 2·27 | 45·70 | 27·46 | 14·29 | 0·11 | 13·45 $Fe_2O_3$ 0·16, MgO 0·06=101·23 |
| 6. Fellinenalp | 2·27 | $\frac{2}{2}$ 46·43 | 25·89 | 14·07 | 0·49 | 13·24 = 100·12 |
| 7. Casarza | | 46·65 | 25·82 | 14·44 | — | 13·00 MgO 0·11 = 100·02 |
| 8. Table Mt., Col. | | 46·03 | 25·28 | 12·77 | 1·04 | [14·48] $K_2O$ 0·13, $Fe_2O_3$ 0·27=100 |
| 9. Black L., Quebec | | 46·24 | 26·03 | 14·09 | — | 13·88 = 100·24 |
| 10. Chili | 2·15 | 47·69 | 25·45 | 14·05 | — | 13·25 MgO *tr.* = 100·44 |
| 11. Tuberão | | 45·96 | 26·03 | 13·53 | — | 13·67 = 99·19 |

According to Damour, Iceland columnar masses lost nothing in dried air; nothing until the heat applied exceeded 100° C.; at 300° it had lost 5 p. c., which it regained in moist air; at a dull red heat the loss was 12 p. c., and it was no longer hygroscopic; at a bright red it lost 13·9 p. c., and became after intumescence a white enamel.

Hersch (l. c.) has obtained the following results, after two hours' heating in each case:

| Temp. | 105° | 130° | 160° | 195° | 225° | 290° | red ht. |
|---|---|---|---|---|---|---|---|
| $H_2O$ p. c. | — | 0·14 | 1·13 | 3·98 | 4·39 | 4·78 | 13·86 p. c. |

**Pyr., etc.**—B.B. sometimes curls up like a worm (whence the name from σκώληξ, *a worm*, which gives *scolecite*, and not *scolesite* or *scolezite*); other varieties intumesce but slightly, and all fuse at 2–2·2 to a white blebby enamel. Gelatinizes with acids like natrolite.

**Obs.**—Occurs in the Berufiord, Iceland, where the crystals often exceed two inches in length, and are occasionally a quarter of an inch thick. It has also been met with in amygdaloid at Staffa; in the Isle of Mull; in Skye, at Talisker; near Eisenach in Saxony; near the Viesch Glacier, Valais; common in fine crystallizations in the Deccan trap area, in British India, near Poona, and from railroad tunnels and cuttings in the Bhor Ghât; in Greenland; at Pargas, Finland; in Auvergne; the valley of Cachayual, in Chili; the Serra de Tuberão, Santa Catharina, Brazil.

In the United States, in *Colorado* at Table Mountain near Golden in cavities in basalt.

In Canada, at Black Lake, Megantic Co., Quebec, in a granite dike in the serpentine region.

**Artif.**—Obtained by Doelter in a manner analogous to other zeolites by recrystallization in a closed tube at 150°. See Jb. Min., **1**, 135, 1890. Lemberg shows that scolecite may be converted into natrolite (and mesolite) by the slow action of soda solutions, Zs. G. Ges., **28**, 551, 1876.

**Ref.**—[1] Ak. H. Stockh. Bihang, **13** (2), No. 8, 1887; cf. also Zeph., Zs. Kr., **8**, 588, 1884; and earlier, Rose, Pogg., **28**, 427, 1833; Luedecke, Jb. Min., **2**, 1, 1881; the latter gives the early literature. Further, Luedecke, Zs. Nat. Halle, **63**, 42, 1890.

[2] Cf. Dx., Min., **1**, 386, 1862, Luedecke, l. c. [3] Zeph., Iceland, l. c. [4] Flink, l. c., also several doubtful planes. [5] Schmidt, Zs. Kr., **11**, 587, 1886; cf. Dx., Luedecke, Flink, l. c., also Wyrouboff, Bull. Soc. Min., **9**, 266, 1886.

On *pyroelectricity*, Rose and Riess, Pogg., **59**, 368, 1843; Hankel, Abh. Sächs. Akad., **12**, 35, 1878, and Wied. Ann., **6**, 56, 1879; Friedel and Gramont, Bull. Soc. Min., **8**, 75, 1885.

**455. MESOLITE.** *Fuchs & Gehlen*, Schw. J., **8**, 353, 1813, **18**, 16, 1816. Mesotype pt. Fibrous Zeolite pt. Mehl-Zeolith pt. Lime-and-Soda Mesotype. Antrimolite *Thom.*, Min., **1**, 326, 1836. Harringtonite *Thom.*, ibid., 328.

Monoclinic and triclinic[1] In prismatic crystals near scolecite in form and angles, and twinned like them. Prismatic angle about 88°. Lateral planes often vertically striated. In more or less divergent groups or tufts, often very delicate. Also massive; nodules or masses usually silky fibrous or columnar; often bristled with capillary crystals; sometimes consisting of interlaced fibres; rarely stalactitic, radiated fibrous within; occasionally cryptocrystalline, porcelain-like.

Des Cloizeaux describes crystals which are twins and show variations in extinction-directions which throw them into the triclinic system, Min., **1**, 388, 1862. Brazilian crystals, examined by Hussak, are also complex twins and apparently triclinic.

Cleavage: prismatic, perfect. Brittle, but tough when cryptocrystalline. H. = 5. G. = 2·2–2·4; 2·39, Iceland. Luster of crystals vitreous; of fibrous masses more or less silky. Color white or colorless, grayish, yellowish. Transparent to translucent; opaque, when amorphous.

**Var.**—Besides (*a*) the ordinary acicular and capillary crystallizations, divergent tufts (less delicate commonly than those of natrolite, but sometimes downy), and fibrous nodules or masses, mesolite occurs (*b*) in fibrous stalactites, with the fibers radiating from the center—the variety called *Antrimolite* by Thomson, from Antrim, Ireland, having H. = 3·5–4. G. = 2·096; also (*c*) amorphous, chalk-white, like an almond in luster, opaque and tough, with H. = 5–5·5, and G. = 2·21, the variety named *Harringtonite* by Thomson, also from Antrim; G. = 2·174, Haughton.

*Galactite* (p. 602) is intermediate between natrolite and ordinary mesolite.

**Comp.**—Intermediate between natrolite and scolecite and corresponding to $\left\{\begin{matrix} m\mathrm{Na_2Al_2Si_3O_{10}.2H_2O} \\ n\mathrm{CaAl_2Si_3O_{10}.3H_2O} \end{matrix}\right.$. The ratio between these two compounds varies somewhat. If, as often, $\mathrm{Na_2 : Ca} = 1 : 2$, the percentage composition is: Silica 46·4, alumina 26·3, lime 9·6, soda 5·3, water 12·4 = 100.

**Anal.**—1–3, Schmid, Pogg., **142**, 121, 1871. 4, Lemberg, Zs. G. Ges., **28**, 552, 1876. 5, Luedecke, Jb. Min., **2**, 33, 1881. 6, Pisani, C. R., **73**, 1448, 1871. 7, O. C. Marsh, Dana Min., 431, 1868. 8, Hillebrand, U. S. G. Surv., Bull. **20**, 35, 1885. 9, Sadtler, Am. Ch. J., **4**, 357, 1883. 10, Hussak, Bol. Comm. G., S. Paulo, No. 7, 5, 1890. 11, 12, Darapsky, Jb. Min., **1**, 66, 1888. 13, Heddle, Phil. Mag., **13**, 148. 1857. 14, C. v. Hauer, Ber. Ak. Wien, **12**, 294, 1854. 15, Haughton, Phil. Mag., **32**, 225, 1866.

| | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. Stromö | 2·16 | 47·40 | 27·05 | 9·16 | 4·69 | 13·35 | MgO 0·06 = 101·71 |
| 2. Iceland | 2·18 | 47·13 | 26·52 | 10·37 | 4·50 | 13·19 | MgO 0·03 = 101·74 |
| 3. " | 2·18 | 46·58 | 27·57 | 9·11 | 3·64 | 12·94 | MgO 0·08 = 99·92 |
| 4. " | | 45·96 | 26·69 | 9·47 | 5·99 | 12·78 | = 99·99 |
| 5. Pflasterkaute | 2·232 | 43·83 | 29·04 | 7·84 | 7·80 | 11·75 | = 100·26 |
| 6. Gignat | | 42·3 | 28·1 | 10 0 | 6·7 | 14·1 | $K_2O$ *tr.* = 101·2 |
| 7. C. Blomidon, N. S. | | 45·89 | 27·55 | 9·13 | 5·09 | 12·79 | $K_2O$ 0·48 = 100·93 |
| 8. Table Mt., Col. | ⅔ | 46·17 | 26·88 | 8·77 | 6·19 | 12·16 | = 100·17 |
| 9. Fritz Is., Pa. | | 43·29 | 25·02 | 12·15 | 3·40 | 16·01 | = 99·87 |
| 10. Botucatú | | 47·61 | 26·80 | 7·08 | 7·80 | 12·11 | = 101·40 |
| 11. Atacama | | 46·74 | 25·99 | 9·11 | 5·23 | 12·41 | = 99·48 |
| 12. Coquimbo | | 45·15 | 26·53 | 11·86 | 2·24 | 13·81 | $K_2O$ 0·45 = 100·04 |
| 13. Ireland, *Antrimolite* | | 45·98 | 26·18 | 10·78 | 4·54 | 13·00 | = 100·45 |
| 14. " *Harringtonite* | 2·174 | 45·07 | 26·21 | 11·32 | 3·75 | 14·34[a] | = 100·69 |
| 15. Bombay, " | | 45·60 | 27·30 | 12·12 | 2·76 | 12·99 | $K_2O$ 0·63, MgO *tr.* = 101·40 |

[a] At 100° 1·41 p. c.

**Pyr., etc.**—Yields water in the closed tube. B.B. becomes opaque, swells up into vermicular forms, but not in so marked a manner as scolecite, fusing easily to a blebby enamel. Gelatinizes with hydrochloric acid (Fuchs).

**Obs.**—Occurs in amygdaloid and related rocks. The fibrous kinds, especially the coarser, are usually a little less smoothly or neatly fibrous than those of natrolite. On Skye, in delicate interlacing crystals called *cotton-stone*, and in feathery tufts, and in solid masses consisting of radiating crystals; in downy tufts and other forms at Naalsö, Färöer; also with chabazite in Eigg; near Edinburgh and Kinross, and at Hartfield Moss, in Scotland; in Antrim, at the Giant's Causeway, in acicular crystallizations; also at Ballintoy in Antrim, stalactitic (*antrimolite*), investing yellow calcite, or chabazite; in Antrim, in veins of amorphous mesolite (*harringtonite*), at Portrush and at the Skerries; and at Magee Island, and Agnew's Hill, 5 m. W. of Larne. In cavities in the basalt of the Pflasterkaute, near Eisenach (Credner, Jb. Min., 59, 1860, Luedecke, l. c.) with thomsonite, gismondite, phillipsite, etc. In augite-porphyryte in the Serra de Botucatú, Brazil; also at other localities, as stated above.

In the United States with other zeolites on Fritz island in the Schuylkill R., Penn.; in the basalt of Table Mt. near Golden, Colorado, with other zeolites. In the North Mountain of King's Co., and Gates's Mountain, of Annapolis Co., N. Scotia, with faröelite, in masses, sometimes large (one reported as large as a man's head), usually within fine fibrous, radiated, and somewhat plumose; also at Cape Blomidon.

**Ref.**—[1] Made triclinic by Dx. on optical grounds (Min., 1, p. 388), the crystals being penetration-twins and a section ∥ *c* being divided into four sectors with extinction-directions inclined 11° to 15° in those adjacent, but alike for those opposite. Luedecke (Jb. Min., 2, 28, 1881; Zs. Nat. Halle, 63, 42, 1890) has attempted to establish an orthorhombic, a monoclinic, and a triclinic variety; the first being galactite from Bishoptown (which, however, is more naturally placed under natrolite); the second the mesolite from Iceland and Pflasterkaute; the third the crystals from an unknown locality described by Des Cloizeaux. Schmidt (Zs. Kr., 11, 594, 1886), however, argues that it is probably monoclinic like scolecite.

## Thomsonite Group.

| | | |
|---|---|---|
| **456.** | **Thomsonite** | Orthorhombic |
| **457.** | **Hydronephelite** | Hexagonal |
| | Ranite. | |

**456. THOMSONITE.** Mesotype pt. *H.*, Tr., 1801. Thomsonite (fr. Scotland) *Brooke*, Ann. Phil., **16**, 193, 1820. Comptonite (fr. Somma) *Brewster*, Ed. Phil. J., **4**, 131, 1821. Mesole *Berz.*, Ed. Phil. J., **7**, 6, 1822. Triploklas *Breith.*, Char., 1832. Chalilite *T. Thomson*, Min., **1**, 324, 1836. Scoulerite *R. D. Thomson*, Phil. Mag., **17**, 408, 1840. Ozarkite (fr. Arkansas) *Shep.*, Am. J. Sc., **2**, 251, 1846. Karphostilbit *v. Walt.*, Vulk. Gest., 272, 1853. Faröelite (= Mesole) *Heddle*, Phil. Mag., **13**, 50, 1857, **15**, 28, 1858. Tonsonite *Ital*.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}99324 : 1 : 1{\cdot}00662$ Brögger[1].
$100 \wedge 110 = 44° \; 48\frac{1}{3}'$, $001 \wedge 101 = 45° \; 23'$, $001 \wedge 011 = 45° \; 11\frac{1}{3}'$.

**Forms**[2]:
$a$ (100, $i$-$\bar{i}$)
$b$ (010, $i$-$\breve{i}$)
$c$ (001, $O$)
$m$ (110, $I$)
$r$ (101, 1-$\bar{i}$)
$d$ (401, 4-$\bar{i}$)?
$e$ (801, 8-$\bar{i}$)?
$x$ (0·1·48, $\frac{1}{48}$-$\breve{i}$)
$y$ (012, $\frac{1}{2}$-$\breve{i}$)
$p$ (111, 1)

1. 2.

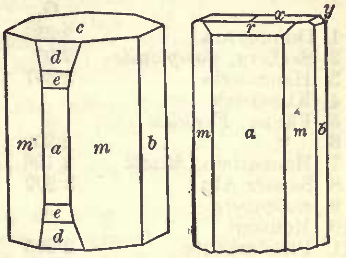


Fig. 1, Kilpatrick, Greg & Lettsom.
2, Norway, Brögger.

The axial ratio (as noted by Bgr.) deviates but little from the isometric system; cf. the angles for $p$ below.

$mm''' = 89° \; 37'$
$rr' = 90° \; 46'$
$ar = {}^*44° \; 37'$
$dd' = 152° \; 17'$
$ee' = 165° \; 56'$
$xx' = 2° \; 24'$
$yy' = 53° \; 26'$
$cy = {}^*26° \; 43'$

$pp' = 71° \; 4\frac{1}{2}'$
$pp'' = 110° \; 0\frac{1}{2}'$
$pp''' = 70° \; 31'$
$pp^{iv} = 69° \; 59\frac{1}{2}'$
$ap = 54° \; 28'$
$bp = 54° \; 44'$
$cp = 55° \; 0'$

Distinct crystals rare; in prisms with prismatic faces strongly striated vertically. Commonly columnar, structure radiated; in radiated spherical concretions; also closely compact.

Cleavage: $b$ perfect; $a$ less so; $c$ in traces. Fracture uneven to subconchoidal. Brittle. H. = 5–5·5. G. = 2·3–2·4. Luster vitreous, more or less pearly. Snow-white; reddish, green; impure varieties brown. Streak uncolored. Transparent to translucent. Pyroelectric. Optically +. Ax. pl. ∥ $c$. Bx ⊥ $b$. Dispersion $\rho > v$ strong. Axial angles, Dx.:

Dumbarton $2E_r = 82°–82° \; 18'$ $2E_{bl} = 84° \; 11'–84° \; 42'$
Seeberg $2H_{a.r} = 55° \; 22'$ $2H_{o.r} = 132° \; 26'$ $\therefore 2V_r = 53° \; 50'$ $2E_r = 85° \; 47'$ $\beta_r = 1{\cdot}503$ Dx.
Mte. Somma $2E_r = 86°$ $2E_{bl} = 89° \; 53'$
Fassathal $2E_r = 93° \; 25'$ $2E_{bl} = 96° \; 53'$

**Var.**—1. *Ordinary*. ($a$) In regular crystals, usually more or less rectangular in outline, prismatic in habit. ($b$) Prisms slender, often vesicular to radiated. ($c$) Radiated fibrous. ($d$) Spherical concretions, consisting of radiated fibers or slender crystals. Also massive, granular to impalpable, and white to reddish brown, less often green as in *lintonite*, anal. 15, 16. The spherical massive forms also radiated with several centers and of varying colors, hence of much beauty when polished.

*Ozarkite* is a white massive thomsonite (as shown by Smith and Brush), either granular or compact, with G. = 2·24, from Arkansas.

2. *Mesole* (*Faröelite* of Heddle), the original from the Färöer, occurs in spherical concretions, consisting of lamellar radiated individuals, pearly in cleavage. It occurs with mesolite and apophyllite, and contains a little more silica than normal thomsonite. Mesole was long since referred to thomsonite by Haidinger.

*Scoulerite* R. D. Thomson, from Portrush, Antrim, is mesole in structure.

3. *Chalilite* Thomson is a compact variety, of a reddish brown color, from the Donegore Mts., Antrim, cf. 5th Ed., p. 425.

**Comp.**—$(Na_2,Ca)Al_2Si_2O_8 + \frac{5}{2}H_2O$ or $(Na_2,Ca)O.Al_2O_3.2SiO_2.\frac{5}{2}H_2O$. The ratio of $Na_2 : Ca$ varies from 3 : 1 to 1 : 1. Percentage composition:

| | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|
| $Ca : Na_2 = 3 : 1$ | 37·0 | 31·4 | 12·9 | 4·8 | 13·9 | = 100 |
| “ “ = 2 : 1 | 36·9 | 31·4 | 11·5 | 6·4 | 13·8 | = 100 |
| “ “ = 1 : 1 | 36·8 | 31·3 | 8·6 | 9·5 | 13·8 | = 100 |

Mesole shows a little more silica, and the same is true of some other varieties, and it does not seem possible to explain this, in all cases, by the assumption of free quartz.

**Anal.**—1, 3, Rg., J. pr. Ch., **59**, 349, 1853. 2, Pogg., **46**, 286, 1839. 4, 5, Lemberg, Zs. G. Ges., **28**, 556, 554, 1876. 6, 7, Hersch, Inaug. Diss., p. 22, Zürich, 1887. 8, Haushofer, J. pr. Ch., **103**, 305, 1868. 9, Svebla, Vh. G. Reichs., 24, 1882. 10, John, ib., 304, 1875, after deducting 19 p. c. $CaCO_3$. 11, Luedecke, Zs. Kr., **7**, 88, 1882. 12, Young, Ch. News, **27**, 56, 1873. 13–15, Miss L. A. Linton, quoted by Peckham and Hall, Am. J. Sc., **19**, 122, 1880. 14*a*, recalculated (to $SiO_2 = 40·45$) on the assumption of the presence of free silica. 16, F. L. Sperry, priv. contr. 17, Smith and Brush, ib., **16**, 50, 1853. 18–20, W. F. Hillebrand, U. S. G. Surv., Bull. **20**, pp. 19, 25, 1885.

| | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Dumbarton | 2·383 | 38·09 | 31·62 | 12·60 | 4·62 | — | 13·40 | = 100·33 |
| 2. Seeberg, *Comptonite* | 2·37 | 38·74 | 30·84 | 13·43 | 3·85 | 0·54 | 13·10 | = 100·50 |
| 3. Hauenstein | 2·357 | 39·63 | 31·25 | 7·27 | 8·03 | — | 13·03 | = 99·21 |
| 4. Kilpatrick | | 37·21 | 31·72 | 13·60 | 4·20 | — | 13·27 | = 100 |
| 5. Färöer, *Faröelite* | | 39·98 | 29·62 | 11·77 | 4·87 | — | 13·76 | = 100 |
| 6. “ “ | 2·252 | 41·56 | 28·23 | 11·39 | 4·20 | — | 14·98 | = 100·36 |
| 7. Hauenstein, *Mesole* | 2·196 | $\frac{2}{2}$ 39·87 | 29·40 | 8·15 | 8·26 | — | 14·52 | = 100·20 |
| 8. Seisser Alp | 2·309 | 39·60 | 31·55 | 11·98 | 4·10 | — | 13·10 | = 100·33 |
| 9. Eulenberg | | 38·44 | 31·48 | 13·60 | 3·53 | — | 12·93 | = 99·98 |
| 10. Monzoni | | 39·24 | 27·90 | 12·45 | 7·95 | 0·60 | 11·86 | = 100 |
| 11. Pflasterkaute | 2·295 | 36·86 | 30·46 | 18·70 | 0·46 | — | 13·22 | = 99·70 |
| 12. Mugdock | 2·380 | 36·84 | 31·57 | 13·54 | 4·31 | — | 13·54 | = 99·80 |
| 13. Grand Marais, *opaq. wh.* | | $\frac{3}{3}$ 40·45 | 29·50 | 10·75 | 4·76 | 0·36 | 13·93 | $Fe_2O_3$ 0·23 = 99·98 |
| 14. “ “ | | $\frac{3}{3}$ 46·02 | 26·72 | 9·40 | 3·76 | 0·39 | 12·80 | $Fe_2O_3$ 0·81 = 99·90 |
| 14*a*. “ “ | | 40·45 | 29·37 | 10·43 | 4·28 | 0·42 | 13·93 | $Fe_2O_3$ 0·88 = 99·76 |
| 15. “ “ *Lintonite* | | 40·61 | 30·21 | 10·37 | 4·06 | 0·49 | 13·75 | FeO 0·40 = 99·89 |
| 16. “ “ “ | | $\frac{2}{2}$ 44·53 | 27·36 | 9·90 | 5·92[a] | — | 13·08 | MgO 0·26 = 101·05 |
| 17. *Ozarkite* | | 36·85 | 29·42 | 13·95 | 3·91 | — | 13·80 | $Fe_2O_3$ 1·55 = 99·48 |
| 18. Table Mt., Col., *spherules* | | 40·52 | 29·22 | 12·43 | 4·31 | — | 12·79 | $Fe_2O_3$ 0·79 = 100·06 |
| 19. “ “ | | 40·88 | 29·68 | 11·88 | 4·72 | — | 12·91 | = 100·07 |
| 20. “ “ | | $\frac{2}{2}$ 40·69 | 29·93 | 11·91 | 4·44 | — | 12·86 | = 99·83 |

[a] Probably a little too high.

The Mittelgebirge mineral changes but slightly in moist or dry air, according to Damour; after two hours at 280° C. it loses 6·1 p. c., and very slowly regains the water lost in the open air, the loss being reduced to 1·5 p. c. after forty hours. At a red heat the loss is 13·3 p. c., and the mineral becomes fused to a white enamel.

Hersch (l. c., anal. 6) obtained the following results after two hours' heating in each case:

| Temp. | 100° | 150° | 195° | 240° | 305° | red ht. |
|---|---|---|---|---|---|---|
| $H_2O$ | 1·61 | 3·68 | 4·84 | 5·58 | 7·95 | 14·98 p. c. |

Also for “ mesolith,” anal. 7:

| Temp. | 100° | 160° | 200° | 250° | 300° | red ht. |
|---|---|---|---|---|---|---|
| $H_2O$ | 2·43 | 3·19 | 4·93 | 5·99 | 7·92 | 14·50 p. c. |

**Pyr., etc.**—B.B. fuses with intumescence at 2 to a white enamel. Gelatinizes with hydrochloric acid.

**Obs.**—Found in cavities in lava and other igneous rocks, sometimes with elæolite as a result of its alteration.

Occurs near Kilpatrick, and at Kilmalcolm and Port Glasgow, Scotland, in amygdaloid; in the lavas of Somma (*comptonite*); in basalt at the Pflasterkaute in Saxe Weimar; at Seeberg and elsewhere in Bohemia, in the cavities of phonolyte; in the Cyclopean islands, Sicily, with analcite and phillipsite; on the islands, Låven, Arö, etc., in the Langesund fiord, also Klokkerholmen near Brevik, Norway; in the Färöer; in phonolyte at Hauenstein, Bohemia; in Hungary, near Schemnitz; at Theiss, Tyrol; at Mt. Monzoni, Fassathal; in straw-yellow needles (*carpholstilbite*) at the Berufiord, Iceland, G. = 2·362.

Long, slender, prismatic crystallizations, of a grayish white color, are obtained at Peter's Point, Nova Scotia, where it is associated with apophyllite, mesotype, laumontite, and other related minerals. In the U. S., occurs fibrous radiated and massive (*ozarkite*) at Magnet Cove, in the Ozark Mts., Arkansas, in cavities in elæolite (from the alteration of which it has apparently resulted), with slender prisms of apatite. Also in the amygdaloid of Grand Marais, L. Superior, which yields the water-worn pebbles on the shores of the lake; they are in part white porcelain-like, in part fibrous radiated with several centers, and showing zones of green, red, and white; also fine granular, of a green color (*lintonite*), anal. 15, 16; named from Miss Laura A. Linton. In the basalt of Table Mt. near Golden, Colorado.

*Mesole* is from the cave of Nalsö, island of Färö; Disco I., Greenland; Annaklef, Sweden, a few miles west of C. Blomidon, Bay of Fundy, near the small village of Ft. George.

**Alt.**—The Mte. Somma comptonite is partially altered, involving a loss of water, assumption of $CaCO_3$, and a change in the amounts of silica and alumina. Analyses by E. Scacchi gave:

| $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $H_2O$ | $CO_2$ |
|---|---|---|---|---|---|
| 41·18 | 12·22 | 38·01 | 2·04 | 1·79 | 1·79 = 99·95 |
| 39·17 | 35·99 | 14·65 | 2·87 | 5·77 | [1·55] = 100 |

Acc. Napoli, Dec. 12, 1888, the analyses corrected by Cathrein, Zs. Kr., **18**, 101, 1890.

Lemberg has shown that solutions of potassium and sodium carbonate in 3½ months accomplished an exchange of potassium and sodium respectively for most of the calcium, but more rapidly in the former case. Further the potash compound so formed is largely reconverted into the original mineral by treatment with calcium chloride. Zs. G. Ges., **28**, 555, 1876.

Doelter shows that by slow cooling after fusion, a crystalline mass is obtained, consisting of distinct anorthite crystals, chiefly twins. This corresponds with the formula above accepted (Rg.) by which it is essentially a hydrate of anorthite.

**Ref.**—[1] Låven, Langesund fiord, Norway, **16**, 641, 1890; also earlier, Zs. Kr., **2**, 289, 1879. [2] See Bgr., l. c., cf. also Greg, Min., 158, 1859, Dx., Min., **1**, 374, 1862. Also perhaps 705, Phillips, but doubtful; cf. Gdt., Index, **3**, 205, 1891. Luedecke, l. c., gives $0\cdot1\cdot50$ (= *x*) on thomsonite from the Pflasterkaute. Twins, resembling harmotome, are mentioned by Guthe, JB. Ges. Hann., **14**, 47, 1864.

PICROTHOMSONITE *Meneghini & Bechi*, Am. J. Sc., **14**, 63, 1852. Picrotonsonite *Ital.* Like thomsonite in form, and near it in composition. The soda is replaced by magnesia, and possibly as a result of alteration. Occurs in radiated masses, laminated in structure; H. = 5; G. = 2·278; luster pearly; white; transparent in small fragments; very fragile. Analysis, Bechi:

$SiO_2$ 40·36 $Al_2O_3$ 31·25 MgO 6·26 CaO 10·99 $Na_2O,K_2O$ 0·29 $H_2O$ 10·79 = 90·94

B.B. fuses to a white enamel, with intumescence. Dissolves in cold acids and gelatinizes. Occurs with caporcianite in the gabbro rosso of Tuscany. The name, from πικρός, *bitter*, and *thomsonite*, alludes to the magnesia present.

**457. HYDRONEPHELITE.** *F. W. Clarke*, Am. J. Sc., **31**, 265, 1886.

Ranite. Rauit S. R. Paijkull, Inaug. Diss., Ber. Ch. Ges., **7**, 1334, 1874. Rauite *wrong orthog.* Hydronephelit-spreustein *Brögger*, Zs. Kr., **16**, 234, 1890.

Probably hexagonal. In massive forms, with radiated structure.

H. = 4·5–6. G. = 2·263 Clarke; 2·48 Paijkull. Luster vitreous. Color white; also dark gray to grayish black. Translucent to nearly opaque. Optically uniaxial, positive.

**Comp., Var.**—For hydronephelite $HNa_2Al_3Si_3O_{12} + 3H_2O$ or $2Na_2O.3Al_2O_3.6SiO_2.7H_2O$ = Silica 39·3, alumina 33·4, soda 13·5, water 13·8 = 100.

Ranite is $(Na_2,Ca)Al_2Si_2O_8 + 2H_2O$, which is equivalent to $\overset{I}{R}_3Al_3Si_3O_{12} + 3H_2O$ like hydronephelite. Calcium is present with the sodium.

**Anal.**—1, F. W. Clarke, l. c. 2, Paijkull, l. c.

| | G. | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. *Hydronephelite* | 2·263 | 38·99 | 33·62 | 0·07 | 13·07 | 1·12 | 12·98 = 99·85 |
| 2. *Ranite* | 2·48 | 39·21 | 31·79 | 5·07 | 11·55 | — | 11·71 $Fe_2O_3$ 0·57 = 99·90 |

Other analyses of hydronephelite on material slightly impure gave results similar to those quoted.

**Pyr., etc.**—Fusible easily to a white enamel. Soluble in hydrochloric acid with gelatinization.

**Obs.**—*Hydronephelite* is from Litchfield, Maine, where it occurs intimately mixed with sodalite, from the alteration of which it has been derived.

*Ranite* occurs on the island Låven (also called Lamö) in the Langesund fiord, Norway, where it has been formed from the alteration of elæolite. Named for the old Norse sea-god, Ran. Brögger shows that it includes part of what has passed under the name of *spreustein*, see also p. 602.

## APPENDIX TO ZEOLITES.

**Chlorastrolite** *C. T. Jackson; J. D. Whitney*, J. Nat. Hist. Boston, **5**, 488, 1847. Shown by Hawes not to be a homogeneous mineral. An analysis gave:

$SiO_2$ 37·41, $Al_2O_3$ 24·62, $Fe_2O_3$ 2·21, FeO 1·81, MgO 3·46, CaO 22·20, $Na_2O$ 0·32, $H_2O$ 7·72 = 99·75, Am. J. Sc., **10**, 25, 1875.

Referred by Hawes to prehnite, but by Lacroix to thomsonite on optical grounds, Bull. Soc. Min., **10**, 147, 1888. It occurs in small rounded pebbles with finely radiated or stellated structure and of a light bluish green color. H. = 5·5. G. = 3·180. Found on the shores of Isle Royale, Lake Superior, derived from the trap. Named from χλωρός, *green*, ἄστρον, *star*, λίθος, *stone.*

**Zonochlorite** *A. E. Foote*, Rep. Amer. Assoc., 65, 1873; App. II, 63. Similar to chlorastrolite. Hawes (Am. J. Sc., **10**, 24, 1875) obtained from an analysis of a dark green specimen: $SiO_2$ 35·94, $Al_2O_3$ 19·41, $Fe_2O_3$ 6·80, FeO 4·54, MgO 2·48, CaO 22·77, $Na_2O$ *tr.*, $H_2O$ 8·40 = 100·34. Microscopic examination showed the presence of green earthy particles as impurities disseminated through a white mineral. From the amygdaloid of Neepigon Bay, Lake Superior.

**Dolianite** *English collectors; Dx.*, Min., **1**, 435, 1862. *A. Lacroix*, Bull. Soc. Min., **8**, 356, 1885. A doubtful zeolitic mineral, stated to come from Knock Station, Ayrshire, Scotland. Occurs in cone-shaped masses with fan-shaped lamellar structure; cleavage basal, easy; soft; luster pearly; color white. Optically uniaxial, negative.

B.B. fuses with some difficulty to a white enamel. Analysis, author unknown:

$SiO_2$ 53·24 $Al_2O_3$ 35·46 CaO 5·73 MgO 0·02 $H_2O$ 4·04 = 98·49

**Episphärite** *A. Knop*, Zs. Kr., **18**, 668, 1891. An undetermined zeolitic mineral occurring in white spherical forms with radiated fibrous structure on natrolite in the phonolyte of Oberschaffhausen, Kaiserstuhl.

**Sasbachite** (Saspachite) *J. Schill*, Jb. Min., 452, 1846, Dx., Min., **1**, 420, 1862. A zeolitic mineral from Sasbach in Kaiserstuhl, afforded J. Schill: $SiO_2$ 51·50, $Al_2O_3$ 16·51, CaO 6·20, $K_2O$ 6·82, MgO 1·93, $H_2O$ 17·00 = 99·96. Occurs in tufts of fibers and concretions; G. = 1·465; H. = 4–5; white or colorless; luster silky to vitreous. Easily soluble in hydrochloric acid. Occurs in doleryte in cavities, and is often overlaid by faujasite and apophyllite.

**Sloanite** *Meneghini & Bechi*, Am. J. Sc., **14**, 64, 1852. Orthorhombic. Cleavage: prismatic (75°) very distinct. In radiated masses with transverse fracture. H. = 4·5. G. = 2·441. Luster pearly. White. Opaque.

Analysis, Bechi, l. c.:

$SiO_2$ 42·19 $Al_2O_3$ 35·00 CaO 8·12 MgO 2·67 $Na_2O$ 0·25 $K_2O$ 0·03 $H_2O$ 12·50 = 100·76

B.B. fuses without intumescence to a white enamel. Dissolves in acids even in the cold, and gelatinizes. From the gabbro rosso of Tuscany. Named after Mr. Sloane, proprietor of the Mte. Catini mine.

**Unknown Zeolite** *O. Beyer*, Min. Mitth., **10**, 31, 1888. In spherical forms and crusts, showing minute crystals (hexagonal?). H. = 4·5. G. = 2·162. Analysis, O. Beyer:

$SiO_2$ 57·50 $Al_2O_3$ 18·11 CaO 4·63 MgO 1·20 $K_2O$ 6·98 $Na_2O$ 2·40 $H_2O$ 10·48 = 101.30

Only slightly attacked by acids. Occurs in amygdaloidal cavities in slag-like inclusions of the basalt of the Grossdehsaer Berg.

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## II. Mica Division.

The species embraced under this Division fall into three groups: 1, the **Mica Group**, including the Micas proper; 2, the **Clintonite Group**, or the Brittle Micas; 3, the **Chlorite Group**. Supplementary to these are the Vermiculites, hydrated compounds chiefly results of the alteration of some one of the micas.

All of the above species have the characteristic micaceous structure, that is, they have highly perfect basal cleavage and yield easily thin laminæ. They belong to the monoclinic system, but the position of the bisectrix in general deviates but little from the normal to the plane of cleavage; all of them show on the basal section plane angles of 60° or 120°, marking the relative position of the chief zones of forms present, and giving them the appearance of hexagonal or rhombohedral symmetry; further, they are more or less closely related among themselves in the angles of prominent forms.

The species of this Division all yield water upon ignition, the micas mostly from 4 to 5 p. c., the chlorites from 10 to 13 p. c.; this is probably to be regarded in all cases as water of constitution, and hence they are not strictly *hydrous* silicates.

More or less closely related to these species are those of the Serpentine and Talc Division and the Kaolin Division following, many of which show distinctly a mica-like structure and cleavage and also pseudo-hexagonal symmetry.

---

### 1. Mica Group. Monoclinic.

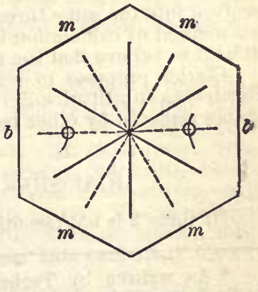
| | | | |
|---|---|---|---|
| 458. | **Muscovite** | Potassium Mica | $H_2KAl_3(SiO_4)_3$ |
| | | | $\grave{a} : \overset{|}{b} : \acute{c} = 0{\cdot}57735 : 1 : 3{\cdot}3128 \quad \beta = 89° 54'$ |
| 459. | **Paragonite** | Sodium Mica | $H_2NaAl_3(SiO_4)_3$ |
| 460. | **Lepidolite** | Lithium Mica | $KLi[Al(OH,F)_2]Al(SiO_3)_3$ pt. |
| 461. | **Zinnwaldite** | Lithium-iron Mica | $(K,Li)_3FeAl_3Si_5O_{16}(OH,F)_2$? |
| 462. | **Biotite** | Magnesium-iron Mica | $(H,K)_2(Mg,\overset{II}{Fe})_2(Al,\overset{III}{Fe})_2(SiO_4)_3$ pt. |
| | | | $\grave{a} : \overset{|}{b} : \acute{c} = 0{\cdot}57735 : 1 : 3{\cdot}2743 \quad \beta = 90° 0'$ |
| 462A. | **Phlogopite** | | $(H,K,(MgF))_3Mg_3Al(SiO_4)_3$ |
| | | Magnesium Mica; usually containing fluorine, nearly free from iron. | |
| 462B. | **Lepidomelane** | Annite | |
| | | Iron Micas. Contain ferric iron in large amount. | |

The species of the MICA GROUP crystallize in the monoclinic system[1], but with a close approximation to either rhombohedral or to orthorhombic symmetry; the plane angles of the base are in all cases 60° or 120°. They are all characterized by highly perfect basal cleavage, yielding very thin, tough, and more or less elastic laminæ. The negative bisectrix, $\mathfrak{a}$, is very nearly normal to the basal plane, varying at most but a few degrees from this; hence a cleavage plate shows the axial interference-figure, which for the pseudo-rhombohedral kinds is often uniaxial or nearly uniaxial. Of the species named above, biotite has usually a very small axial angle, and is often sensibly uniaxial; the axial angle of phlogopite is also small, usually 10° to 12°; for muscovite, paragonite, lepidolite the angle is large, in air commonly from 50° to 70°.

The Micas may be referred to the same fundamental axial ratio with an angle of obliquity differing but little from 90°; they show to a considerable extent the same forms, and their isomorphism is further indicated by their not infrequent intercrystallization in parallel position, as biotite with muscovite, lepidolite with muscovite, etc.

A blow with a somewhat dull-pointed instrument on a cleavage plate of a mica develops in all the species a six-rayed *percussion-figure*[2] (f. 1), two lines of which are parallel to the prismatic edges, the third, which is the most strongly characterized (Leitstrahl *Germ.*), is parallel to the clinopinacoid or plane of symmetry. The micas are often divided into two classes, according to the position of the plane of the optic axes. In the *first class* belong those kinds for which the optic axial plane is normal to *b* (010), the plane of symmetry (f. 1); in the *second class* the axial plane is parallel to the plane of symmetry. The percussion-figure serves to fix the crystallographic orientation when crystalline faces are wanting. A second series of lines at right angles to those mentioned may be more or less distinctly developed

1.



by pressure[3] of a dull point on an elastic surface, forming the so-called *pressure-figure;* this is sometimes six-rayed, more often shows three branches only, and sometimes only two are developed. In f. 1 the position of the pressure-figure is indicated by the dotted lines. These lines are connected with gliding-planes inclined some 67° to the plane of cleavage (see beyond).

The micas of the *first class* include: Muscovite, paragonite, lepidolite, also some rare varieties of biotite called anomite.

The *second class* embraces: Zinnwaldite and most biotite, including lepidomelane and phlogopite.

Chemically considered, the micas are silicates, and in most cases orthosilicates, of aluminium with potassium and hydrogen, also often magnesium, ferrous iron, and in certain cases ferric iron, sodium, lithium (rarely rubidium and cæsium); further, rarely, barium, manganese, chromium. Fluorine is prominent in some species, and titanium is also sometimes present. Other elements (boron, etc.) may be present in traces. All micas yield water upon ignition in consequence of the hydrogen (or hydroxyl) which they contain.

The composition of the micas is still involved to a greater or less degree in uncertainty, and although much light has been thrown upon the subject in recent years, it is impossible to give general formulas, for all the different species, which do not rest to a greater or less extent upon hypothesis[4].

Tschermak explains the composition of the micas by regarding them as isomorphous mixtures of the following fundamental molecules:*

$$K = H_2KAl_3Si_3O_{12} \qquad M = Mg_6Si_3O_{12} \qquad S = H_4Si_6O_{12}$$

Of these, K corresponds to ordinary muscovite; M is a hypothetical polymere of chrysolite, and S a hypothetical silicon hydroxide which may also take the form $Si_5F_{12}O_4$. In K other ratios may exist between the hydrogen and potassium, e.g., $K'' = HK_2Al_3Si_3O_{12}$, etc.; also the potassium may be replaced by sodium and lithium; further, the aluminium by ferric iron (and chromium). Also the magnesium in M may be replaced by ferrous iron and manganese. As briefly summarized by the author the composition is as follows:

Ordinary Muscovite, as already stated, corresponds to the simple orthosilicate formula, $H_2KAl_3Si_3O_{12}$. Some kinds, however, are more acidic and are interpreted as equivalent to $3H_2KAl_3Si_3O_{12} + H_4Si_5O_{12}$.

Lepidolite corresponds to $3K_3Al_3Si_3O_{12} + Si_5F_{12}O_4$, with the potassium one-half replaced by lithium and the fluorine by hydrogen.

Zinnwaldite is $(K,Li)_3Al_3Si_3O_{12},Fe_5Si_3O_{12},Si_5(F,H)_{12}O_4$ in the ratio of 10 : 2 : 3.

Ordinary Biotite ("Meroxene") is $HKAl_2Si_2O_8$ and $Mg_4Si_2O_8$ in the ratio of 1 : 1, 2 : 1, and intermediate ratios.

For the "Anomite" analyzed the composition is assumed $HK_2Al_3Si_3O_{12},Mg_6Si_3O_{12}$, also in the ratios from 1 : 1 to 2 : 1.

Lepidomelane is $H_2KAl_3Si_3O_{12}$ and $Mg_6Si_3O_{12}$, with the aluminium largely replaced by ferric iron.

Phlogopite is regarded as containing the molecules $K_3Al_3Si_3O_{12},Mg_6Si_3O_{12},H_4Si_5O_{12}$ (or $Si_4F_{12}O_4$), often in the ratio 3 : 4 : 1.

For the fuller discussion of the subject and the process of calculation by which these supposed fundamental molecules are deduced, reference is made to the original memoirs.

Rammelsberg[4] regards the micas as containing the three silicates $R_2SiO_3$, $R_4SiO_4$, $R_6SiO_5$ in various molecular relations, e.g., Muscovite is $R_4SiO_4 + Al_4Si_3O_{12}$; the more acidic kinds are $R_{14}Si_4O_{15} = R_2SiO_3 + 3R_4SiO_4$, which is further written $m\overset{I}{R}_{14}Si_4O_{16} + n\overset{II}{R}_7Si_4O_{16} + p\overset{III}{R}_{14}Si_{12}O_{45}$, in which $m : n : p = 5 : 1 : 5$, $7 : 1 : 7$, $9 : 1 : 9$ in different cases. Similarly the other micas are resolved into the same three silicates, and the ratios in which they enter are calculated. That this method of calculation is applicable to any silicate, however complex, is obvious, but it is difficult to believe that the results reached really give the true constitution of the compounds.

Clarke[4] proposes to regard all the orthosilicate micas (as indeed other aluminous orthosilicates) as substitution derivatives of $Al_4(SiO_4)_3$, in which the aluminium is more or less completely replaced by other metals, the possible types being:

$$\begin{array}{ccc} 1. & 2. & 3. \\ \overset{I}{R}_3Al_3(SiO_4)_3 & \overset{I}{R}_6Al_2(SiO_4)_3 & \overset{I}{R}_9Al(SiO_4)_3 \end{array}$$

Of these 2 is not essential, since it may be resolved into equal molecules of 1 and 3. Here

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* As written by Tschermak, these have the double form, $K = H_4K_2Al_6Si_6O_{24}$, etc., and similarly beyond.

$\overset{I}{R}$ represents a univalent metal, as H,K,Na,Li, or a univalent radical, as MgF,$AlF_2$,AlO. Further, type 1 is obviously equivalent to $\overset{I}{R}\overset{II}{R}Al_3(SiO_4)_3$, or again to $\overset{II}{R}_3Al_6(SiO_4)_6$, where $\overset{II}{R}$ = Mg,Fe,Mn, etc.; similarly for the others.

Under these types may be embraced, then, all the orthosilicate micas, those with fluorine being assumed to contain the group MgF (or $AlF_2$), and those with an excess of oxygen the univalent group AlO.

For the more acid micas, the assumption is made that, analogous to the feldspars, they contain polysilicic acid, $H_4Si_3O_8$, which is tetrabasic like orthosilicic acid. For this there would be types similar to these above, so that the composition of a given mica would be expressed:

$$\begin{array}{ccc} 1. & 2. & 3. \\ \left\{\begin{array}{l} mR_3Al_3(SiO_4)_3 \\ nR_3Al_3(Si_3O_8)_3 \end{array}\right. & \left\{\begin{array}{l} mR_6Al_2(SiO_4)_3 \\ nR_6Al_2(Si_3O_8)_3 \end{array}\right. & \left\{\begin{array}{l} mR_9Al(SiO_4)_3 \text{ etc.} \\ nR_9Al(Si_3O_8)_3 \end{array}\right. \end{array}$$

Or representing $SiO_4$ and $Si_3O_8$ by X, the micas then would fall within the limits of $\overset{I}{R}_3Al_3X_3$ and $R_9AlX_3$.

The application to muscovite will explain this: Ordinary muscovite is $H_2KAl_3(SiO_4)_3$ conforming to type 1 above where $R_3 = H_2K$; the acidic muscovites (phengite of Tschermak) are regarded as molecular mixtures of

$$H_2KAl_3(SiO_4)_3 \quad \text{and} \quad H_2KAl_3(Si_3O_8)_3$$

Again normal lepidolite is a metasilicate, but (p. 311) metasilicic acid is equivalent to combined molecules of ortho- and polysilicic acid: $2H_2SiO_3 = H_4SiO_4 + H_4Si_3O_8$.

Further, since the Li and $AlF_2$ vary somewhat with the silica and hence seem to be connected with $Si_3O_8$, normal lepidolite is resolved into

$$HKLiAl_3(SiO_4)_3 + (AlF_2)_3K_3Li_3Al(Si_3O_6)_3$$

The view of Clarke has the advantage that it assumes only one hypothetical molecule, which, moreover, is analogous to known compounds which play an important part in the Feldspar Group.

**Artif.**—The artificial formation of some of the micas has been recently accomplished by several methods. Early statements on the occurrence of mica-like minerals in slags are more or less questionable; more recently Vogt (Ak. H. Stockh., Bih. **9**, 1, 39, 1884) describes mica in the slags of Kafveltorp, see also Id., Arch. Math. Nat., **13**, 90, 1889. Hautefeuille and St. Giles (C. R., **104**, 508, 1887) by fusing the constituents of iron-mica mixed with $\frac{1}{5}$ of fluoride of silicon and potassium obtained on cooling (when some 3 to 4 p. c. of fluorine still remained) a mass of thin hexagonal tables, which were uniaxial, highly pleochroic (pale and deep brown). Similar mica scales of colorless, green, or brown were obtained when a small amount of potassium arsenate was added, and hydrogen allowed to act on the fused mass. Khrushchov in 1888 (Bull. Soc. Min., **11**, 173) announced the formation of biotite, margarite, and muscovite(?) by fusing together different substances (as magnesia, baryta, cryolite) with lepidolite or a magma having its composition with an excess of silica, alumina and alkaline fluorides. Cf. also Min. Mitth , **9**, 55, 1887, in which place the same author earlier describes an artificial magnesium mica. Doelter (Min. Mitth., **10**, 67, 1888, Jb. Min., **2**, 178, 1888) has also found several of the micas by fusing various natural silicates (hornblende, actinolite, glaucophane, andalusite, garnet, etc.) with the fluorides of sodium and magnesium; micas corresponding to biotite, phlogopite, muscovite, zinnwaldite were obtained.

Pliny probably included the mineral mica with the *Lapis specularis* (**36**, 45) or *Selenite;* and the shavings or scales of *Lapis specularis* strown over the "Circus Maximus," to produce an agreeable whiteness, were probably those of a soft silvery mica schist. His *Hammochrysos* also (**37**, 73, named from *ἄμμος, sand, χρυσός, gold)* was probably sand from a yellowish mica schist, which abounds by the roadside in many mica-schist regions. Agricola speaks of the deceptive character of this silvery and golden dust, as cited below. This silvery and golden mica in scales is the *Cat-silver* and *Cat-gold* of mediæval Europe (Katzengold, Katzensilber, *Germ.*, Or (Argent) des chats *Fr.*).

The following is the synonymy of the mineral since the time of Pliny:

Mica, Ammochrysos, colore argento ita simile sit, ut pueros et rerum metallicarum imperitos decipere possit, *Germ.* Glimmer, Katzen-Silber, *Agric.*, Foss., 254, 447, Interpr., 466, 1546. Specularis lapis adulterinus flexilis sexangulorum *Capeller*. Prodr. Cryst., 26, 1723. Mica [Talc not included]. Vitrum Muscoviticum. V. Rutheniticum, Skimmer, VAR. alba (Kattsilver), flava (Kattgull), rubra, viridis [Chlorite fr. Sahlberg] nigra. squamosa. radians, fluctuans, hemispherica, *Wall.*, Min., 129, 131, 1747. Mica pt. [rest Talc, Chlorite], Verre de Moscovie, etc., *Fr. Trl.* Wall., **1**, 241, 1753. Mica, Glimmer, Vitrum Muscoviticum (in plates), Mica squamosa (in scales) *Cronst.*, Min., 88, 1758. Isinglass (in large plates), Glimmer or Mica (in small scales) pt. (rest Talc, Chlorite) *Hill*, Foss., 10, 13, 1771. Glimmer [Chlorite and Talc excluded] *Wern.*, Bergm. J., 37, 1789.

The word *mica* has been said to come from the Latin *mica, a crumb* or grain, as it was formerly applied especially to the mineral in scales. It is usually derived, however, from the Latin *micare*, signifying (like the German name *Glimmer*) *to shine.*

**Ref.**—[1] On the crystallization of the micas, see Tschermak, who first proved them to be all monoclinic, Ber. Ak. Wien, **76** (1), 97, 1877, and Zs. Kr., **2**, 14, 1877; also Koksharov, Mem. Ac. St. Pet., **24**, 1, 1877, Min. Russl., **7**, 167, *et seq.*, **8**, 1, etc.; cf. also references under the individual species beyond. [2] Reusch ("Körnerprobe"), Ber. Ak. Berlin, 428, July 9, 1868, 83, Feb. 4, 1869, 440, May 29, 1873. [3] Bauer, percussion- and pressure-figures, Pogg., **138**, 337, 1869; Zs G. Ges., **26**, 137, 1874. See also Reusch, Ber. Ak. Berlin, 530, 1869, on the effect of superimposed mica plates with axes inclined 60° in producing elliptically polarized light; also Cooke, Mem. Am. Ac. Boston, 35, 1874. *Etching-figures*, Baumhauer, Zs. Kr., **3**, 113, 1878; Wiik, Öfv. Finsk. Soc., 22, 1880. *Elasticity* investigated, Coromilas, Inaug. Diss., Tübingen, 1877 (Zs. Kr., **1**, 411, 1877).

[4] On the composition of the group, see Tschermak, l. c., and Ber. Ak. Wien, **78** (1), 5, 1878, or Zs. Kr., 3, 122, 1878. Also Rammelsberg, Ber. Ak. Berlin, 616, 1878, 248, 833, 1879; Zs. G. Ges., **31**, 676, 1879; Wied. Ann., **7**, 136, 1879, **9**, 113, 302, 1880; Min. Ch. Erg., 112 *et seq.*, 1886. The analyses of Rammelsberg, quoted in the following pages, are in general taken from the last-named source. The whole subject has been more recently reviewed by the same author in Abh. Ak. Berlin, 1889 (read Feb. 14). See also Clarke, Am. J. Sc., **38**, 384, 1889, **40**, 410, 1890; also earlier papers noted under the several species beyond, as, ibid., **32**, 353, 1886, **34**, 131, 1887.

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**458. MUSCOVITE.** Common Mica; Potash Mica; Biaxial Mica; Oblique Mica. Glimmer, Kaliglimmer, Zweiaxiger Glimmer, *Germ.* Muscovite *Dana*, Min., 356, 1850. Phengit *Kbl.*, Taf., 62, 1853.

DAMOURITE. Hydromica. Gilbertite *Thomson*, Min., **1**, 235, 1836. Nacrite (fr. Maine) *Thom.*, Rec. Gen. Sc., **3**, 332, 1836. Talcite (fr. Wicklow) *Thomson*, Rec. Gen. Sc., **3**, 332, 1836 [not Talcite *Kirwan* = massive scaly talc]. Margarodit *Schafhäutl*, Lieb. Ann., **46**, 336, 1843. Damourite *Delesse*, Ann. Ch. Phys., **15**, 248, 1845. Adamsite *Shep.*, Hitchcock's Rep. G. Vt., **1**, 484, 1857. Sterlingite *J. P. Cooke*, Mem. Am. Ac. Boston, 39, 1874. Sericit *List*, Lieb. Ann., **81**, 257, 1852. Metasericit *Sandberger*, Unt. Erzg., 77, 1882. Hydromuscovite *A. Johnstone*, Q. J. G. Soc., **45**, 363, 1889. Onkosin *Kobell*, J. pr. Ch., **2**, 295, 1834. Onkophyllit *Sandberger*, Ber. Ak. München, **18**, 480, 1888.

Didymit (Didrimit) *Schafhäutl*, Lieb. Ann., **46**, 330, 1843. Didrimit, *Id.*, J. pr. Ch., **76**, 136, 1859. Amphilogite *Schafhäutl*, Lieb. Ann., **46**, 330, 1843. Leucophyllite *Starkl*, Jb. G. Reichs., **33**, 653, 1883. Pyknophyllit *Starkl*, ibid., 649, 1883. Lepidomorphit *Sandberger*, Unt. Erzg., 344, 1885.

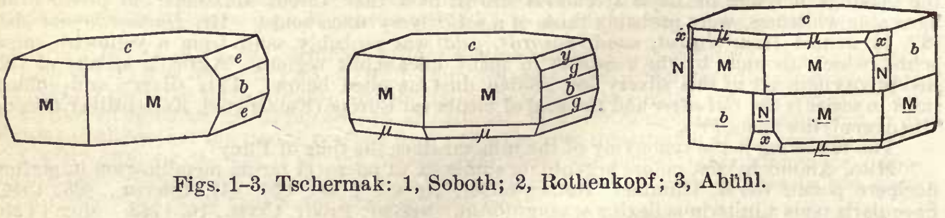
Fuchsite, Chromglimmer pt., *Schafhäutl*, Lieb. Ann., **44**, 40, 1842. Œllacherite *Dana*, Am. J. Sc., **44**, 256, 1867. Sandbergerite *Heddle*, Enc. Brit., **16**, 413, 1883.

Monoclinic. Axes $\grave{a} : \overset{1}{\bar{b}} : \acute{c} = 0{\cdot}57735 : 1 : 3{\cdot}3128$; $\beta = 89° \ 54\tfrac{1}{6}' = 001 \wedge 100$ Tschermak[1].

$100 \wedge 110 = 30° \ 0'$, $001 \wedge 101 = 80° \ 12\tfrac{1}{2}'$, $001 \wedge 011 = 73° \ 12\tfrac{1}{6}'$.

**Forms:** *e* (023, $\tfrac{2}{3}$-ì) *g* (0·17·1, 17-ì) *M* (221, − 2) *N* (261, − 6-3̀)
*b* (010, *i*-ì) *r* (011, 1-ì)? *o* (112, − $\tfrac{1}{2}$) *μ* ($\bar{1}$11, 1) *x* ($\bar{1}$31, 3-3̀)
*c* (001, *O*) *y* (043, $\tfrac{4}{3}$-ì) *n* (334, − $\tfrac{3}{4}$)?

Also *ρ* ($\bar{2}$05, $\tfrac{2}{5}$-ī), *ζ* (135, − $\tfrac{3}{5}$-3̀), gliding-planes.



Figs. 1–3, Tschermak: 1, Soboth; 2, Rothenkopf; 3, Abühl.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *cρ* | = 66° 32′ | *cn* | = 78° 32½′ | *cζ* | = 66° 25′ | *NN′* | = 119° 48′ |
| *ce* | = 65° 38′ | *cM* | = *85° 36′ | *oo′* | = 57° 10′ | *ζζ′* | = 105° 4′ |
| *cr* | = 73° 12′ | *cμ* | = *81° 30′ | *MM′* | = 59° 48′ | *bx* | = 30° 22′ |
| *cy* | = 77° 15′ | *cx* | = 85° 4′ | *μμ′* | = 59° 16½′ | *bN* | = 30° 6′ |
| *co* | = 73° 7½′ | *cN* | = 87° 27½′ | *xx′* | = 119° 16′ | *bcM* | = *60° 0′ |

Twins common according to the *mica-law:* tw. plane a plane in the zone *cM* normal to *c*, the crystals often united by *c* and chiefly left-handed twins (see further under biotite, and f. 3, 4, p. 628). Crystals rhombic or hexagonal in outline with plane angles of 60° or 120°. Habit tabular, passing into tapering forms with planes more or less rough and strongly striated horizontally; vicinal forms common. Folia often very small and aggregated in stellate, plumose, or globular forms; or in scales, and scaly massive; also crypto-crystalline and compact massive.

Cleavage: basal, eminent. Also planes of secondary cleavage ‖ *b* and several undetermined pyramids in the unit series as shown in the percussion-figure, which is a six-rayed star with rays ‖ *m*, *m′* and *b*, see p. 611. Parting by pressure further developed ‖ the gliding-planes $\rho$ $(\bar{2}05)$ and $\zeta$ (135) inclined about 66½° to *c*; natural plates hence often yield narrow strips or thin fibers ‖ axis *b*, and less distinct in directions inclined 60° to this; the traces of these planes of parting on *c* give the pressure-figure (p. 612). Thin laminæ flexible and elastic when bent, very tough, harsh to the touch, passing into kinds which are less elastic and have a more or less unctuous or talc-like feel. Etching-figures on *c* monoclinic in symmetry.

H. = 2–2·5. G. = 2·76–3. Luster vitreous to more or less pearly or silky. Colorless, gray, brown, hair-brown, pale green, and violet, yellow, dark olive-green, rarely rose-red. Streak uncolored. Transparent to translucent.

Pleochroism usually feeble; distinct in some deep colored varieties (see beyond). Absorption in the direction normal to the cleavage plane (vibrations ‖ $\mathfrak{b}$, $\mathfrak{c}$) strong, much more so than transversely (vibrations ‖ $\mathfrak{a}$); hence a crystal unless thin is nearly or quite opaque in the first direction when translucent through the prism. Optically −. Double refraction rather strong. Ax. pl. ⊥ *b* and nearly ⊥ *c*. $Bx_a$ (= $\mathfrak{a}$) inclined about − 1° (behind) to a normal to *c*. Dispersion $\rho > v$. Axial angle variable, usually about 70°, but diminishing to 50° in kinds (phengite) relatively high in silica. The axial angle also diminishes somewhat with increase of temperature. Axial angles, Tschermak:

| | | | | |
|---|---|---|---|---|
| Bengal | $2E_r = 69° 12'$ | $2E_y = 68° 54'$ | $2E_{gr} = 68° 30'$ | $2E_{bl} = 67° 54'$ |
| Abühl | $2E_r = 63° 1'$ | $2E_y = 62° 46'$ | $2E_{gr} = 62° 15'$ | |
| Rothenkopf | $2E_r = 60° 38'$ | $2E_y = 60° 12'$ | $2E_{gr} = 60° 6'$ | |

Also, Scharizer:

| | | | | |
|---|---|---|---|---|
| Schüttenhofen | $2E_r = 74° 50'$ | $2E_y = 73° 52'$ | $\beta = 1·5135$ | $\gamma = 1·5261$ |
| | $2E_r = 70° 40'$ | $2E_y = 70° 4'$ | | |

A large number of measurements of the axial angle are given by Silliman, also others by Grailich these are quoted in 5th Ed., pp. 312–314.

Refractive indices:

| | | | |
|---|---|---|---|
| $\alpha_y = 1·5609$ Na | $\beta_y = 1·5941$ | $\gamma_y = 1·5997$ | Kohlrausch |
| $\alpha_r = 1·5566$ Li | $\beta_r = 1·5899$ | $\gamma_r = 1·5943$ | Pulfrich |
| $\alpha_y = 1·5601$ Na | $\beta_y = 1·5936$ | $\gamma_y = 1·5977$ | " |
| $\alpha_{gr} = 1·5635$ Tl | $\beta_{gr} = 1·5967$ | $\gamma_{gr} = 1·6005$ | " |

Measurements showing variation of axial angle with temperature, Dx.:

| | | | | |
|---|---|---|---|---|
| N. Hampshire | $2E_r = 70° 29'$ at 12° | 68° 56′ at 95°·5 | 68° 17′ at 146°·5 | 68° 5′ at 185°·8 |
| Goshen, *rose-red* | $2E = 76° 35'$ at 12° | 76° 7′ at 95°·5 | 75° 30′ at 146°·5 | 75° 10′ at 170°·8 |

Tschermak found the apparent angle between $Bx_a$ (= $\mathfrak{a}$) and the normal to *c* for crystals from Abühl, − 1° 42′; Bengal, − 1° 40′; East Indies, − 0° 31′.

**Var.**—1. *Ordinary Muscovite.* In crystals as above described, often tabular ‖ *c*, also tapering with vertical faces rough and striated; the basal plane often rough unless as developed by cleavage. More commonly in plates without distinct outline, except as developed by pressure (see above); the plates sometimes very large, but passing into fine scales, arranged in plumose or other forms. In normal muscovite the thin laminæ spring back with force when bent, the scales are more or less harsh to the touch, unless very small, and a pearly luster is seldom prominent.

2. DAMOURITE. Including margarodite, gilbertite, hydro-muscovite, and most hydro-mica in general. Folia less elastic and luster somewhat pearly or silky and feel unctuous like talc. The scales are usually small and it passes into forms which are fine scaly or fibrous, as sericite, and finally into the compact crypto-crystalline kinds called oncosine, including much pinite.

Axial angle for damourite chiefly from 60° to 70°; for Pontivy 10°–12° Dx. Named after the French chemist, Damour. Often derived by alteration of cyanite, topaz (anal. 21, 22), corundum (anal. 27). Although often spoken of as *hydrous* micas, it does not appear that damourite and the varieties following necessarily contain more water than ordinary muscovite; they may, however, give it off more readily.

*Sterlingite*, Cooke, is a variety of damourite from Sterling, Mass., associated with spodumene in the vein of a large boulder rock. It differs from the damourite of Pontivy only in having a large axial angle (70°), which, however, has proved to be characteristic of most damourite.

*Margarodite*, as named by Schafhäutl, was the talc-like mica of Mt. Greiner in the Zillerthal (anal. 36); granular to scaly in structure, luster pearly, color grayish white. By various authors (Greg & Lettsom, Kenngott, Dana, 5th Ed., *et al.*) the name has been used for kinds of muscovites now more commonly embraced under the head of damourite. Named from μαργαρίτης, a *pearl*, in allusion to the luster.

Tschermak notes that the original margarodite has something of the brittleness of paragonite and margarite; he regards it as a mixture of these micas with muscovite.

*Gilbertite*, as originally described by Thomson, was in whitish, silky forms from the tin mine of Stenna-Gwynn (Stonagwyn), St. Austell, Cornwall, with fluorite in granite. Named after Davies Gilbert, a President of the Royal Society. Frenzel describes the same mineral from the tin mines of the Erzgebirge (Saxony and Bohemia), Ehrenfriedersdorf, Zinnwald, etc.

It has a greenish to yellowish white color; translucent. H. = 1. G. = 2·65–2·72. It occurs massive, with a dense to crystalline structure, filling cavities between the cassiterite and wolframite. A second variety occurs in spherical or stellate forms, and also in groups of six-sided tabular crystals. It is, moreover, found pseudomorph after scheelite and apatite. H. = 3. G. = 2·82. Greg & Lettsom (p. 201) include gilbertite and also Thomson's nacrite and talcite under margarodite.

Talcite is from Wicklow, Ireland, where it invests crystals of andalusite; called by Thomson crystals of nacrite.

*Adamsite* of Shepard is a greenish black mica, constituting a micaceous schist or rock in Derby, Vt. It contains, according to G. J. Brush (Am. J. Sc., **34**, 216, 1862): $SiO_2$ 47·76, $Al_2O_3(Fe_2O_3)$ 36·29, CaO 0·24, MgO 1·85, alkalies [8·77], ign. 5·09 = 100. It has all the ordinary characters of common mica; it is referred by Brush to margarodite.

*Ivigtite T. D. Rand*, Proc. Ac. Philad., 142, 1868. In films and seams in massive cryolite from Greenland. Granular, approaching micaceous. H. = 2–2·5. G. = 2·05. Color pale yellowish green to yellow. Analysis: $SiO_2$ 36·49, $Al_2O_3$ 24·09, $Fe_2O_3$ 7·54, $Na_2O$ 16·03, F 0·75, $H_2O$ 3·42, loss 11·68 = 100. See Hagemann, Am. J. Sc., **47**, 133, 1869, and Min., App. I, p. 7; also Johnstrup, who refers it to gilbertite, Förh. Skand. Nat., **12**, 240, 1883.

*Sericite* is a fine scaly muscovite united in fibrous aggregates and characterized by its silky luster (hence the name from σηρικός, *silky*). It was described from the silky-schist (sericite-schist) of the Nerothal near Wiesbaden, and shown to have a somewhat wide distribution in the Taunus and elsewhere. Its essential identity with muscovite, earlier suggested, has been insisted upon by Laspeyres (Zs. Kr., **4**, 244, 1879), and later by others. It is shown that the material analyzed has usually been more or less impure. According to Laspeyres the original sericite was derived from the alteration of feldspar.

*Metasericite* of Sandberger is a greenish white fine scaly substance with a soapy feel. It occurs as an alteration-product of oligoclase in granular gneiss of the Wildschapbach-Thal in Baden. See anal. 45.

*Lepidomorphite*, also of Sandberger, is a fine scaly product of the alteration of oligoclase in the granite of Wittichen, Baden. It has the high silica of the phengite varieties of muscovite; anal. 46.

*Pycnophyllite* forms spherical or elongated masses with quartz in mica schist. Feel greasy, talc-like. Color leek-green, apple-green, sea-green. From Kohlgraben (anal. 47), also from Aspang, in the Klein-Pischingbach-thal in Austria (anal. 48).

*Leucophyllite* forms masses resembling sericite from the Anna-Kapelle, northwest of Wiesmath (anal. 49), and from Ofenbach near Frohsdorf on the Leitha, Austria (anal. 50).

3. Oncosine. Forms rounded aggregates, compact in structure and of a light green color, embedded in dolomite of Passecken near Tamsweg, Salzburg. It has been referred to pinite and is probably to be taken as a compact form of muscovite (cf. Tschermak).

Named from ογκωσις, a *swelling up*, in allusion to its intumescence B.B. A compact form of muscovite from South Africa has been described by Cohen, Jb. Min., **1**, 123, 1887, and anal. 51, 52. See further p. 621 for other substances referred to pinite, which, so far as they are homogeneous, probably belong here with muscovite.

*Oncophyllite* is a name proposed by Sandberger for the secondary compact mica, like oncosine, derived from the alteration of feldspar.

*Didymite* (didrimite, amphilogite) is mica in fine scales of a greenish or grayish white color, occurring in the chlorite schists of the Zillerthal, and supposed to be peculiar in containing calcium carbonate; this, however, is probably due to impurity. Named didymite from δίδυμος, *twin;* amphilogite from αμφίλογος, *doubt*, in allusion to the uncertain composition.

The following are peculiar in composition:

Fuchsite. Chromglimmer *Germ.* A mica characterized by the presence of chromium sesquioxide. The original was from Schwarzenstein in the Zillerthal (anal. 53); other varieties have since been noted from other points. Named from the chemist, J. N. v. Fuchs.

A chromium mica from the Ural, examined by Arzruni (anal. 56), gave the axial angles: $2E_r = 71° 34'$. $2E_y = 68° 35'$, $2E_{gr} = 67° 17'$.

Another from Montgomery Co., Maryland, examined by A. C. Gill (anal. 58), was strongly pleochroic: 𝔠 bluish chrome-green; 𝔟 yellowish green; 𝔞 robin's-egg blue. Axial angles: $2E_r = 71° 24'$ Li, $2E_y = 68° 16'$ Na.

The variety from Ouro Preto, analyzed by Gorceix (anal. 60) gave Des Cloizeaux 2E = 69° to 70°, dispersion $\rho > v$.

AVALITE *Losanitsch*, Ber. Chem. Ges., **17**, 1774, 1884. Occurs in earthy aggregates of thin crystalline scales in the quartzyte of Mt. Avala near Belgrade. Analysis of material freed by decantation and boiling in aqua regia from impurities, except some sand and chromite:

| $SiO_2$ | $Cr_2O_3$ | $Al_2O_3$ | $Fe_2O_3$ | MgO | $K_2O$ | ign. | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 56·13 | 14·59 | 14·37 | 1·10 | 0·43 | 3·54 | 5·38 | 2·39 chromite 1·68 = 99·61 |

Two other analyses of less pure material gave about the same results. It apparently belongs near the above chromium micas, but the material examined was too impure to allow of a decision in regard to its exact composition.

OELLACHERITE including part of the so-called barium mica (other kinds belong to biotite), contains several per cent. of BaO. G. = 2·884–2·994. $2E_r = 79° 21'$, $2E_{bl} = 78° 45'$, Dx. The original occurs near Kemmat in the Pfitschthal, Tyrol. Occurs also in the mica schist of the Habachthal, Salzburg, Sandberger, Jb. Min., 624, 1875, 367, 1879. See anals. 61–63.

**Comp., Var.**—For the most part an orthosilicate of aluminium and potassium $(H,K)AlSiO_4$. If, as in the common kinds, H : K = 2 : 1, this becomes $H_2KAl_3Si_3O_{12} = 2H_2O.K_2O.3Al_2O_3.6SiO_2$ = Silica 45·2, alumina 38·5, potash 11·8, water 4·5 = 100.

Some kinds give a larger amount of silica than corresponds to a normal orthosilicate, and they are called *phengite* by Tschermak (cf. p. 612), anal. 16 *et seq.* This name was given originally by Breithaupt. As shown by Clarke, these acid muscovites (cf. p. 613) can be most simply regarded as molecular mixtures of $H_2KAl_3(SiO_4)_3$ and $H_2KAl_3(Si_3O_8)_3$.

Iron is usually present in small amount only; barium is rarely present as above noted, also chromium in some cases.

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20, Delesse, l. c. 21, 22, Chatard, Am. J. Sc., **28**, 21, 1884. 23, F. W. Clarke, ib., **32**, 354, 1886. 24, Schwarz, quoted by Tschermak, Ber. Ak. Wien, **58** (1), 17, 1868. 25, Sharples and Koenig, Am. Phil. Soc., **13**, 384, 1873. 26, Genth, ib. 27, Koenig, ib. 28, Cooke, Mem. Am. Ac. Boston, 39, 1874. 29, 30, Smith and Brush, Am. J. Sc., **16**, 46, 1853. 31, Id., ibid., **15**, 210, 1853. 32, Lehunt, quoted by Thomson, Min., **1**, 236, 1836. 33–35, Frenzel, Jb. Min., 794, 1873. 36, Schafhäutl, l. c., Lieb. Ann., 46, 325, 1843. 37, Hlasiwetz, Kenng. Ueb., 67, 1858. 38, Laspeyres, Zs. Kr., **4**, 249, 1879, after deducting 19 p.c. insol. 39, Groddeck, Jb. Min., Beil., **2**, 90, 1883. 40, 41, Schwager [quoted by Gümbel, G. Beschr. Fichtelgebirge, 126, 1879], Hintze, Min., **2**, 634, 1891. 42, Takayama, quoted by B. Kōtō, J. Coll. Sc., Japan, **2**, 89, 1888. 43, Sennhofer, Min. Mitth., **5**, 188, 1883. 44, Schmidt, Jb. Min., Beil., **4**, 429, 1886. 45, Sandberger, l. c., 46, Id., ibid., p. 344. 47–50, Starkl, l. c. 51, 52, Cohen, Jb. Min., **1**, 123, 1887. 53, Kobell, J. pr. Ch., **2**, 295, 1834. 54, Cossa, quoted by Gastaldi, Att. Acc. Torino, **10**, 197, 1874.

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*Muscovite.*

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Bengal | 2·831 | 45·57 | 36·72 | 0·95 | 1·28 | 0·38 | 0·21 | 8·81 | 0·62 | 5·05 | 0·15 | $Li_2O$ 0·19<br>[= 99·93 |
| 2. East Indies | 2·830 | 45·71 | 36·57 | 1·19 | 1·07 | 0·71 | 0·46 | 9·22 | 0·79 | 4·83 | 0·12 | = 100·67 |
| 3. Schüttenhofen | 2·835 | 43·67 | 36·70 | 2·10 | 0·55 | — | — | 8·57[a] | 1·95 | 5·50[b] | 0·35 | $Li_2O$ *tr.*<br>[= 99·39 |
| 4. " | 2·854 | 44·08 | 36·84 | 0·48 | 0·99 | — | 0·20 | 11·10 | 0·21 | 6·15 | 0·19 | $Li_2O$ 0·37<br>[= 100·61 |
| 5. Forst, Tyrol | 2·93 | 45·28 | 37·59 | — | 1·18[c] | 0·17 | 0·09 | 10·32 | 1·20 | 4·12 | — | = 99·95 |
| 6. Auburn, Me. | | 44·48 | 35·70 | 1·09 | 1·07 | *tr.* | 0·10 | 9·77 | 2·41 | 5·50 | 0·72 | $Li_2O$ *tr.*<br>[= 100·84 |

[a] Incl. Rb,Cs. [b] Below 300° 1·15. [c] MnO 0·25.

| | | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7. | Alex. Co., N. C. | | 45·40 | 33·66 | 2·36 | — | 1·86 | — | 8·33 | 1·41 | 5·46 | 0·69 | $TiO_2$ 1·10 [= 100·27 |
| 8. | Goshen, *pink* | 2·859 | 47·02 | 36·83 | 0·51 | 1·05[a] | 0·26 | — | 9·80 | 0·30[b] | 3·90 | 0·52 | = 100·19 |
| 9. | Freiberg | | 46·74 | 32·56 | 1·55 | 0·92 | 1·18 | — | 10·37 | 1·02 | 3·55 | — | $TiO_2$ 1·52 [= 99·41 |
| 10. | S. Royalston | 2·947 | 45·97 | 30·40 | 5·11 | 1·05 | 2·03 | — | 9·92 | 0·59 | 4·00 | 0·74 | = 99·81 |
| 11. | Ytterby, *white* | | 45·21 | 33·40 | 2·78 | 2·00 | 1·58 | — | 10·71 | 0·42 | 3·95 | 0·94 | = 100·99 |
| 12. | Broddbo, | | 47·13 | 30·60 | 4·81 | 0·61 | 1·30 | — | 10·26 | 0·74 | 4·02 | 0·64 | = 100·11 |
| 13. | Bamle | 2·752 | 45·38 | 30·16 | 3·65 | 0·86 | 1·20 | — | 10·49 | 1·83 | 5·99 | — | $TiO_2$ 1·48 [= 101·04 |
| 14. | Haddam | 2·802 | 45·05 | 30·57 | 1·14 | 1·73 | 0·97 | — | 10·23 | 2·13 | 6·19 | 1·26 | = 99·27 |
| 15. | Zillerthal | 2·892 | 45·87 | 30·86 | 5·70 | 1·69 | 1·56 | 0·23 | 9·07 | 0·54 | 4·60 | — | = 100·12 |
| 16. | Soboth | | 48·76 | 29·91 | 4·24 | 0·41 | 2·63 | 0·33 | 6·83 | 2·31 | 4·60 | — | = 100·02 |
| 17. | Rheinwaldhorn | 2·867 | 47·69 | 28·30 | 1·02 | 3·88 | 2·72 | — | 9·06 | 1·87 | 4·07 | — | $TiO_2$ 0·11 [= 98·72 |
| 18. | " | 2·895 | 47·72 | 25·96 | 1·76 | 6·55 | 2·30 | — | 10·18 | 1·70 | 3·42 | — | $TiO_2$ 0·18 [= 99·77 |
| 19. | Syra, *light green* | | 49·34 | 23·69 | 6·84 | — | 2·97 | 1·25 | 10·74 | 0·78 | 4·40 | — | = 100·01 |

[a] MnO. [b] Incl. $Li_2O$.

| | | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Damourite.* | | | | | | | | | | | |
| 20. | Pontivy | 2·792 | 45·22 | 37·85 | *tr.* | — | — | *tr.* | 11·20 | — | 5·25 | = 99·52 |
| 21. | Stoneham, Me. | | 45·19 | 33·32 | — | 4·25 | 0·36 | — | 11·06 | 1·57 | 4·48 | MnO 0·58 [= 100·81 |
| 22. | " " | | 45·34 | 33·98 | — | 3·96 | 0·10 | 0·22 | 10·73 | 1·49 | 4·78 | MnO 0·51 [= 101·09 |
| 23. | Hebron, Me. | 2·87 | 43·90 | 38·71 | 0·58 | 0·25 | 0·41 | 0·05 | 10·92 | 1·05 | 4·25 | MnO 0·04 [= 100·16 |
| 24. | Salzburg | 2·806 | 45·48 | 38·15 | *tr.* | — | 0·17 | 0·76 | 9·25 | 1·12 | 4·69 | = 99·62 |
| 25. | Unionville, Pa. | 2·851 | 43·03 | 39·06 | 1·48 | — | 0·30 | *tr.* | 10·05 | 0·58 | 5·40 | = 99·90 |
| 26. | Laurens Co., S. C. | | 45·71 | 34·12 | 3·45 | — | 0·71 | 0·48 | 10·36 | 0·49 | 4·67 | = 99·99 |
| 27. | Culsagee Mine, N.C. | 2·867 | 45·62 | 35·93 | 2·93 | — | 0·34 | *tr.* | 9·40 | 0·71 | 4·93 | = 99·86 |
| 28. | Sterling, Mass. | | 43·87 | 36·45 | 3·36 | — | — | — | 10·86 | — | 5·19 | = 99·73 |
| 29. | Monroe | | 46·50 | 33·91 | 2·69 | — | 0·90 | — | 7·32 | 2·70 | 4·63 | F 0·82, [Cl 0·31 = 99·78 |
| 30. | " | | 45·70 | 33·76 | 3·11 | — | 1·15 | — | 7·49 | 2·85 | 4·90 | F 0·82, [Cl 0·31 = 100·09 |
| 31. | Litchfield | | 44·60 | 36·23 | 1·34 | — | 0·37 | 0·50 | 6·20 | 4·10 | 5·26 | = 100·60 |
| | *Gilbertite.* | | | | | | | | | | | |
| 32. | Cornwall | 2·65 | 45·15 | 40·11 | — | 2·43 | 1·90 | 4·17 | — | — | 4·25 | = 98·01 |
| 33. | Ehrenfriedersdorf | | 48·96 | 30·96 | — | 2·24 | 1·97 | 0·26 | 8·47 | 1·65 | 3·83 | F 1·04 [= 99·38 |
| 34. | Pobershau | | 48·10 | 32·30 | — | 3·30 | 1·12 | 0·40 | 10·02 | — | 4·09 | F 0·81 [= 100·14 |
| 35. | Ehrenfriedersdorf | 2·82 | 48·10 | 31·55 | — | 3·10 | 1·33 | 1·30 | 8·62 | 2·14 | 3·52 | F 0·88 [= 100·54 |
| | *Margarodite.* | | | | | | | | | | | |
| 36. | Zillerthal | | 47·05 | 34·90 | 1·50 | — | 1·95 | — | 7·96 | 4·07 | 1·45 | = 98·88 |
| 37. | Pfitschthal | | 45·48 | 33·80 | 6·25 | — | — | 0·48 | 7·31 | 6·22 | 0·36 | = 99·90 |
| | *Sericite.* | | | | | | | | | | | |
| 38. | Hallgarten | 2·809 | 45·36 | 32·92 | 2·05 | 1·76 | 0·89 | 0·50 | 11·67 | 0·72 | 4·13 | = 100 |
| 39. | Werlau | 2·875 | 45·58 | 36·76 | 1·13 | 0·03[a] | 0·85 | — | 9·29 | 1·36 | 5·16 | = 100·16 |
| 40. | Fürstenstein | | 54·00 | 26·23 | 3·81 | — | 0·83 | 0·52 | 4·41 | 4·00 | 4·31 | $TiO_2$ 1·51 [= 99·62 |
| 41. | Dürrberg | | 55·80 | 27·72 | 3·07 | — | 0·53 | 0·14 | 5·62 | 1·51 | 4·03 | = 98·42 |
| 42. | Otakisan | | 53·01 | 34·70 | *tr.* | — | 0·50 | 0·27 | 6·05 | 1·01 | 4·67 | = 100·21 |
| 43. | Wiltau | | 41·35 | 19·28 | 17·87 | — | 2·06 | 0·37 | 8·29 | 3·48 | 6·16 | C 0·18 [= 99·04 |
| 44. | Windgälle | | 51·83 | 28·77 | 2·63 | 1·91 | 0·54 | 0·63 | 8·63 | 0·98 | 3·77 | = 99·69 |
| 45. | *Metasericite* | 2·67 | 52·58 | 23·56 | — | 5·76 | 2·43 | 0·65 | 9·52 | — | 5·94 | = 100·44 |
| 46. | *Lepidomorphite* | | 58·90 | 25·28 | 2·30 | — | 1·49 | 0·65 | 5·73 | 1·37 | 4·14 | = 99·86 |
| 47. | *Pycnophyllite* | 2·796 | 48·89 | 29·37 | 2·38 | 0·51 | 2·67 | 1·25 | 6·52 | 3·34 | 4·63 | = 99·56 |
| 48. | " | | 50·09 | 26·48 | 3·67 | — | 3·93 | 0·45 | 10·77 | | 4·61 | = 100 |

[c] CuO.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 49. *Leucophyllite* | 2·723 | 57·11 | 19·80 | 2·99 | — | 8·85 | 0·49 | 3·39 | 1·42 | 6·30 | =100·35 |
| 50. " | | 52·81 | 23·21 | 3·51 | — | 8·90 | 0·45 | [4·18] | | 6·94 | =100 |
| 51. Griqualand West *comp.* | 2·832 | 45·39 | 38·72 | 0·61 | — | 0·17 | 0·45 | 7·51 | 1·69 | 5·48[a] | $TiO_2$ 0·98 [= 101·00 |
| 52. " " | 2·856 | 42·70 | 29·98 | 7·62 | 1·57 | *tr.* | 0·37 | 10·57 | 1·52 | 4·96[b] | = 99·29 |
| 53. *Oncosine* | | 52·52 | 30·88 | — | 0·80 | 3·82 | — | 6·38 | — | 4·60 | = 99·00 |
| 54. Fenestrelle | | 47·96 | 31·03 | — | — | 3·42 | 1·07 | 10·44 | 4·08 | 2·41 | =100·41 |

[a] Below 300°, 0·57 p. c. [b] Below 300°, 0·18 p. c.

*Chrome-mica.*

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Cr_2O_3$ | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 55. Tyrol, *Fuchsite* | | 47·95 | 34·45 | 1·80 | 3·95 | 0·71 | 0·59 | 10·75 | 0·37 | — | F 0·36 [=100·93 |
| 56. Sysersk, *green* | 2·88 | 46·17 | 29·71 | 2·03 | 3·51 | 2·28 | — | 10·40 | — | 5·42 | = 99·52 |
| 57. Aird Is., L. Huron | | 45·49 | 31·08 | *tr.* | 3·09 | 3·36 | 0·51 | 9·76 | 0·90 | 5·85 | =100·04 |
| 58. Montgomery Co., Md. | | 42·21 | 34·55 | 1·03 | 2·03 | 3·13 | 0·47 | 9·16 | 0·82 | 6·77 | =100·17 |
| 59 Salm Chateau | 2·819 | 45·68 | 34·17 | 2·35 | 0·84 | 3·84 | 0·27 | 4·47 | 2·23 | 4·65 | $Li_2O$ *tr.* [= 98·50 |
| 60 Ouro Preto | 2·78 | 46·5 | 37·2 | | 0·9 | 0·8 | — | 7·9 | 1·3 | 4·7 | = 99·3 |

*Oellacherite.*

| | G. | $SiO_2$ | $Al_2O_3$ | FeO | BaO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. Pfitschthal | 2·894 | 42·59 | 30·18 | 1·74 | 4·65 | 4·85 | 1·03 | 7·61 | 1·42 | 4·43 | $Fe_2O_3$ 0·91, CuO 0·31, MnO 0·12, SrO 0·09 = 99·93 |
| 62. Sterzing | | 42·90 | 32·40 | 2·40 | 5·82 | 3·10 | 0·80 | 7·47 | 1·73 | 3·02 | = 99·64 |
| 63. Habachthal | 2·83 | 49·44 | 26·05 | 2·31[a] | 5·76 | 3·03 | 1·81 | 7·54 | — | 4·24 | =100·18 |

[a] Incl. 0·29 p. c. MnO.

The rose-colored mica, of Goshen, Mass. (erroneously called lepidolite), afforded Mallet: $K_2O$ 9·08, $Na_2O$ 0·99, $Li_2O$ 0·64, Am. J. Sc., **23**, 180, 1857. Cf. also anal. 8.

**Pyr., etc.**—In the closed tube gives water, which with brazil-wood often reacts for fluorine. B.B. whitens and fuses on the thin edges (F. = 5·7, v. Kobell) to a gray or yellow glass. With fluxes gives reactions for iron and sometimes manganese, rarely chromium. Not decomposed by acids. Decomposed on fusion with alkaline carbonates.

**Obs.**—Muscovite is the most common of the micas. It is one of the essential constituents of granite, gneiss, mica schist, and other related rocks, and is occasionally met with in granular limestone; in volcanic rocks it is rare; it occurs also disseminated sparingly in many fragmental rocks. The crystallized forms are most common in cavities in granite, associated with adularia, albite, tourmaline, etc. Coarse lamellar aggregations often form the matrix of topaz, tourmaline, and other mineral species in granitic veins. The varieties with unctuous talc-like feel and pearly or silky luster are characteristic of much mica (" hydro-mica ") schist which has often been erroneously called talcose schist. Muscovite is frequently of secondary origin, being derived from the alteration of other species, *e.g.*, topaz, cyanite (damourite), feldspar (oncosine), etc., cf. also pinite, beyond; muscovite forms with albite the mineral-aggregate called cymatolite, derived from spodumene, cf. p. 368.

Muscovite often encloses flattened crystals of garnet, tourmaline, also quartz in thin plates between the sheets; further not infrequently magnetite in dendrite-like forms following in part the directions of the percussion-figure, also those of the pressure-figure (f. 1, p. 611). These markings were erroneously referred by Rose to hematite; their true nature was shown by Brush (Am. J. Sc., **48**, 361, 1869). Rose's argument against their being magnetite, based upon their want of opacity, has no force, since even the native metals are translucent in sufficiently thin layers.

Many localities of muscovite, and of the different varieties, have been given in the preceding pages. Some of the best known localities, more especially those which have furnished well crystallized specimens, are: Abühl in the Sulzbachthal, with adularia; similar on the Rothenkopf in the Zillerthal, Tyrol; Soboth, west of Eibiswald in Styria, also St. Radegrund; St. Gothard, Binnenthal, and elsewhere in Switzerland; Mourne Mts., Ireland; Cornwall; Utö, Finbo, Falun, Sweden; Skutterud, Norway. In the region of Ekaterinburg, at Alabashka near Mursinka, in cavities in granite and at other points in the Ural, sometimes in large plates; also in the Ilmen Mts. on the east side of L. Ilmen; San Domingo, Brazil. Also obtained in large plates from Greenland.

Exported in large quantities from the East Indies and most of it from the Hazáribágh district in Bengal; also obtained in large plates in the granite veins of Mysore, and at Wangtu bridge on the Sutlej in the Punjab Himalayas (Mallet, Min. India, 97, 1887).

In *Maine*, at Mount Mica in the town of Paris; at Buckfield, in fine crystals; also at East Woodstock; Rumford; at Unity, of a green color, on the estate of James Neal (Thomson's *nacrite*, wrongly referred to Brunswick). In *N. Hamp.*, at Acworth, Grafton and Alstead, in granite, the plates at times a yard across and perfectly transparent; also in Groton (Valencia mine); at Nashua; Hoyt hill in Orange. In *Mass.*, at Chesterfield, with tourmaline and albite, sometimes pink; at Barre and South Royalston, in two localities, with beryl; at Mendon and

Brimfield; at Chester, Hampden Co., faint greenish; at Goshen, rose-red (anal. 8, sometimes misnamed lepidolite); prismatic mica, at Russell. In *Conn.*, at Monroe, of a dusky brown color, having internal hexagonal bands of a darker shade; at Glastonbury, with feldspar; at Trumbull, at the topaz vein in coarse radiated aggregations; at Litchfield, with cyanite, colorless and pearly; in brown hexagonal crystal at the Middletown feldspar quarry; at Haddam, pale brownish, with columbite, and also similar at another locality with garnets; at Branchville, with albite, microcline, spodumene, etc., both in large sheets and in aggregates with curved concentric structure; New Milford, with feldspar, green and yellow beryl, etc.

In *N. York*, 6 m. S.E. of Warwick, crystals and plates sometimes a foot in diameter, in a vein of feldspar; a mile N.W. of Edenville, in six-sided and rhombic prisms; silvery, near Edenville; in St. Lawrence Co., 8 m. from Potsdam, on the road to Pierrepont, in plates 7 in. across; town of Edwards, in large prisms, six-sided or rhombic; Greenfield, near Saratoga, in reddish brown crystals with chrysoberyl; on the Croton aqueduct, near Yonkers, in rhombic prisms with a transverse parting.

In *Penn.*, in fine hexagonal crystals of a dark brown color at Pennsbury, near Pennsville, Chester Co.; at Unionville, whitish; Delaware Co., at Middletown, smoky brown with hexagonal internal bands, which are due to magnetite; at Chesnut Hill, near the Wissahickon, a green variety; at Leiperville, Delaware Co., faint greenish. In *N. Jersey*, in crystals at Newton and Franklin. In *Maryland*, at Jones's Falls, a mile and three-quarters from Baltimore; the plates show by transmitted light a series of concentric hexagons, the sides of which are parallel with the sides of a hexagonal prism; it has been mined in Howard and Montgomery Cos. In *Virginia*, at Amelia Court House, with albite, microlite, beryl, monazite, helvite; also in Grayson, Henry, Patrick, Carroll Cos. In *No. Carolina*, extensively mined at many places in the western part of the state, and often obtained in very large sheets, at times more than 3 feet in diameter; there are numerous localities in Macon, Jackson, Haywood, Buncombe, Ashe, McDowell, Mitchell, Yancey, Alexander, Cleveland, and other counties; the chief mines are in Mitchell, Yancey, Jackson, and Macon Cos. The mica mines have also afforded many rare species, as columbite, samarskite, hatchettolite, uraninite, etc. A pink-colored muscovite occurs at Ray's mine in Yancey Co., and at the Flat Rock mine, Mitchell Co. Occurs in fine crystals at the spodumene (hiddenite) locality in Alexander Co., the crystals often dusted over with a chloritic coating giving them a bronze appearance; with magnetite at Buckhorn, Chatham Co.; with quartz at Hickory, Catawba Co.; with pyrite in Stokes Co. Compact to fibrous or scaly varieties occur at various points with corundum in Macon Co., and elsewhere; also a kind in yellow or white pearly scales as a result of the alteration of cyanite at Crowder's and Clubbs' mountains; similarly in Yancey Co., and other points. Soft pseudomorphous crystals having the form of staurolite, from Cherokee Co., are referred to muscovite by Genth. In *S. Carolina*, muscovite deposits occur in Anderson, Oconee, and Pickens Cos.; also in Georgia and Alabama.

Mica mines have also been worked to some extent in the Black Hills, in Custer and Pennington Cos. of South Dakota; in Washington, at Rockford, Spokane Co.; in Colorado, at Turkey Creek, 35 miles from Denver; near Pueblo; also from the neighborhood of Fort Collins. In New Mexico, at the Cribbensville mines, Petaca, Rio Arriba Co. In California, at Salmon Mt., Siskiyou Co.; deposits also occur at Gold Lake, Plumas Co.; El Dorado Co.; Ivanpah distr., San Bernardino Co.; Susanville, Lassen Co.; Kern Co. It is a common mineral at many points in the granite of the western United States.

The production of mica in the United States was 70,500 pounds in 1887, valued at $142,250; 2000 tons of mica waste were ground worth $15,000. The amount mined in 1888 was much smaller, while in 1882, 1883, 1884, the amount varied from 100,000 pounds to 147,410 pounds (Min. Res. U. S.).

Muscovite was so named by J. D. Dana in 1850, from *Vitrum Muscoviticum* or *Muscovy-glass*, formerly a popular name of the mineral. The derivations of the names of prominent varieties are given in the preceding pages.

**Alt.**—Mica at times becomes hydrated, losing its elasticity and transparency, and often some portion of the potash; and at the same time it may take up magnesia, lime, or soda. These changes may be promoted by waters containing carbonates of these bases. It occurs altered to *steatite* and *serpentine*, and cases of alteration to amphibole and stilpnosiderite have been mentioned. It sometimes passes by alteration into a form of "vermiculite." Cf. p. 664. A mica from Leon Co., Texas, has been examined by G. W. Leighton, which is characterized (J. P. Cooke) as an early stage in this alteration. Opaque; laminæ brittle; luster pearly; B.B. swells, the laminæ separate and fuses at 5 to 6. Analysis, Leighton, Am. J. Sc., **32**, 317, 1886:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 48·95 | 25·17 | 9·40 | 1·69 | *tr.* | 11·08 | *tr.* | 4·31 | = 100·60 |

**Artif.**—See p. 613.

**Ref.**—[1] Rothenkopf, Zillerthal, l. c. (ref. 614). For crystals from Abühl Tschermak calculates $001 \wedge 201 = 84° 9'$. Cf. also Marignac, Bibl. Univ., **6**, 300, 1847; Dx., Min., **1**, 485, 1862; Kk., Min. Russl., **2**, 121 *et seq.*, **7**, 225 *et seq.* (Mem. Akad. St. Pet., 1877, read May 17), **8**, 5, 1878. See also Kk., ibid., **7**, 301–344, for valuable abstracts of early papers, literature, etc. On vicinal planes on the muscovite of Abühl, Rothenkopf, see Tschermak, l. c.

The position here taken is that finally adopted by Tschermak (priv. contr., May, 1891) as most satisfactorily showing the relation to the other micas, the chlorites, etc. Tschermak (l. c., 1877, and Min., 1883) earlier made $M = 110$, $e = 011$, $\rho = \bar{1}02$, $\zeta = 133$, etc.; for this the fundamental angles on p. 614 give the axial ratio:

$$\grave{a} : \breve{b} : \acute{c} = 0{\cdot}5775 : 1 : 2{\cdot}2175 \qquad \beta = 84° \, 55'.$$

This position has certain obvious advantages in simplicity of symbols, etc., to the one adopted. Cf. also p. 614. Muscovite was earlier regarded as orthorhombic with monoclinic hemihedrism.

On *percussion-figure*, pressure-figure, etc., see references on p. 614. *Etching-figures* Baumhauer, Ber. Ak. München, 245, 1874, 99, 1875; Wiik, Zs. Kr., **7**, 187 (ref.), 1882. *Elasticity*, Coromilas, Inaug. Diss., Tübingen, 1877, abstr. in Zs. Kr., **1**, 411, 1877.

*Refractive indices*, see Bauer, Ber. Ak. Berlin, p. 693, Nov. 27, 1877; Min. Mitth., **1**, 14, 1878; Kohlrausch [Vh. Ges. Würzburg, **12**, 1877]; Matthiessen, Zs. Kr., **3**, 330 (ref.), 1879; Pulfrich, Wied. Ann., **30**, 499, 1887; Scharizer, Zs. Kr., **12**, 8, 1886; Hecht, Jb. Min., Beil., **6**, 271, 1889. *Axial angles*, Tschermak, l. c.; Silliman, Am J. Sc., **10**, 372, 1850; Grailich, Ber. Ak. Wien, **11**, 46, 1853; Bauer, Pogg., **138**, 350, 1869 *et al.;* Dx., l. c., and N. R., 75–81, 1867. *Electrical conductivity*, inductive power, etc., J. Curie, Ann. Ch. Phys., **17**, 385, 1889, **18**, 229, 1889; Schultze, Wied. Ann., **36**, 655, 1889; Bouty, C. R., 110, 846, 1890.

**Pinite.** A general term used to include a large number of alteration-products of iolite, spodumene, nephelite, scapolite, feldspar, and other minerals. In composition essentially a hydrous silicate of aluminium and potassium corresponding more or less closely to muscovite, of which it is probably to be regarded as a massive, compact variety, usually very impure from the admixture of clay and other substances.

Characters, as follows: Amorphous; granular to cryptocrystalline. Rarely a submicaceous cleavage. H. = 2·5–3·5. G. = 2·6–2·85. Luster feeble, waxy. Color grayish white, grayish green, pea-green, dull green, brownish, reddish. Translucent to opaque.

The following are some of the minerals classed as pinite (cf. also p. 616). They are further referred to under the original minerals in the several cases; typical analyses are given below; for others, see 5th Ed., pp. 481, 482.

PINITE. Speckstein [fr. the Pini mine at Aue, near Schneeberg] *Hoffmann*, Bergm. J., 156, 1789; Kieselerde + Thonerde, etc., *Klapr.*, ib., 227, 1790. Pinit *Karsten*, Tab., 28, 73, 1800. The original pinite is in 6- to 12-sided prisms; color brown; occurs in granite, pseudomorphous after iolite.

GIGANTOLITE *Nordenskiöld*, Act. Soc. Sc. Fenn., **1**, 2, 377, 1840. From gneissoid granite of Tammela, Finland, in large 6- and 12-sided prisms, with basal cleavage; H. = 2·5; G. = 2·862–2·878; luster somewhat waxy; color greenish to dark steel-gray, sometimes approaching submetallic in luster, owing to the alteration of the original iolite and the presence of uncombined oxide of iron. *Iberite* Svanberg (Öfv. Ak. Stockh., **1**, 219, 1844), from Montalvan, near Toledo, Spain, is the same mineral in characters; H. = 2·5; G. = 2·89. Both are a result of the alteration of iolite.

GIESECKITE (fr. Greenland, *Allan*, Ann. Phil., **2**, 1813). In 6-sided prisms, pseudomorphous after nephelite. Brought by Giesecke from Akulliardsuk and Kangerdluarsuk, Greenland, where it occurs in compact feldspar. Also from Diana, N. Y. See *nephelite*, p. 426.

LYTHRODES *Karsten*, Mag. Ges. Fr. Berlin, **4**, 78, 1810; *John*, Ch. Unt., **1**, 171; Splittriger Wernerit *Hausm.*, 520, 1813, is from the zircon-syenite of Fredriksvärn and Laurvik. It is regarded as altered nephelite.

LIEBENERITE *Marignac*, Bibl. Univ., **6**, 193, 1848, is essentially the same; from a porphyritic feldspathic rock of Mt. Viesena, in the Fleimsthal; it occurs in 6-sided prisms.

DYSYNTRIBITE *Shepard*, Proc. Am. Assoc., 311, 1851, Am. J. Sc., **12**, 209, 1851. Essentially the same with the gieseckite from Diana and elsewhere, Lewis Co., N. Y.; it constitutes masses or a rock, sometimes slaty in structure, and somewhat resembles serpentine, though more waxy in aspect; H. = 3–3·5; G. = 2·76–2·81; colors often mottled, usually greenish, sometimes reddish or spotted with red. Associated with phlogopite, etc.

PAROPHITE *T. S. Hunt*, Rep. G. Can., 1852, 1863. Similar to dysyntribite, but less pure, it is regarded by Hunt as a rock, and not a simple mineral; the name alludes to a resemblance to serpentine. It constitutes a schistose rock at St. Nicholas and Famine R., Can.; also in Stanstead, on the E. shore of L. Memphremagog, with chloritic schist; and at Pownal, Vermont.

ROSITE *Svanberg* (Ak. H. Stockh., 1840). A granular red mineral, occurring in granular limestone at Åker in Södermanland; H. = 2·5, G. = 2·72. G. Rose and others make it *altered anorthite.*

POLYARGITE *Svanberg*, l. c. Occurs in reddish lamellar masses at Tunaberg, Sweden; H. = 4; G. = 2·768; named from πολύς, *much*, and ἀργός, *sparkle.* Cf. Palmgren, G. För. Förh., **1**, 188, 1873. The name *Pyrrholite* has been given to a reddish lamellar mineral from Tunaberg, which is very similar to polyargite (Dx., Min., **1**, 302, 1862); it has H. = 3–4; and cleavage surfaces inclined together about 87°; and is apparently anorthite less altered than in rosite and polyargite.

PINITOID *A. Knop* (Jb. Min., 558, 1859). A rock, like dysyntribite in characters, and a schist called "*pinitoid schist*" approaches parophite. *Pinitoid* has H. = 2·5; G. = 2·788; color leek-, oil-, and grayish green. Occurs in the region between Freiberg and Chemnitz, Saxony, pseudomorphous after feldspar, in a half-decomposed granitic porphyry, constituting about 25 p. c. of the rock. Also from other localities, cf. Cohen, Zs. Kr., **7**, 405, 1882.

HYGROPHILITE *Laspeyres*, Min. Mitth., 147, 1873. A pinite-like substance, at least in part derived from feldspar. G. = 2·670. From Halle-an-der-Saale. A similar mineral occurs as the result of the alteration of oligoclase in the gneiss of the Wildschapbach-Thal, Baden (Sandberger, Unt. Erz., 59, 1882.

WILSONITE *T. S. Hunt*, Rep. G. Can., 1853, 1863. A pseudomorph, with the form and cleavage of *scapolite;* H. = 3 5; G. = 2·76–2·78; luster somewhat pearly; color rose-red; fragments translucent. It is from Bathurst. Can , where it was first found by Dr. Wilson; also St. Lawrence Co., N. Y. See also p. 473. *Terenite* (p. 473), from Antwerp, St. Lawrence Co., may be the same.

KILLINITE *Thomson*, Min., **1**, 330, 1836. From Killiney Bay, Ireland, pseudomorph after spodumene, see p. 368.

Grattarola describes a pinite formed from andalusite from San Piero, Elba, Boll. Com. Geol., 333, 1876.

The pinite of Stolpen near Neustadt, called *micarel* by Freiesleben (p. 473), is according to Wichmann not a pseudomorph after iolite, Zs. G. Ges., **26**, 701, 1874.

AGALMATOLITE (Agalmatolithus. Bildstein (fr. China), *Klapr.*, Beitr., **2**, 184, 1797. Pagodite *Napione*. J. Phys., **46**, 220, 1798). Like ordinary massive pinite in its amorphous compact texture, luster, and other physical characters, but contains more silica, which may be from free quartz or feldspar as impurity. The Chinese has H. = 2–2·5; G. = 2·785–2·815, Klapr. Colors same as for pinite, usually grayish, grayish green, brownish, yellowish.

A similar mineral in composition comes from Nagyág in Transylvania, and Ochsenkopf near Schwarzenberg in Saxony. *Agalmatolite* was named from *ἄγαλμα, an image*, and *pagodite* from *pagoda*, the Chinese carving the soft stone into miniature pagodas, images etc. Part of the so-called agalmatolite of China is true pinite in composition, another part is compact pyrophyllite, and still another steatite (see these species).

OOSITE (Oösit *Marx*, ib., **3**, 216, 1834), is near oncosine (p. 616); it is white to reddish or brownish red, and occurs in 6- and 12-sided prisms; it is from the Oös valley, Baden, occurring in what is called pinite-porphyry.

*Gongylite* (Gongylit *Thoreld*, Act. Soc. Sc. Fenn., **3**, 815, A. Nord., Beskrifn. Finl. Min., 146, 1855) is yellowish or yellowish brown, and has cleavage in two directions; with H. = 4–5; G. = 2·7. From a schist called talcose schist at Kimsamo in Finland.

**Anal.**—1, Rg., Min. Ch. 835, 1860. 2, Hauer, Jb. G. Reichs., **5**, 76, 1854. 3, Brush, Am. J. Sc., **26**, 641, 858. 4, Hauer, l. c., 147, 1853. 5, Smith and Brush, Am. J. Sc., **16**, 50, 1853. 6, T. S. Hunt, Rep. G. Canada, 484, 1863. 7, Laspeyres, l. c 8, Killing, quoted by Sandberger, Unt. Erz., 58, 1882. 9, 10, Quoted by Crosby, Tech. Q., 248, 1889. 11, C. L. Reese, Chem. News, **50**, 209, 1884. 12, C. H. Slaytor, ibid.

| | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Penig, *Pinite* | | 47·00 | 28·36 | 7·86 | — | 2·48 | 0·79 | 10·74 | 1·07 | 3·83 | =102·13 |
| 2. Greenland, *Gieseckite* | $\frac{2}{2}$ | 45·88 | 26·93 | — | 6·30 | 7·87 | — | 4·84 | — | 6·82 | = 98·64 |
| 3. Diana, " | $\frac{3}{8}$ | 45·66 | 31·53 | 0·27 | 0·77 | 3·48 | 2·20 | 8·21 | 0·88 | 6·97 | = 99·97 |
| 4. Fleims, *Liebenerite* | | 44·45 | 38·75 | 2·26 | | *tr.* | 1·58 | 6·45 | 2·79 | [4·75] | =101·03 |
| 5. Jefferson Co., *Dysyntr.* | | 44·80 | 34·90 | 3·01 | 0·30[a] | 0·42 | 0·66 | 6·87 | 3·60 | 5·38 | = 99·94 |
| 6. St. Nicholas, *Parophite* | | 48·46 | 27·55 | — | 5·08 | 2·02 | 2·05 | 5·16 | 2·35 | 7·14 | = 99·81 |
| 7. Halle, *Hygrophilite* | $\frac{2}{2}$ | 48·42 | 32·06 | — | 3·26 | 1·72 | 1·15 | 5·67 | 1·37 | 9·02 | =102·67 |
| 8. Wildschapbach | | 48·60 | 32·82 | — | 2·76 | 2·37 | 0·84 | 4·08 | 1·32 | 8·83 | =101·62 |
| 9. E. Massachusetts, *Pinite* | | 54·04 | 36·83 | | — | 1·30 | 0·43 | 10·01 | 0·72 | 4·76 | |
| 10. " " | | 44·51 | 34·71 | | — | 0·56 | 0·17 | 7·95 | 0·16 | 4·31 | |
| 11. Madison Co., N. C., " | | 47·28 | 36·47 | — | — | *tr.* | 0·28 | 11·40 | 0·74 | 4·39 | =100·56 |
| 12. " " " " | | 47·31 | 38·11 | — | — | — | — | 13·37 | — | 1·05 | = 99·84 |

[a] MnO.

The pinite of anal. **9** is described by Crosby (l. c., also Am. J. Sc., **19**, 116, 1880) as common in eastern Massachusetts, especially in the vicinity of Boston, where it occurs as a soft, greenish, unctuous mineral, both in the felsyte and the conglomerate. In the latter it makes up much of the pebbles and the enclosing paste, and is referred for its feldspathic origin to Primordial times.

CATASPILITE. Kataspilit *Igelström*, Öfv. Ak. Stockh., **24**, 14, 1867. Pseudomorphous after iolite, and presenting its forms.

H. = 2·5. Luster pearly. Color ash-gray. Subtranslucent. Analysis, Igelström (l. c.):

| $SiO_2$ | $Al_2O_3(Fe_2O_3)$ | MgO | CaO | $Na_2O$ | $K_2O$ | ign. | |
|---|---|---|---|---|---|---|---|
| 40·05 | 28·95 | 8·20 | 7·43 | 5·25 | 6·90 | [3·22] | = 100 |

From a gray chlorite rock at Långban, in Wermland, Sweden, distributed through it in druses as large as peas. Named from *κατασπιλάζειν* in allusion to this mode of occurrence.

**459. PARAGONITE.** Paragonit *Schafhäutl*, Lieb. Ann., **46**, 334, 1843. Pregrattit *L. Liebener*, Kenng. Ueb., 53, 1861, 1862. Natronglimmer *Germ.* Soda mica. Cossaite *Gastaldi*, Att. Acc. Torino, **10**, 189, 1874.

Massive, sometimes consisting distinctly of fine scales; also compact.

Cleavage: basal, eminent. H. = 2·5–3. G. = 2·78–2·90; ~~2·78~~ Schafhäutl. Luster strong pearly. Color yellowish, grayish, grayish white, greenish, light apple-green. Translucent; single scales transparent. Optically −. Orientation and ax. angle (70°) as in muscovite. Dispersion $\rho > v$. Tschermak.

**Comp.**—A sodium mica, corresponding to muscovite in composition $H_2NaAl_3Si_3O_{12}$ or $2H_2O.Na_2O.3Al_2O_3.6SiO_2$ = Silica 47·1, alumina 40·1, soda 8·1, water 4·7 = 100. A little potassium is often present.

**Anal.**—1, Rg., Zs. G. Ges., **14**, 761, 1862. 2, Œllacher, Kenng. Ueb., l. c. 3, Genth, Am. Phil. Soc., **13**, 390, 1873. 4, Kobell, J. pr. Ch., **107**, 167, 1869. 5, 6, Cossa, Att. Acc. Torino, l. c. 7, Piolti, ibid., **23**, 257, 1888

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Mte. Campione | | ⅔ 46·81 | 40·06 | *tr.* | — | 0·65 | 1·26 | *tr.* | 6·40 | 4·82 | = 100 |
| 2. Pregratten | | | | | | | | | | | [= 100·70 |
| *Pregrattite* | 2·895 | 44·65 | 40·41 | — | 0·84 | 0·37 | 0·52 | 1·71 | 7·06 | 5·04 | $Cr_2O_3$ 0·10 |
| 3. Ochsenkopf | | 45·14 | 40·91 | 0·68 | — | *tr.* | 0·58 | 0·96 | 6·74 | 4·99 | = 100 |
| 4. Virgenthal | 2·9 | 48·00 | 38·29 | 0·91 | — | 0·36 | — | 1·89 | 6·70 | 2·51 | = 98·66 |
| *Cossaite* | | | | | | | | | | | |
| 5. Borgofranco | 2·896 | 46·67 | 39·02 | 2·01 | — | — | — | 1·36 | 6·37 | 4·91 | = 100·34 |
| 6. Mt. Blasier | 2·890 | 46·68 | 39·88 | 1·06 | — | — | — | 0·84 | 6·91 | 5·08 | = 100·45 |
| 7. Bousson | 3·075 | 46·49 | 40·68 | 2·68 | — | — | — | 1·34 | 4·75 | 4·57 | $Li_2O$ *tr.* [= 100·51 |

**Pyr., etc.**—B.B. fusible with difficulty. The pregrattite exfoliates somewhat like vermiculite, and becomes milk-white on the edges.

**Obs.**—Paragonite constitutes the mass of the rock at Monte Campione near Faido in Canton Tessin, Switzerland, containing cyanite and staurolite; called paragonite-schist. The rock also contains garnet and black tourmaline. Also from the Ochsenkopf, Schwarzenberg, Saxony, and the Virgenthal; also forms the compact ground-mass resembling soapstone enclosing actinolite in the Pfitschthal and Zillerthal. From the Island of Syra with iolite, staurolite, cyanite. Pregratten in the Pusterthal (*Pregrattite*), Tyrol.

*Cossaite* is a compact variety, showing but little micaceous structure, first identified in an antique ring or bracelet, dug up in the neighborhood of Turin; also found at the mines of Borgofranco, near Ivrea, and at Mt. Blasier. Named for Professor Cossa, who gave the first description. Also (anal. 7) from the Colle di Bousson, Valle di Susa, in compact form with apple-green color forming layers between limestone layers.

Named from *παράγειν, to mislead.*

EUPHYLLITE *B. Silliman, Jr.*, Am. J. Sc., **8**, 381, 1849. A sodium-potassium mica apparently intermediate between muscovite and paragonite, but more basic. Structure as in mica, but laminæ not as easily separable. Laminæ rather brittle.

H. = 3·5–4·5. G. = 2·963–3·008 Silliman; 2·83 Smith and Brush. Luster of cleavage surface bright pearly, inclining to adamantine. Color white to colorless; sides faint grayish sea-green or whitish. Transparent to translucent; at times opaque or nearly so. Biaxial; axial angle 71½°, Silliman.

Tschermak identified in a specimen from Unionville, showing euphyllite and tourmaline, scales like paragonite; others with large axial angle referred to margarite, and still others with a very small axial angle. That the original material was similarly heterogeneous is not so clear.

**Anal.**—1–4, Smith and Brush, Am. J. Sc., **15**, 209, 1853.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Unionville | 2·83 | 40·29 | 43·00 | 1·30 | 0·62 | 1·01 | 5·16 | 3·94 | 5·00 | = 100·32 |
| 2. " | | 39·64 | 42·40 | 1·60 | 0·70 | 1·00 | 5·16 | 3·94 | 5·08 | = 99·52 |
| 3. " | | 40·21 | 41·50 | 1·50 | 0·78 | 1·88 | 4·26 | 3·25 | 5·91 | = 99·29 |
| 4. " | | 40·96 | 41·40 | 1·30 | 0·70 | 1·11 | 4·26 | 3·25 | 6·23 | = 99·21 |

The specimen for analysis 2 by Smith and Brush was from the original one described by Silliman. Their results show that the earlier analysis of Crooke (Am. J. Sc., 8, 381, 1849) and those of Erni and Garret (Dana Min., 3d Ed., 362, 1850) are erroneous. Erni's and Crooke's specimens were from the same that afforded the material for analysis 2 of Smith and Brush.

Occurs associated with tourmaline and corundum at Unionville, Delaware Co., Pa. The impression of the crystals of tourmaline on the lateral surface of the euphyllite leaves a very smooth, hard-looking surface. Also in the same vicinity in aggregated laminæ, or scales, or compact masses.

Dr. Smith refers to euphyllite, with a query, a mica found by him with the emery of Asia Minor and the islands of the Grecian Archipelago which afforded him the following results (Am. J. Sc., **11**, 62, 1851, **15**, 210, 1853):

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MgO | CaO | $K_2O$(little $Na_2O$) | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. Gumuch-dagh | 42·80 | 40·61 | 1·30 | *tr.* | 3·01 | *undet.* | 5·62 |
| 2. Kulah | 43 62 | 38·10 | 3·50 | 0·25 | 0·52 | 7·83 | 5·51 = 99·33 |
| 3. " | 42·71 | 37·52 | 2·32 | *tr.* | 1·41 | *undet.* | 5·95 |
| 4. Nicaria | 42 60 | 37·45 | 1·70 | *tr.* | 0·68 | 9·76 | 5·20 = 97·39 |

An emerald-green mica from Pipra, South Rewah, India, is referred here by Mallet (Min. India, 130, 1887) It is similarly associated with corundum and tourmaline. An analysis by Tween gave:

$SiO_2$ 43·53 $Al_2O_3$ 43·87 $Cr_2O_3$ 0·91 CaO 1·45 $K_2O$ 7·80 $H_2O$ 4·60 = 102·16

**460. LEPIDOLITE.** Violetfarbigen Zeolith (fr. Rozena) *v. Born*, Crell's Ann., **2**, 196, 1791. Lilalith (ib.) *v. Born*. Schuppenstein *Germ.* Lepidolith *Klapr.*, Schrift. Ges. Berl., **11**, 59, 1794, Bergm. J., **2**, 80, 1792, Beitr., **1**, 21, 279, 1795, **2**, 191. Lepidolite *Kirw.*, **1**, 208, 1794. Lithionglimmer *C. Gmelin*, Gilb. Ann., **64**, 371, 1820. Lithia Mica. Lithionit *Kbl.*, Taf., 54, 1853. Rabenglimmer, Siderischer Fels-Glimmer (fr. Altenberg), *Breith.*, Char., 1823, 1832, Handb., 404, 1841.

In aggregates of short prisms, often with rounded terminal faces. Crystals sometimes twins or trillings according to the mica law[1]. Also in cleavable plates, but commonly massive scaly-granular, coarse or fine.

Cleavage: basal, highly eminent. H. = 2·5–4. G. = 2·8–2·9. Luster pearly. Color rose-red, violet gray or lilac, yellowish, grayish white, white. Translucent.

Optically –. Ax. pl. usually ⊥ *b*; rarely ∥ *b* Scharizer. $Bx_a$ ($\mathfrak{a}$) inclined 1° 47′ red, and 1° 33½′ yellow (Na) to normal to *c*. Axial angle large, from 50°–72°, Elba, Tschermak. Also Scharizer[1]:

| Schüttenhofen | | Siberia | | Wolkenburg | |
|---|---|---|---|---|---|
| | $2E_r = 83^\circ\ 16'$ | | $2E_r = 72^\circ\ 42'$ | | $2E_r = 57^\circ\ 13'$ |
| " | $2E_y = 84^\circ\ 1'$ | " | $2E_y = 73^\circ\ 2'$ | " | $2E_y = 57^\circ\ 10'$ |

Indices $\beta_y$ = 1·5975 $\gamma_y$ = 1·6047

**Comp.**—In part a metasilicate $\overset{\text{I}}{R}_3Al(SiO_3)_3$ or $KLi[Al(OH,F)_2]Al(SiO_3)_3$. The ratio of fluorine and hydroxyl is variable.

Following in the line of Clarke's suggestion (p. 612), typical lepidolite may be considered as having the formula

$$\overset{\text{I}}{R}_6Al_2(SiO_4)_3 + \overset{\text{I}}{R}_6Al_2(Si_3O_8)_3. \quad \overset{\text{I}}{R} = K,Li,(AlF_2),(Al(OH)_2), \text{ also } Rb,Cs.$$

Clarke, however, prefers to consider it as consisting of equal molecules of

$$HKLiAl_2(SiO_4)_3 \text{ and } K_3Li_3(AlF_2)_3Al(Si_3O_8)_3.$$

See Clarke, l. c. (p. 613), and U. S. G. Surv., Bull. **42**, 1887; also earlier Am. J. Sc., **32**, 357, 1886; further, Tschermak, l. c., and Scharizer. Zs. Kr., **13**, 464, 1887. Scharizer regards lepidolites as isomorphous mixtures of muscovite $R_3Al_3Si_3O_{12}$ and the silicate ("lithionitsilicat") $(OH,F)_3R_4Al_3Si_5O_{16}$.

**Anal.**—1, 2, Berwerth, quoted by Tschermak, l. c. 3, Rg. Ber. Ak. Berlin, 624, 1878. 4, Scharizer, Zs. Kr., **13**, 464, 1888. 5–11, R. B. Riggs, quoted by Clarke, Am. J. Sc., **32**, 356, 1886.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | $K_2O$ | $Li_2O$ | $Na_2O$ | $H_2O$ | F |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Paris | 2·855 | 50·39 | 28·19 | — | — | — | 12·34 | 5·08 | — | 2·36 | 5·15 |
| | | | | | | | | | | | [= 103·51 |
| 2. Rozena | 2·839 | 50·98 | 27·80 | — | 0·05 | — | 10·78 | 5·88 | — | 0·96 | 7·88 |
| | | | | | | | | | | | [$P_2O_5$ 0·05 = 104·38 |
| 3. Yushakova | | 50·26 | 21·47 | — | — | 5·36[a] | 11·08 | 4·88 | 0 54 | 0·66 | 8·71 |
| | | | | | | | | | | | [Cl 1·16 = 104·12 |

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | $K_2O$ | $Li_2O$ | $Na_2O$ | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4. Schüttenhofen | 2·825 | 49·25 | 25·27 | — | 0·84 | 0·85 | 13·85[b] | 5·38 | 0·35 | 1·76 | 5·68 | [$SnO_2$ 0·06 = 103·29 |
| 5. Rumford, *purple* | | 51·52 | 25·96 | 0·31 | — | 0·20 | 11·01 | 4·90 | 1·06 | 0·95 | 5·80 | [CaO,MgO 0·18 = 101·89 |
| 6. Paris, *foliated* | | 50·92 | 24·99 | 0·30 | 0·23 | *tr.* | 11·38 | 4·20 | 2·11 | 1·96 | 6·29 | [= 102·38 |
| 7. Hebron, *granular* | | 48·80 | 28·30 | 0·29 | 0·09 | 0·08 | 12·21[c] | 4·49 | 0·74 | 1·73 | 4·96 | [CaO,MgO 0·17 = 101·86 |
| 8. Auburn, *border* | | 49·62 | 27·30 | 0·31 | 0·07 | 0·55 | 11·19[d] | 4·34 | 2·17 | 1·52 | 5·45 | [= 102·52 |
| 9. " *granular* | | 51·11 | 25·26 | 0·20 | 0·07 | 0·17 | 12·25[e] | 4·98 | 1·43 | 0·94 | 6·57 | [CaO,MgO 0·13 = 103·11 |
| 10. Norway, *white* | | 49·52 | 28·80 | 0·40 | 0·24 | 0·07 | 12·63[f] | 3·87 | 0·13 | 1·72 | 5·18 | [CaO,MgO 0·15 = 102·71 |
| 11. " *brown* | | 50·17 | 25·40 | 0·87 | 0·45 | 0·23 | 13·40[g] | 4·03 | — | 2·02 | 5·05 | [CaO,MgO *und.* = 101·62 |

[a] Incl. MgO. [b] Incl. Rb,Cs. [c] $Rb_2O,Cs_2O$ 0·77. [d] $Rb_2O$ 2·44, $Cs_2O$ 0·72. [e] $Rb_2O$ 1·29, $Cs_2O$ 0·45. [f] $Rb_2O$ 3·73, $Cs_2O$ 0·08. [g] Also $Na_2O$.

Page (Ch. News, **48**, 109, 1883) found in a lead-gray lepidolite from the greisen at Píhra, Hazáribágh, Bengal (anal. by Tween, Rec. G. Surv. India, **7**, 43, 1874), the alkalies:

| $K_2O$ | $Li_2O$ | $Na_2O$ | $Rb_2O$ | $Cs_2O$ |
|---|---|---|---|---|
| 8·60 | 1·75 | 0·61 | 0·07 | *tr.*? |

**Pyr., etc.**—In the closed tube gives water and reaction for fluorine. B.B. fuses with intumescence at 2–2·5 to a white or grayish glass, sometimes magnetic, coloring the flame purplish red at the moment of fusion (lithia). With the fluxes some varieties give reactions for iron and manganese. Attacked but not completely decomposed by acids. After fusion, gelatinizes with hydrochloric acid.

**Obs.**—Occurs in granite and gneiss, especially in granitic veins, and is associated sometimes with cassiterite, red, green, or black tourmaline, amblygonite, spodumene, etc. It is often associated with muscovite in parallel position (cf. Scharizer).

Found near Utö in Sweden; at Altenberg, Chursdorf, and Penig in Saxony; Eulenlohe in the Fichtelgebirge; Yushakova in the Ural; lilac or reddish violet at Rozena (or Rožna) in Moravia; near Chanteloube, Dept. Haute Vienne, France; at Campo on Elba; brown at St. Michael's Mount in Cornwall; Argyll in Scotland; Tyrone in Ireland. In the granite of Hazáribágh, Bengal, India, with muscovite.

In the United States, common in the western part of Maine, in Hebron, Auburn, Norway, Paris, Rumford; both granular and a broad foliated varieties are found, often associated with rubellite, also with spodumene and amblygonite; at Chesterfield, Mass., with red tourmaline in the town of Peru; reported from Pownal, Durham, Yarmouth, and Freeport; granular near Middletown, Conn. The rose mica of Goshen, Mass., is muscovite (anal. 8, p. 618). Lepidolite also occurs with rubellite eight miles from San Diego, California.

Lepidolite occurs near Barkevik, Langesund fiord, as a part of the so-called pterolite which has resulted from the alteration of barkevikite (p. 403).

Named lepidolite from λεπίς, *scale*, after the earlier German name *Schuppenstein*, alluding to the scaly structure of the massive variety of Rozena.

**Ref.**—[1] See Scharizer, Zs. Kr., **12**, 5, 1886; **13**, 22, 464, 1887.

COOKEITE *G. J. Brush*, Am. J. Sc., **41**, 246, 1866.

In minute scales, and in slender six-sided prisms, sometimes vermicularly bent. Often as a coating. Cleavage, basal, perfect. Scales flexible, inelastic. H. = 2·5. G. = 2·70. Luster pearly on plane of cleavage. Color white to yellowish green. In thin scales transparent.

Approaches a hydrous lithia mica in composition. Anal.—P. Collier, l. c.:

| $SiO_2$ | $Al_2O_3$ | $Li_2O$ | $K_2O$ | $H_2O$ | $SiF_4$ |
|---|---|---|---|---|---|
| $\frac{3}{3}$ 34·93 | 44·91 | 2·82 | 2·57 | 13·41 | 0·47 $H_2O$ exp. at 100° 0·38 = 99·49 |

Three determinations of the silica obtained 35 04, 34·05, 35·71 p. c. The alumina contained a little oxide of iron.

B.B. exfoliates like vermiculite, and colors the flame intense carmine-red. In the closed tube yields water, which is at first neutral, then becomes acid by decomposing the fluoride of silicon evolved, while a ring of silica is deposited. Tube slightly etched. Fusible on thin edges, and gives blue color with cobalt solution. With phosphorus salt gives skeleton of silica. Partially decomposed by sulphuric acid.

Occurs with tourmaline and lepidolite at Hebron and Paris, Me., often as a pearly coating on crystals of rubellite, of which it appears to be a product of alteration. Probably similarly associated at Elba. Also at Pádar, Kashmir, with sapphire, green tourmaline, spodumene (La Touche, Rec. G. Surv. Ind., **23**, 59, 1890).

Named after Prof. J. P. Cooke, of Cambridge.

**461. ZINNWALDITE.** *Haidinger*, Handb., 521, 1845. Lithionit *von Kobell*, Taf., **54**, 1853. Rabenglimmer *Breith.* Lithionglimmer *pt.* Lithioneisenglimmer *Germ.*

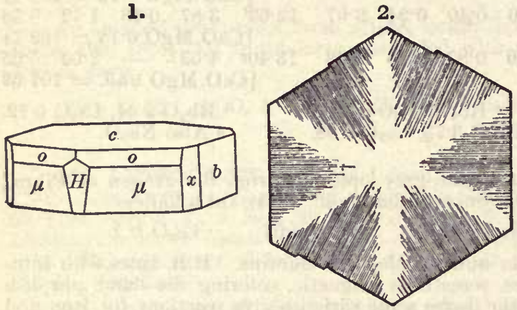
Cryophyllite *J. P. Cooke*, Am. J. Sc., **43**, 217, 1867. Polylithionit *Lorenzen*, Zs. Kr., **9**, 251, 1884.

Monoclinic. In form near biotite (meroxene).

**Forms:** *b* (010, *i-ì*), *c* (001, *O*); *H* (201, — 2-ī), *o* (112, — ½), *M* (221, — 2), *μ* (1̄11, 1), *x* (1̄31, 3-3̀).

Measured angles: $cH = 85°$, $cM = 85°$, $co = 73° 19'$, $c\mu = 81°$ to $82°$, $bx = 30° 30'$.

Twins: according to the mica law, with *c* as comp.-face. Faces *b*, *c* often bright, the others dull. A fine wrinkling common on the cleavage surfaces normal to the edges of the *b* planes (f. 2, twin). Crystals often in fan-shaped groups; in rosettes.



Figs, 1, 2, Zinnwald, Tschermak.

Cleavage: basal perfect. Laminæ tough and flexible. H. = 2·5–3. G. = 2·82–3·20. Luster often pearly. Color pale violet, or yellow to brown and dark gray. Successive layers of different colors.

Pleochroism distinct in some kinds: in dark varieties, 𝔠 and 𝔟, dark brown, 𝔞 yellowish brown or reddish; in light colored kinds, 𝔠, 𝔟 brownish gray, 𝔞 nearly colorless. Absorption 𝔠 > 𝔟 > 𝔞 (Rosenbusch). Optically —. Ax. pl. ∥ *b*. $Bx_a$ nearly ⊥ *c*. Apparent angle 𝔞 *c* = — 1° 18′ red, — 1° 4′ Na, — 0° 57′ Tl. Axial angles:

| | | | |
|---|---|---|---|
| Zinnwald | $2E_r = 50° 36'$ | $2E_y = 50° 25'$ | $2E_{gr} = 50° 5'$ Tl |
| Siberia | $2E_r = 65° 28'$ | $2E_y = 65° 19'$ | 𝔞 *c* = 4° 4′ and 4° 2′ Tschermak |

**Var.**—*Ordinary.* As described above.

*Rabenglimmer* from Altenberg is a ferruginous zinnwaldite, Tsch. Color dark gray. Axial angle nearly zero. G. = 3·15–3·19 Breith. Turner found 19·78 p. c. $Fe_2O_3$, 7·49 $K_2O$, 3 06 $Li_2O$.

*Cryophyllite* from Rockport, Mass., is naturally referred here, although of rather different composition. Crystals mostly simple. G. = 2·909. Color emerald-green axially; brownish red laterally (Cooke). Optical characters as with zinnwaldite; $2E_y = 56°$. Strongly pleochroic: 𝔠 violet, 𝔟 greenish gray.

*Polylithionite* is a lithium mica from Kangerdluarsuk, Greenland. It is related to zinnwaldite, but contains more silica and alkalies, less alumina, and almost no iron. Lorenzen obtained:

| | | |
|---|---|---|
| $2E_r = 67° 13'$ Li | $2E_y = 67° 19'$ | $2E_{gr} = 67° 51'$ |
| 𝔞 *c* = 0° 18′ | 0° 5′ to 8′ | 0° 13′ |

**Comp., Var.**—Approximates empirically to $(K,Li)_3FeAl_3Si_6O_{16}(OH,F)_2$ as given by Groth. Clarke calculates $H_2K_4Li_4Fe_3Al_8F_8Si_{14}O_{42}$. Cf. also p. 612. Analysis 1 gives $Li_2O : K_2O : H_2O : FeO : Al_2O_3 : SiO_2 : F = 1 : 1·1 : 0·5 : 1·7 : 2·1 : 7 : 3·8$.

*Cryophyllite* is somewhat different, namely, $\overset{I}{R}_6(AlF_2)Al(SiO_3)_5$ Clarke. *Polylithionite* gives the empirical formula $(Li,Na,K)_{16}F_6Al_4Si_{16}O_{43}$.

**Anal.**—1, Berwerth, Min. Mitth., 346, 1877. 2, Rg., Min. Ch., 121, 1886. Earlier analyses gave discordant results, 5th Ed., p. 315 (under lepidolite).

3, Cooke, Am. J. Sc., **48**, 217, 1867. 4–6, Riggs, ib., **32**, 358, 1886.

7, Lorenzen, Medd. Grönland, **2**, 1884, and Min. Mag., **5**, 65, 1882. 8, Id., ibid., **7**, 1884.

*Zinnwaldite.*

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | $K_2O$ | $Li_2O$ | $Na_2O$ | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Zinnwald | | 45·87 | 22·50 | 0·66 | 11·61 | 1·75 | 10·46 | 3·28 | 0·42 | 0·91 | 7·94 | $P_2O_5$ 0·08<br>[= 105·48 |
| 2. " | | 46·44 | 21·84 | 1·41 | 10·06 | 1·89 | 10·58 | 3·36 | 0·54 | — | 7·62 | = 103·74 |

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | $K_2O$ | $Li_2O$ | $Na_2O$ | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Cryophyllite* | | | | | | | | | | | | |
| 3. Cape Ann | 2·909 | 51·49 | 16·77 | 1·97 | 7·98 | 0·34[a] | 13·15 | 4·06 | *tr.* | — | 3·42[b] | MgO 0·76, [$Rb_2O$ *tr.* = 99·94 |
| 4. " " | | 51·96 | 16·89 | 2·63 | 6·32 | 0·24 | 10·70 | 4·87 | 0·87 | ~~1·31~~ | 6·78 | CaO,MgO [0·15 = 102·72 |
| 5. " " | | 51·46 | 16·22 | 2·21 | 7·63 | 0·06 | 10·65 | 4·81 | 0·89 | 1·12 | 7·44 | MgO 0·17 [= 102·66 |
| 6. " " | | 52·17 | 16·39 | 4·11 | 5·99 | 0·32 | 10·48 | 4·99 | 0·63 | 1·46 | 7·02 | = 103·56 |

| *Polylithionite* | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | $K_2O$ | $Li_2O$ | $Na_2O$ | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|---|---|---|
| 7. Kangerdluarsuk | 58·93 | 12·83 | 1·11 | — | 5·37 | 9·07 | 7·63 | 4·99 | | = 99·93 |
| 8. " | ⅜ 59·25 | 12·57 | — | 0·93 | 5·37 | 9·04 | 7·63 | — | 7·32 | = 102·11 |

[a] $Mn_2O_3$. [b] $SiF_4$.

**Pyr., etc.**—Nearly as with lepidolite, but more fusible and reacts for iron.

Cryophyllite fuses in the flame of a candle; and B.B., with some intumescence to a grayish enamel (F. = 1·5-2), giving a lithia reaction. In fine powder decomposed by the dilute acids, the silica separating as a powder. The fluorine is not expelled even at a red heat.

**Obs.**—Occurs at Zinnwald and Altenberg (*Rabenglimmer*) in the Erzgebirge in connection with tin deposits; similarly in Cornwall, at St. Just, and elsewhere. In the granite of the Mourne Mts., Ireland, showing a zonal structure. the center dark green with an axial angle of 44° 4′; the border giving 52° 6′ (Sollas). Also from Siberia, exact locality unknown.

*Cryophyllite* occurs in the granite of Cape Ann, with danalite and annite. Named from *κρυός, ice*, and *φύλλον, leaf*, in allusion to its easy fusibility and foliated structure.

*Polylithionite* is from Kangerdluarsuk, Greenland, where it occurs embedded in albite with ægirite, steenstrupine, analcite.

PROTOLITHIONITE *F. Sandberger*, Unt. Erzg., 169, 1885. A lithium-iron mica from the granite of the Erzgebirge, Fichtelgebirge, etc. Color dark. Optically nearly uniaxial. The typical occurrence is that in the tourmaline-granite of Eibenstock, Saxony. Sandberger regards it as the source of the zinnwaldite, hence the name. Anal.—1, Schröder, l. c., and Jb. Min., 2, 93, 1883. 2, Niemeyer, ibid.

| | G. | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $K_2O$ | $Na_2O$ | $Li_2O$ | F | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Eibenstock | 2·98 | 39·04 | 0·57 | 23·56 | 6·10 | 12·42 | — | 0·97 | 0·78 | 8·51 | 0·71 | 3·39 | *undet.* | 3·25 | [$SnO_2$ 0·22 = 99·52 |
| 2. Geyer | 2·88 | 37·83 | 0·30 | 24·35 | 7·59 | 11·78 | 0·27 | 0·44 | 0·20 | 10·03 | 2·24 | 1·73 | 4·28 | 1·23 | [$SnO_2$ *tr.* = 102·27 |

**462. BIOTITE.** Magnesia-Mica pt., Hexagonal Mica, Uniaxial Mica. Astrites meroxenus (fr. Vesuv.) *Breith.*, Handb., 382, 1841. Rubellan = Astrites trappicus, *Breith.*, ib., 379. Biotit *Hausm.*, Handb., 671, 1847. Rhombenglimmer (fr. Greenwood Furnace) *Kenngott*, Pogg., **73**, 661. Euchlorite *C. U. Shepard*, Pisani, C. R., **83**, 167, 1876. Meroxen, Anomit *Tschermak*, Ber. Ak. Wien, **76** (1), 1877, Zs. Kr., **2**, 14, 1878. Haughtonite *Heddle*, Min. Mag., **3**, 72, 1879. Siderophyllite *H. C. Lewis*, Proc. Ac. Philad., 254, 1880. Manganophyllite. Manganophyll *Igelström*, Jb. Min., 296, 1872. Manganofyll *Swed.*

Monoclinic; pseudo-rhombohedral. Axes $\grave{a} : \bar{b} : \acute{c} = 0·57735 : 1 : 3·27432$; $\beta = {}^*90° = 001 \wedge 100$ Rath[1].

$100 \wedge 110 = 30°\,0'$, $001 \wedge \bar{1}01 = 80°\,0'$, $001 \wedge 011 = 73°\,1'$.

**Forms**[2]:
*a* (100, *i*-ī)
*b* (010, *i*-ì)
*c* (001, *O*)
*m* (110, *I*)?
*Q* (130, *i*-3̀)
*σ* ($\bar{1}$04, $\frac{1}{4}$-ī)
*ρ* ($\bar{2}$05, $\frac{2}{5}$-ī)
*x* ($\bar{1}$02, $\frac{1}{2}$-ī)

*r* ($\bar{1}$01, 1-ī)
*i* (013, $\frac{1}{3}$-ì)
*e* (023, $\frac{2}{3}$-ì)
*Ψ* (011, 1-ì)
*y* (043, $\frac{4}{3}$-ì)
Σ (032, $\frac{3}{2}$-ì)
ξ (0·12·7, $\frac{12}{7}$-ì)
*α* (021, 2-ì)
*β* (052, $\frac{5}{2}$-ì)
*υ* (041, 4-ì)

*φ* (061, 6-ì)
𝔞 (1·1·12, − $\frac{1}{12}$)
*k* (118, − $\frac{1}{8}$)
Z (113, − $\frac{1}{3}$)
*h* (225, − $\frac{2}{5}$)
*o* (112, − $\frac{1}{2}$)
*u* (7·7·10, − $\frac{7}{10}$)
*ν* (334, − $\frac{3}{4}$)
*W* (9·9·10, − $\frac{9}{10}$)

*ε* (332, − $\frac{3}{2}$)
*M* (221, − 2)
*f* (331, − 3)
*w* ($\bar{1}$19, $\frac{1}{9}$)
*v* ($\bar{1}$17, $\frac{1}{7}$)
*t* ($\bar{1}$16, $\frac{1}{6}$)
*s* ($\bar{1}$15, $\frac{1}{5}$)
*q* ($\bar{1}$14, $\frac{1}{4}$)
*l* ($\bar{5}$58, $\frac{5}{8}$)

*n* ($\bar{2}$23, $\frac{2}{3}$)
*μ* ($\bar{1}$11, 1)
*ι* ($\bar{9}$98, $\frac{9}{8}$)
*κ* ($\bar{5}$54, $\frac{5}{4}$)
*S* ($\bar{5}$51, 5)
*K* (2·6·15, − $\frac{2}{5}$-3̀)?
*ζ* (135, − $\frac{3}{5}$-3̀)?
*d* (134, − $\frac{3}{4}$-3̀)
*z* (132, − $\frac{3}{2}$-3̀)

The forms *σ* ($\bar{1}$04), *ρ* ($\bar{2}$05), *ζ* (135), and perhaps *K* (2·6·15) are gliding-planes.

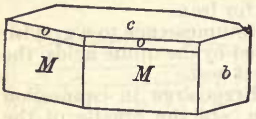
$mm'$ = 60° 0′
[illegible] = 60° 0′
$c\sigma$ = 54° 48′
$c\rho$ = 66° 13′
$cx$ = 70° 34½′
$cr$ = *80° 0′
$ci$ = 47° 30′
$ce$ = 65° 23′
$c\Psi$ = 73° 1′
$cy$ = 77° 6′
$c\Sigma$ = 78° 29½′
$c\alpha$ = 81° 19′

$c\beta$ = 83° 2′
$c\upsilon$ = 85° 32′
$c\phi$ = 87° 5′
$ck$ = 39° 18′
$cZ$ = 62° 7′
$ch$ = 69° 6′
$co$ = 73° 1′
$c\nu$ = 78° 29½′
$c\epsilon$ = 84° 11′
$cM$ = 85° 38′
$cf$ = 87° 5′
$ww$ = 36° 2½′

$cv$ = 43° 5½′
$ct$ = 47° 30′
$cs$ = 52° 38′
$cq$ = 58° 35′
$cn$ = 77° 6′
$c\mu$ = 81° 19′
$c\kappa$ = 83° 2′
$cS$ = 88° 15′
$c\zeta$ = 66° 13′
$cz$ = 80° 0′
$hh'$ = 55° 42′
$oo'$ = 57° 8′

$MM'$ = 59° 48½
$ss'$ = 46° 50′
$qq'$ = 50° 31′
$nn'$ = 58° 20′
$\mu\mu'$ = 59° 14½′
$\zeta\zeta'$ = 104° 50′
$zz'$ = 117° 3′
$bo$ = 61° 26′
$bM$ = 60° 6′
$b\mu$ = 60° 23′
$bz$ = 31° 28½′
$bcM$ = *60° 0′

1.



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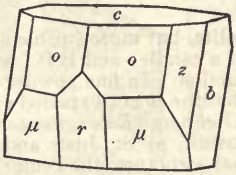

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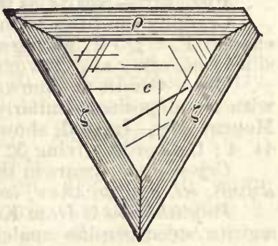

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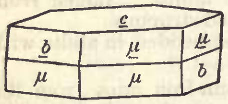

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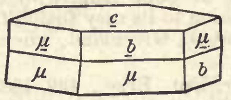


Figs. 1–5, Tschermak: 1, 2, Vesuvius, simple crystals; 3, 4, twins; 5, Greenwood Furnace, parting form with the gliding-planes ρ ($\bar{2}05$), ζ (135).

Common forms *c, b, o* (112), *μ* ($\bar{1}11$); *c* usually brilliant, also the others somewhat less so, but *o, μ*, often striated ∥ *c*, and *c* also finely striated ∥ edge *b/c*. Habit tabular or short prismatic; the pyramidal faces often repeated in oscillatory combination. Vicinal forms not uncommon. Crystals often apparently rhombohedral in symmetry since *r* ($\bar{1}01$) and *z* (132), *z′* ($1\bar{3}2$), which are inclined to *c* at nearly the same angle, often occur together; further, the zones to which these faces belong are inclined 120° to each other, hence the hexagonal outline of basal sections.

Twins[3], according to the mica law, tw. pl. a plane in the prismatic zone ⊥ *c*, sometimes contact-twins with the tw. pl. also the comp.-face, and either symmetrically or unsymmetrically situated. Also comp.-face *c* one crystal above the other, and either right-handed (f. 3) or left-handed (f. 4). Often in disseminated scales, sometimes in massive aggregations of cleavable scales.

Cleavage: basal, highly perfect; planes of separation ∥ *b* and *μ* ($\bar{1}11$) and other less definitely determined pyramids ($\bar{1}12$, 111, 114) in the unit series, as shown in the percussion-figure, Tsch. Gliding-planes *ρ* ($\bar{2}05$), *ζ* (135) shown in the pressure-figure inclined about 66° to *c*; also *σ* ($\bar{1}04$) inclined 55° to *c*, and perhaps (104). These gliding-planes yield pseudo-crystalline forms (f. 5) which are especially prominent with anomite. Etching-figures in general hexagonal in form. H. = 2·5–3. G. = 2·7–3·1. Luster splendent, and more or less pearly on a cleavage surface, and sometimes submetallic when black; lateral surfaces vitreous when smooth and shining. Colors usually green to black, often deep black in thick crystals, and sometimes even in thin laminæ, unless the laminæ are very thin; such thin laminæ green, blood-red, or brown by transmitted light; also pale yellow to dark brown; rarely white. Streak uncolored. Transparent to opaque.

Pleochroism strong; absorption $\mathfrak{b} = \mathfrak{c}$ nearly, for $\mathfrak{a}$ much stronger. Hence sections ∥ *c* (001) dark green or brown to opaque; those ⊥ *c* lighter and deep brown or green for vibrations ∥ *c*, pale yellow, green or red for vibrations ⊥ *c*. Pleochroic halos often noted, particularly about microscopic inclusions. Optically −. Double refraction strong. Ax. pl. usually ∥ *b*, rarely ⊥ *b*. $Bx_{\mathfrak{a}}$ (= $\mathfrak{a}$) nearly coincident with the normal to *c*, but inclined about half a degree, sometimes to the front, sometimes the reverse. Axial angle usually very small, and often sensibly uniaxial; also up to 50°.

Tschermak obtained on a yellow crystal from Vesuvius (meroxene) for the apparent angle between $Bx_a$ (= $\mathfrak{a}$) and the normal to *c*, − 32′ red glass (Na same); on a brown crystal + 43′ red, 43′ Na, 42′ Tl; again on a black crystal 7′ Na, 3′ green glass. On anomite from Greenwood Furnace the same angle was − 35′ Na.

He also gives the following axial angles (cf. anals. beyond) for meroxene:

| | | | | |
|---|---|---|---|---|
| Morawitza, *olive-green* | $2E_r$ = 0° to 4° | | | [$2E_{gr}$ = 9° 24′ |
| Vesuvius, *yellow* | $2E_r$ = 6° 16′ | $2E_y$ = 6° 24′ | *brown* $2E_r$ = 7° 59′ | $2E_y$ = 8° 10′ |
| " *deep brown* | $2E_y$ = 7° 51′ | $2E_{gr}$ = 8° 18′ | $2E_r$ = 9° 21′ | $2E_y$ = 10° 23′ |
| " *dark green* | $2E_r$ = 12° 22′ | $2E_y$ = 12° 48′ | $2E_{gr}$ = 13° 18′ | also $2E_y$ = 37° 30′ |
| Cherbarkul, *black* | $2E_y$ = 20° | | Albani Mts., *black* | $2E_y$ = 56° |

Anomite, L. Baikal $2E_r$ = 12° 44′ and 16°. Also $2E_{gr}$ = 15° 42′ and 12° 20′ on different parts of the same specimen. Again, $2E_r$ = 12°, 14° 12′, the axial angle diminishing with increase of iron.

Greenwood Furnace $2E_r$ = 12° 55′ red glass $2E_y$ = 12° 40′ Na $2E_{gr}$ = 12° 35′ green glass

**Comp., Var.**—In most cases an orthosilicate, and as shown by Tschermak chiefly ranging between $(H,K)_2(Mg,Fe)_4(Al,Fe)_2Si_4O_{16}$ and $(H,K)_2(Mg,Fe)_2Al_2Si_3O_{12}$. Of these the second formula may be said to represent typical biotite. The amount of iron varies widely as shown in the analyses which follow.

Biotite is divided into two classes by Tschermak:

I. MEROXENE. Axial plane ∥ *b*. II. ANOMITE. Ax. pl. ⊥ *b*. Of these, meroxene includes nearly all ordinary biotite, while anomite is, so far as yet observed, of restricted occurrence, the typical localities being Greenwood Furnace, Orange Co., N. Y., and L. Baikal in E. Siberia (see also beyond). An attempt was made by Tschermak to establish a separate composition for anomite, but the observations are too few to establish this, if indeed a uniform difference really goes with the change in optical character, which seems improbable. *Meroxene* is Breithaupt's name early given to the Vesuvian biotite. Anomite is from *ἄνομος*, *contrary to law*.

*Barytbiotite*, of Knop, is a kind of biotite from Schelingen in the Kaiserstuhl, containing 7·3 p. c. baryta, anal. 28.

A *chrome magnesia mica* (*Chromglimmer*) of a green color, from Schwarzenstein, in Zillerthal, afforded Schafhäutl (Lieb. Ann., **46**, 325, 1843) over 5 p. c. of oxide of chromium. He obtained: $SiO_2$ 47·68, $Al_2O_3$ 15·15, $Cr_2O_3$ 5·90, $Fe_2O_3$ 5·72, MnO 1·05, MgO 11·58, $Na_2O$ 1·17, $K_2O$ 7·27, $H_2O$ 2·86 = 98·38.

*Siderophyllite* of Lewis is a black mica from the Pike's Peak region, in which the magnesium is chiefly replaced by ferrous iron; cf. anal. 31, which gives the formula $3H_2O.6(K,Na,Li)_2O.21FeO.10Al_2O_3.30SiO_2$

*Haughtonite* is also characterized by the large amount of iron replacing magnesium. G. = 2·96–3·13. Fuses with difficulty to a black magnetic globule. Color dark brown to jet black. Axial angle small. Occurs mostly in granitic and gneissoid rocks, also in dioryte, at various Scottish localities, as from hornblendic gneiss of Roneval; the hill of Capval; Nishibost; from the shore of Loch-na-Muilne; Fionaven in Sutherland; Ben Stack; Rispond; Clach-an-Eoin; Kinnaird's Head, Aberdeenshire; Cove near Aberdeen; Lairg, in Sutherland; Portsoy in Banffshire. Cf. anal. 30. Named after Dr. Samuel Haughton of Dublin.

*Manganophyllite* occurs in crystals, thick tabular ∥ *c*; also tabular ∥ *b* with *m* and *o* strongly developed. Forms: *b*, *c*, *m*, *e*, *o*, *μ*, *z* (p. 627). Angles (meas., Flink): *ce* = 65° 33′, *co* = 72° 45′, *cμ* = 81° 29′, *bo* = 61° 38′, *bμ* = 60° 23′.

In aggregations of thin scales. Color bronze- to copper-red. Streak pale red. Translucent and rose-red in thin scales. Pleochroism strongly marked, but varying with the composition: ∥ *c* ($\mathfrak{b}$, $\mathfrak{c}$) colorless or pale yellowish red; ⊥ *c* ($\mathfrak{a}$) deep reddish brown. Absorption in some varieties a maximum for rays with vibrations ⊥ *c* unlike other micas. In others, which contain most manganese, absorption normal, like biotite, here $\mathfrak{a}$ red-brown, $\mathfrak{b}$ and $\mathfrak{c}$ dark brown. Certain intermediate kinds show no pleochroism (Hamberg).

In composition manganophyllite is a manganesian biotite, but varying widely in the relative amounts of manganese and other elements. Cf. anals. 33–36.

**Anal.**—1, John, Min. Mitth., 242, 1874. 2, Hamm, Min. Mitth., 32, 1873. 3, Smith & Brush, Am. J. Sc., **16**, 45 1853. 4, Rg., Min. Ch., Erg., 118, 1886. 5, Rumpf, Min. Mitth., 177, 1874. 6, 7, Rg., Jb. Min., **2**, 227, 1885. 8, Pisani, C. R., **83**, 167, 1876. 9, Berwerth, Min. Mitth., 112, 1877. 10, Rg., Min. Ch., Erg., 118, 1886. 11, Zellner. 12–19, Rg., l. c. 20, Becker, Zs. Kr., **17**, 130, 1889. 21, Clarke & Riggs, Am. J. Sc., **34**, 135, 1886. 22, Schlaepfer, Recherches sur la comp. d. micas, etc., 1889. 23–28, Knop, Zs. Kr., **12**, 604, 1887. 29, Hawes, Am. J. Sc., **11**, 431, 1876. 30, Heddle, Min. Mag., **3**, 72, 1879; also numerous other analyses, ibid., p. 81, and **4**, 221, 1881. 31, Lewis & Genth, Proc. Ac. Philad., Jan. 28, 1878. 32, Clarke &

Riggs, Am. J. Sc., **34**, 136, 1887. 33, Igelström, l. c. 34, Flink, Ak. H. Stockh., Bihang, **13** (2), 7, 70, 1888. 35, 36, Hamberg, G. För. Förh., **12**, 567, 1890.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Lake Baikal | 2·870 | 40·00 | 17·28 | 0·72 | 4·88 | 23·91 | — | 8·57 | 1·47 | 1·37 | 1·57 | [= 99·77 |
| 2. Greenwood F. | 2·846 | 40·81 | 16·47 | 2·16 | 5·92 | 21·08 | — | 9·01 | 1·55 | 2·19 | *tr.* | [= 99·19 |
| 3. " | | 39·88 | 14·99 | 7·68 | — | 23·69 | — | 9·11 | 1·12 | 1·30 | 0·95 | [Cl 0·44 = 99·16 |
| 4. Monzoni, *drk. grn.* | | 41·70 | 16·86 | 2·23 | 2·74 | 24·70 | — | 8·93 | 0·28 | 1·14 | 0·53 | [= 99·11 |
| 5. Morawitza | 2·75 | 40·16 | 15·79 | 2·53 | 4·12 | 26·15 | *tr.* | 7·64 | 0·37 | 3·58 | — | [= 100·34 |
| 6. Branchville, *black* | 2·898 | 44·94 | 31·69 | 4·75 | 3·90 | — | — | 8·00 | 0·59 | 3·85 | 0·93 | [$Li_2O$ 0·21 = 98·86 |
| 7. " | 3·030 | 38·47 | 24·27 | 7·65 | 11·87 | — | — | 9·64 | 1·13 | 2·88 | 2·43 | [$Li_2O$ 1·38 = 99·72 |
| 8. Chester, Mass., *Euchlorite* | 2·84 | 39·55 | 15·95 | 7·80 | — | 22·25 | — | 10·35 | | 4·10 | — | [= 100 |
| 9. Vesuvius | 2·86 | 39·30 | 16·95 | 0·48 | 8·45 | 21·89 | 0·82 | 7·79 | 0·49 | 4·02 | 0·89 | [= 101·08 |
| 10. Arendal, *black* | | 38·89 | 14·53 | 4·58 | 8·92 | 20·28 | — | 10·08 | 0·40 | 0·94 | 1·49 | [= 100·11 |
| 11. Chebarkul | 3·00 | 38·49 | 14·43 | 5·44 | 14·75 | 16·34 | — | 8·12 | 0·53 | 0·89 | *tr.* | [= 98 99 |
| 12. Miask, *black* | | 32·49 | 12·34 | 6·56 | 25·13 | 5·29 | — | 9·59 | 0·88 | 2·42 | 1·61 | [$TiO_2$ 4·03 = 100·34 |
| 13. Filipstad | | 38·20 | 15·45 | 8·63 | 9·59 | 16·58 | 1·50 | 9·17 | 0·18 | 1·94 | 1·15 | [= 102·39 |
| 14. Sterzing | | 39·82 | 19·25 | 2·62 | 5·73 | 20·00 | 1·41[b] | 8·33 | 0·66 | 1·69 | *tr.* | [= 99·51 |
| 15. Persberg | | 37·77 | 15·96 | 6·63 | 14·43 | 12·26 | — | 8·23 | 0·27 | 2·67 | 0·44 | [$TiO_2$ 2·12 = 100·78 |
| 16. Renchthal | | 37·67 | 18·79 | 6·48 | 15·28 | 9·72 | — | 8·93 | 1·92 | 2·33 | *tr.* | [= 101·12 |
| 17. Hitterö, *green-brown* | | 39·01 | 15·44 | 9·37 | 13·67 | 11·30 | — | 8·62 | 0·14 | 2 93 | 1·29 | [= 101·77 |
| 18. St. Dennis | | 37·93 | 24·89 | 7·85 | 14·87 | 0·28 | — | 8·64 | 0·40 | 1·54 | 4·23 | [= 100·63 |
| 19. Brevik, *green* | | 32·97 | 11·88 | 16·48 | 24·36[a] | 1·08 | — | 8·03 | 0·30 | 3·35 | 1·29 | [$TiO_2$ 2·42 = 102·16 |
| 20. Freiberg | | 34·70 | 17·17 | 2·11 | 19·55[a] | 9·52 | — | 8·91 | 1·24 | 3·56 | 0·20 | [$TiO_2$ 4·58 = 101·54 |
| 21. Auburn, Me. | | 34·67 | 30·09 | 2·42 | 16·99[a] | 1·98 | — | 7·55 | 1·67 | 4·64 | 0·28 | [= 100·29 |
| 22. Miask | 3·084 | 33·24 | 14·90 | 5·92 | 24·52[a] | 5·15 | 0·40 | 7·77 | 1·45 | 2·19 | — | [$TiO_2$ 4·73 = 100·27 |

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | $TiO_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23. Böstenbach | | 37·60 | 19·68 | 2·29 | 15·04 | 13·24 | — | 6·18 | 0·71 | 3·42 | 1·67 | [$Cr_2O_3$ 0·18 = 100·01 |
| 24. Freiersbach | | 32·83 | 18·40 | 1·46 | 19·90 | 11·56 | — | 7·53 | 2·09 | 3·05 | 3·30 | [= 100·12 |
| 25. Easton, Pa. | | 34·82 | 16·91 | 4·19 | 15·96 | 13·98 | — | 7·48 | 2·49 | 1·79 | 2·00 | [= 99·62 |
| 26. Hochberg | | 36·42 | 17·92 | 2·83 | 7·04 | 20 52 | — | 6 54 | 2·60 | 2·50 | 3·99 | [= 100·36 |
| 27. Klausenalp | | 37·90 | 18·83 | 4·22 | 15·86 | 14·20 | — | 6·96 | 0·59 | 1·23 | 0·21 | [= 100·0 |
| 28. Schelingen *Barytbiotite* | | 35·83 | 18·82 | 2·63 | — | 28·34 | 7·31[c] | 6·27 | 1·01 | — | — | [= 100·21 |
| 29. Middletown, Ct. | 2·96 | ⅔ 35·61 | 20·03 | 0·13 | 23·04[a] | 5·23 | — | 9·69 | 0·52 | 1·87 | 1·46 | [F 0·76, $Li_2O$ 0·93, Cl *tr.* = 99·27 |
| 30. Roneval, *Haughtonite* | 3·03 | 37·16 | 15·01 | 7·69 | 18·39[a] | 8·88 | 1·13 | 8·18 | 1·60 | 2·12 | — | [= 100·16 |
| 31. Pike's Peak *Siderophyllite* | 3·1 | 36·68 | 20·41 | 1·55 | 27·60[a] | 1·14 | 0·81 | 9·20 | 1·09 | 1·01 | — | [$Li_2O$ 0 37 = 99·86 |
| 32. Pike's Peak | | 34·21 | 16 53 | 20·15 | 15·08[a] | 1·34 | 0·48 | 6·50 | 1·43 | 4·54 | 0·08 | [= 100·34 |

[a] Incl. MnO, in 9, 0·59 p. c.; in 19 3·64; in 20, 0·50; in 21, 0·85; in 22, 0·95; in 29, 1·19; in 30, 1·04; in 31, 2·10; in 32, 0·91. [b] BaO. [c] BaO 6·84, SrO 0·47.

*Manganophyllite.*

|  | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MnO | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ | F |
|---|---|---|---|---|---|---|---|---|---|---|
| 33. Pajsberg | 38·50 | 11·00 | 3·78[a] | 21·40 | 3·20 | 15·01 | 5·51 |  | 1·60 | — =100 |
| 34. Långban | 41·36 | 16·02 | 4·66 | 5·41 | — | 13·27 | 11·43 | 2·09 | 4·62 | 0·49= 99·35 |
| 35. Pajsberg, *red-brn.* | 40·64 | 9·43 | 3·66 | 9·68 | — | 22 31 | 10·50 | 0·35 | 4·30 | 0·30 $Li_2O$ 0·29 [= 101·46 |
| 36. " *dark brn.* | 36·42 | 12·64 | 4·50[b] | 17·13 | 0·20 | 14·73 | 8·78 | 0·38 | 4·60 | 0·33 $Li_2O$ 0·40 [= 100 11 |

[a] FeO. [b] 0·70 $Mn_2O_3$

**Pyr., etc.**—In the closed tube gives a little water. Some varieties give the reaction for fluorine in the open tube; some kinds give little or no reaction for iron with the fluxes, while others give strong reactions for iron. B.B. whitens and fuses on the thin edges. Completely decomposed by sulphuric acid, leaving the silica in thin scales.

Manganophyllite becomes black upon ignition and gives a strong manganese reaction with the fluxes. Soluble in hydrochloric acid with separation of silica.

**Obs.**—Biotite is a common constituent of the crystalline rocks, granite, gneiss, mica schist, etc., being often associated with muscovite and sometimes largely taking its place. Also very common, as muscovite is not, in eruptive rocks of all ages, syenite, andesyte, trachyte, etc. Further, it occurs as a result of secondary action in certain contact rocks, and as produced by the alteration of a variety of species. It is not infrequently associated in parallel position with muscovite, the latter, for example, forming the outer portions of plates having a nucleus of biotite; sometimes in similar plates the two species are in twinning position with reference to each other (cf. Lcx., Jb. Min., 630, 1878).

Some of the prominent localities of crystallized biotite are, as follow: first of all, Vesuvius, where it is very common and occurs particularly in ejected limestone masses on Monte Somma, associated with augite, chrysolite, nephelite, humite, etc. The crystals are sometimes nearly colorless or yellow and then usually complex in form; also dark green to black. Occurs also in the Albani Mts.; Mt. Monzoni in the Fassathal, in green or greenish black crystals; Schwarzenstein in the Zillerthal and in the Pfitschthal with black tourmaline; Rezbánya and Morawitza in Hungary; Schelingen and other points in the Kaiserstuhl; the Laacher See; on the west side of L. Ilmen near Miask, etc.

In the United States ordinary biotite is common in granite, gneiss, etc., but notable localities of distinct crystals are not numerous. It occurs with muscovite (wh. see) as a more or less prominent constituent of the pegmatyte veins in Maine, New Hampshire, Massachusetts, Connecticut, Pennsylvania; also similarly in Virginia and North Carolina. Interesting specimens have been obtained at Litchfield, Me.; Acworth, N. H.; Craftsbury, Vt. (nodular masses of biotite cemented by quartz); Portland, Middletown, Branchville, Conn.; St. Lawrence Co., N. Y.; in N. Carolina. in crystals at the mica mines of Mitchell, Haywood, Yancey counties, and especially Macon County; in the Pike's Peak region in Colorado, where the variety siderophyllite was obtained.

The variety *anomite,* as already noted, is rare. The typical localities are L. Baikal in eastern Siberia, where it occurs with apatite, diopside, etc., in a coarse granular limestone on the river Sliudianka; also at Greenwood Furnace, Orange Co., New York, where it is characterized by the pseudo-crystalline forms (f. 5, p. 628), often rhombohedral, showing the gliding-planes $\rho$, $\zeta$. A few other occurrences have been noted, as in gneiss at Steinegg, Lower Austria; the nephelinyte of the Katzenbuckel; kersantyte of Michaelstein near Blankenburg in the Harz; in melilite-basalt of Alnö, Westernorrland, Sweden, etc.

*Manganophyllite* occurs in cavities filled with calcite, with tephroite, rhodonite, richterite, less often hematite, magnetite, garnet, etc., at the Harstig mine at Pajsberg, Wermland, Sweden; also at Långban and probably at Jakobsberg near Nordmark. Named from *manganese* and *φυλλον, leaf.*

See further on localities under the varieties above; also phlogopite, lepidomelane, following, which are probably to be regarded as hardly more than well characterized varieties of biotite.

Biotite is named after the French physicist, Biot (1774–1862).

**Alt.**—Biotite is often altered by the assumption of water and oxidation of the iron and many supposed species have been based upon such products; a loss of transparency, a bronze luster on the surface, etc., are early changes. Cf. below, and also under the vermiculites.

**Artif.**—See p. 613.

**Ref.**—[1] Rath, Vesuvius, Pogg., Erg. Bd., **6**, 366, 1873. He showed that the angles *cr* and *cz* are sensibly equal; measurement gave:

$$001 \wedge \bar{1}01 = 80^\circ\ 0' \qquad 001 \wedge 132 = 80^\circ\ 1' \qquad 001 \wedge 1\bar{3}2 = 80^\circ\ 0'$$

The position of Tschermak is here followed (cf. p. 620). In his original paper Tschermak assumed the fundamental angles (Rath) $cr = 80^\circ\ 0'$, $cz = 80^\circ\ 0\frac{1}{2}'$, $oo' = 57^\circ\ 10'$, which give:

$$\grave{a} : \bar{b} : \grave{c} = 0{\cdot}5777 : 1 : 3{\cdot}2772 \qquad \beta = 89^\circ\ 59\tfrac{5}{6}'$$

or, if $M = 110$ (Tschermak, Min., 1883)

$$\grave{a} : \bar{b} : \grave{c} = 0{\cdot}5777 : 1 : 2{\cdot}1932 \qquad \beta = 84^\circ\ 58'.$$

If the first axial ratio is accepted the signs of the planes must be changed, that is $r = 101$, $M = \bar{2}21$, etc. It is obvious, however, that the angles are not decisive in showing on which side the obliquity really lies, hence the position here taken, with $\beta = 90°$, is to be regarded as conventional only. With Koksharov and some other authors the position in this regard is reversed; moreover, the axis $\dot{c}$ (Kk.) has only half the length here taken, hence with him $o = \bar{1}11$, $r = 201\,(g)$, $z = \bar{1}31\,(d)$, etc. Laspeyres has proposed another position for biotite to bring it into correspondence with Koksharov's position of clinochlore. Cf. Zs. Kr., **17**, 541, 1890.

[2] Cf. Tschermak, l. c., also Phillips, Min., 103, 1837; Mgc., Suppl. Bibl. Univ., **6**, 301, 1847; Mlr. Min., 387, 1852; Kk., Min. Russl., **2**, 113, 291, **7**, 225, **8**, 5, Mem. Akad. St. Pet., 1877 (read May 17); Dx., Min., **1**, 484, 1862; Hbg., Min. Not., **7**, 15, 1866; Rath, l. c. Hbg. (l. c.) discusses the earlier results and gives a list of planes, noted by different authors, referred to the rhombohedral form. Some of the forms deduced from early observations must be regarded as doubtful.

[3] The *mica law* is here and elsewhere stated in the form given by Tschermak. Brögger prefers to regard the normal to *c* (001) as the tw. axis and the angle of revolution 120°. See Zs. Kr., **16**, 24–41, 1890, **18**, 374, 1890; also Hamberg, G. För. Förh., **12**, 585, 1890.

The following have probably been derived from biotite; still other alteration products are noted under the vermiculites, to which some of these approximate.

RUBELLAN *Breith.* is considered an altered biotite; it occurs in small hexagonal forms, of a red color, in the basalt of the Laacher See and elsewhere. Cf. Hollrung, Min. Mitth., **5**, 304, 1882.

EUKAMPTITE *Kenngott*, Ueb., 1853, 58, 1855, described under the name *Chloritähnliches Mineral* in Ber. Ak. Wien, **11**, 609, 1853. A hydrous biotite, probably a result of alteration, from Presburg, Hungary. It is between mica and chlorite in its characters.

VOIGTITE *Schmid*, Pogg., **97**, 108, 1856. Probably a hydrated biotite; it occurs in a graphic granite at Ehrenberg near Ilmenau. See 5th Ed., p. 486.

RASTOLYTE *Shepard*, Min., 1857, Appendix, p. vi; Am. J. Sc., **24**, 128, 1857. Similar to voigtite, from Monroe, N. Y.

HYDROBIOTITE *H. C. Lewis.* A hydrated biotite. The name has been similarly but more definitely used by Schrauf, Zs. Kr., **6**, 381, 1882.

PSEUDOBIOTITE *A. Knop*, Zs. Kr., **12**, 607, 1887. An altered biotite occurring in the granular limestone of the Schelinger Matten in the Kaiserstuhl. Analysis, Knop and Wagner:

| $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ | MgO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| $\frac{2}{2}$ 35·91 | 1·15 | 15·18 | 10·85 | 0·89 | 22 80 | 2·90 | *tr.* | 10·77 = 100·45. |

BASTONITE *Dumont*, Dx. Min., **1**, 498, 1862. A mica in large plicated plates, of a greenish brown color, greasy luster, very small optical angle, easily fusible into a black enamel, discovered by Dumont in a quartzyte from Bastogne, Belgian Luxembourg. The same mica in small pearly scales of a bronze-like color has been investigated by Klement and shown to be a somewhat altered iron mica. G. = 2·928. 2E = 10° 45′–12° 54′. Dispersion $\rho < v$. B.B. exfoliates and fuses finally to a black magnetic glass. Decomposed in hot acid. Analysis, Klement, Bull. Mus. Belg., **1**, 40, 1882.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| Libramont | 36·91 | 20·04 | 20·01 | 3·73 | 7·96 | 0·95 | 3·07 | 0·22 | 6·98[a] = 99·87 |

[a] Below 300° 1·61 p. c.

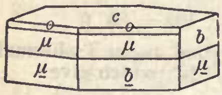
**462A. Phlogopite.** Magnesia-Mica pt. Rhombic Mica. Rhombenglimmer pt. Phlogopit (fr. Antwerp, N. Y.) *Breith.*, Handb., 398, 1841.

Monoclinic. In form and angles near biotite.

**Forms:** *b* (010, *i-ī*), *c* (001, *O*), *M* (221, − 2), *o* (112, − ½), *μ* ($\bar{1}11$, 1). Measured angles, *cM* = 85°, *co* = 73°, *cμ* = 81° 30′.

Twins as with ordinary biotite (p. 628) united by *c* (f. 1); also united by a vertical plane and then showing a fine feather-like striation ∥ edge *c/b*. Crystals often large and coarse. Usually oblong six-sided prisms, more or less tapering, with irregular sides.

1.



Cleavage: basal, highly eminent. Thin laminæ tough and elastic. Parting ∥ *σ* ($\bar{1}04$) and *ζ* (135) as with biotite, p. 628; also ∥ $\bar{1}34$ inclined about 71° to *c*; H. = 2 5–3. G. = 2·78–2·85. Luster pearly, often submetallic on cleavage surface. Color yellowish brown to brownish red, with often something of a copper-like reflection; also pale brownish yellow, green, white, colorless. Transparent to translucent in thin folia. Often exhibits asterism in transmitted light, due to regularly arranged inclusions (see below).

Pleochroism distinct in colored varieties: $\mathfrak{c}$ brownish red, $\mathfrak{b}$ brownish green, $\mathfrak{a}$ yellow. Absorption $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$, Burgess. Optically −. Ax. pl. ∥ *b*. $Bx_a$ nearly ⊥ *c*. Apparent angle $\mathfrak{a}c = -24'$ red, $-9'$ green, Burgess; also 1° 19′ Natural Bridge. Axial angle small but variable even in the same specimen, from 0° to 17° 25′ for red. $2E_r = 17° 25'$ Edwards (anal. 4). Dispersion $\rho < v$. The axial angle appears to increase with the amount of iron. Cf. Silliman, 5th Ed., p. 303 and Am. J. Sc., **10**, 372, 1850.

**Comp.**—A magnesium mica, near biotite, but containing little iron. Potassium is prominent as in all the micas, and in most cases fluorine. Typical phlogopite, according to Clarke, is $\overset{I}{R}_3Mg_3Al(SiO_4)_3$, where $\overset{I}{R} = H,K,MgF$. The Burgess phlogopite corresponds very closely to $H_2KMg_3Al(SiO_4)_3 + K(MgF)Mg_2Al(SiO_4)_3$. Clarke and Schneider, Am. J. Sc., **40**, 410, 1890. Analysis 8, discussed by Penfield and Sperry, conforms to the orthosilicate formula, $H_6K_2Mg_7Al_2(SiO_4)_7$. Cf. also Clarke, l. c.

While phlogopite cannot be sharply separated from biotite, its character and method of occurrence are so far constant and peculiar that it is most naturally placed by itself, while perhaps not deserving the full rank of an independent species.

**Anal.**—1, Ludwig, Min. Mitth., 240, 1874. 2, Neminar, ib., p. 241. 3, Poppovits, ib. 4, Berwerth, ib., quoted by Tschermak, Ber. Ak. Wien, **78** (1), 31, 1878. 5–7, Rg., Min. Ch., Erg., 117, 1886. 8, E. S. Sperry, Am. J. Sc., **36**, 329, 1888. 9, 10, Clarke and Schneider, **40**, 410, 1890. 11, 12, Penfield, priv. contr.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | BaO | $K_2O$ | $Na_2O$ | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Pargas | 2·867 | 43·43 | 13·76 | 0·16 | 1·35 | 27·20 | — | 8·06 | 1·30 | 0·92 | 4·21 | = 100·39 |
| 2. Pennsbury, Pa.? | 2·779 | 44·29 | 12·12 | 1·40 | 1·44 | 27·86 | — | 7·06 | 2·16 | 2·09 | 1·94 | = 100·36 |
| 3. Ratnapura | 2·742 | 42·26 | 15·64 | 0·23 | 1·52 | 27·23 | — | 8·68 | — | 2·91 | 2·19 | = 100·66 |
| 4. Edwards, N. Y. | | 40·64 | 14·11 | 2·28 | 0·69 | 27·97 | 2·54 | 8·16 | 1·16 | 3·21 | 0·82 | = 101·58 |
| 5. Pargas | | 42·55 | 12·74 | 1·31 | 0·49 | 27·62 | — | 8·92 | 0·83 | 1·18 | 4·59 | = 100·23 |
| 6. Rossie | | 43·17 | 13·43 | 1·51 | — | 27·47 | — | 8·73 | 0·39 | 0·40 | 5·41 | $Li_2O$ 0·53 [= 101·04 |
| 7. Gouverneur | | 43·00 | 13·27 | 1·71 | — | 27·70 | — | 10·32 | 0·30 | 0·38 | 5·67 | = 102·35 |
| 8. Edwards | 2·792 ⅔ | 44·81 | 10·87 | — | 0·31 | 28·90 | — | 8·40 | 0·46[a] | 5·42 | — | ign (100°) [0·96 = 100·13 |
| 9. " | | 45·05 | 11·25 | — | 0·14 | 29·38 | — | 8·52 | 0·52[b] | 5·37 | — | = 100·23 |
| 10. Burgess | | 39·66 | 17·00 | 0·27 | 0·20 | 26·49 | 0·62 | 9·97 | 0·60 | 2·99 | 2·24 | $Ti_2O$ 0·56 [= 100·60 |
| 11. De Kalb, *white* | 2·862 | 42·06[c] | 13·21 | 0·16 | 0·11 | 28·16 | 2·08 | 8·78 | 1·04 | 3·10 | 3·07 | = 101·77 |
| 12. Rossie, *black* | 2·950 | 40·63 | 13·04 | 1·12 | 7·62 | 21·47 | 0·04 | 10·14 | 0·57 | 2·47 | 4·00 | $TiO_2$ 1·16 [= 102·26 |

[a] Incl. 0·08 $Li_2O$. [b] Incl. 0·07 $Li_2O$. [c] Incl. 0.38 $TiO_2$.

**Pyr., etc.**—In the closed tube gives a little water. Some varieties give the reaction for fluorine in the open tube, while most give little or no reaction for iron with the fluxes. B.B. whitens and fuses on the thin edges. Completely decomposed by sulphuric acid, leaving the silica in thin scales.

**Obs.**—Phlogopite is especially characteristic of serpentine, and crystalline limestone or dolomite. It is often associated with pyroxene, amphibole, etc. Prominent localities are: Pargas, Finland, in crystalline limestone with diopside, pargasite; Åker and Sala in Sweden; Campolongo in Switzerland (Tessin), in dolomite; Ratnapura, Ceylon, etc.

Phlogopite occurs also in New York, at Gouverneur, of a brownish copper-red; at Pope's Mills, St. Lawrence Co.; Natural Bridge, Jefferson Co; colorless at Edwards, N. Y.; Oxbow. Also at Sterling Mine, Morris Co., N. J., rich yellowish brown, inclining to red, in limestone; at Suckasunny mine, N. J., deep olive-brown, inclining to yellow, in limestone; Newton, N. J., yellow, in limestone; Franklin Furnace; Lockwood, Sussex Co., N. J., deep olive-brown, like the mica of Fine, N. Y., in limestone. The crystals at Clarke's Hill, St. Lawrence Co., are very large, sometimes nearly two feet long (f. 2).

2.

At North and South Burgess, Ontario, in fine crystals, sometimes very large; also in Grenville, Buckingham, Templeton, and elsewhere in Quebec; in general, common in the crystalline limestones of the Laurentian.

Named from *φλογωπός, fire-like,* in allusion to the color.

The asterism of phlogopite, seen when a candle-flame is viewed through a thin sheet, is a common character, particularly prominent in the kinds from northern New York and Canada. It has been shown to be due to minute acicular inclusions arranged chiefly in the direction of the rays of the pressure-figure (f. 1, p. 611), producing a distinct six-rayed star; also parallel to the lines of the percussion-figure, giving a secondary star, usually less prominent than the other.

The nature of these inclusions is uncertain, and the same mineral may not always be the cause. Rose suggested cyanite, but later referred them to a uniaxial mica; rutile needles have been noted by Sandberger, and also by Lacroix; further tourmaline by Rosenbusch. Cf. the following authors:

G. Rose, Ber. Ak. Berlin, 614, Oct. 30, 1862. Sandberger, Jb. Min., **2**, 192, 1882. Lcx., Templeton, Bull. Soc. Min., **8**, 99, 1885; Ceylon, **12**, 341, 1889. Tschermak, Ber. Ak. Wien, **76** (1), 125, 1877. Rosenbusch, Mikr. Phys., 487, 1885. Lindgren, quoted by Clarke, Am. J. Sc., **40**, 411. 1890.

**Alt.**—The phlogopites are quite liable to change, losing their elasticity, becoming pearly in luster, with often brownish spots, as if from the hydration of the oxide of iron. In some cases an alteration to steatite and serpentine has been observed. A number of different "vermiculites" derived from phlogopite have been described, as noted beyond.

Aspidolite. Aspidolith *F. v. Kobell*, Ber. Ak. München, March 6, 1869.

An olive-green mica, brownish yellow in thin leaves, with pearly, submetallic luster. Occurs in aggregations of prismatic crystals. Axial angle 11° 55′. Analysis gave:

| | $SiO_2$ | $Al_2O_3$ | MgO | FeO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| G. = 2·72 | 46·44 | 10·50 | 26·30 | 9·00 | 4·77 | 2·52 | 1·33 | = 100·86 |

The composition approaches that of a soda phlogopite, but it needs further examination.

B.B. exfoliates like vermiculite, giving water in the closed tube. In the forceps difficultly fusible to a dirty gray-white glass. Entirely decomposed by hydrochloric acid, leaving the silica in pearly scales.

Found in the Zillerthal, in Tyrol, associated with chlorite.

**462B. Lepidomelane.** *Hausmann*, Gel. Anz. Gött., 945, 1840. Annite *Dana*, Min., 1868.

In small six-sided tables, or an aggregate of minute scales. Sometimes (Bgr., Zs. Kr., **16**, 189, 1890) in distinct crystals with the forms:

*b* (010, *i*-ĭ), *c* (001, *O*), *π* (201, − 2-ĭ), *y* (043, $\frac{4}{3}$-ĭ), *o* (112, − $\frac{1}{2}$), *M* (221, − 2), *μ* (1̄11, 1). Angles (Bgr.): *cπ* = 84° 48′, *cM* = 85° 29½′, *cμ* = 81° 2½′, *MM‴* = 59° 48′, *μμ′* = 59° 12′.

Cleavage: basal, eminent, as in other micas. Somewhat brittle. H. = 3. G. = 3·0–3·2. Luster adamantine, inclining to vitreous, pearly. Color black, with occasionally a leek-green reflection. Streak grayish green. Opaque, or translucent in very thin laminæ. Ax. plane ‖ *b*. Ax. angle small, from 0° to 8°. For anal. 6, 5°–8°.

**Comp.**—Chiefly characterized by the large amount of ferric iron. In part an orthosilicate, in part a more basic compound. It can hardly be regarded otherwise than as a variety of biotite. Anal. 6 gives $(H,K)_2Fe_3(Fe,Al)_4(SiO_4)_5$.

**Anal.**—1, Soltmann, Pogg., **50**, 664, 1840. 2, Haughton, Q. J. G. Soc., **15**, 129, 1859. 3, Scheerer, Zs. G. Ges., **14**, 56, 1862. 4, Rube, ibid. 5, Baltzer, Jb. Min., 654, 1872. 6, Rg., Min. Ch., Erg., 119, 1886. 7, Flink, Zs. Kr., **16**, 191, 1890; earlier, Scheerer. 8, 9, Riggs, Am. J. Sc., **31**, 268, 1886. 10, Id., ibid., **34**, 133, 1887. 11, Clarke & Schneider, ib., **40**, 410, 1890. 12, Cooke, ibid., **43**, 222, 1867. 13, Riggs, ibid., Am. J. Sc., **32**, 359, 1886.

| | | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Wermland | G. = 3.00 | 37·40 | — | 11·60 | 27·66 | 12·43 | — | 0·26 | | 9·20 | — | 0·60 | = 99·15 |
| 2. Ballyelin | | 35·55 | — | 17·08 | 23·70 | 3·55 | 1·95 | 3·07 | 0·61 | 9·45 | 0·35 | 4·30 | = 99·61 |
| 3. Freiberg | | 37·50 | 3·06 | 17·87 | 12·93 | 9·95 | 0·20 | 10·15 | 0·45 | 0·83 | 3·00 | 3·48 | = 99·42 |
| 4. " | | 36·89 | 3·16 | 15·00 | 16·29 | 6·95 | — | 9·65 | 1·75 | 6·06 | — | 4·40 | = 100·15 |
| 5. Adamello | G. = 3·07 | 36·43 | — | 14·40 | 16 71 | 17·40 | *tr.* | 6·87 | 1·66 | 5·54 | 0·03 | — | = 99·04 |
| 6. " Brevik " | | 32·97 | 2·42 | 11·88 | 16·48 | 20·72 | 3·64 | 1·08 | — | 8·03 | 0·30 | 3·35 | F 1·29 = 102·16 |
| 7. Langesund fiord | | 34·37 | 4·68 | 6·84 | 24·89 | 7·47 | 2·41 | 4·05 | 0·78 | 9·03 | 2·13 | 2·27 | = 98·92 |
| 8. Litchfield, Me. | | 32·09 | — | 18·52 | 19·49 | 14·10 | 1·42 | 1·01 | — | 8·12 | 1·55 | 4·62 | = 100·92 |
| 9. " " | | 32·35 | — | 17·47 | 24·22 | 13·11 | 1·02 | — | 0·89 | 6·40[a] | 0·70 | 4·67 | = 100·83 |
| 10. Baltimore | | 35·78 | — | 16·39 | 14·55 | 11·02 | 1·08 | 8·67 | — | 7·76 | 0·56 | 4·48 | = 100·29 |
| 11. Port Henry | | 34·52 | 2·70 | 13·22 | 7·80 | 22·27 | 0·41 | 5·82 | — | 8·59 | 0·20[b] | 4·39 | F 0·34, (Co,Ni)O 0·30 = 100·56 |
| 12. *Annite* | G. = 3·169 | 39·55 | — | 16·73 | 12·07 | 17·48 | 0·60[c] | 0·62 | — | 10·66 | 0·59[d] | 1·50 | $SiF_4$ 0·62 = 100·42 |
| 13. " | | 31·96 | 3·42 | 11·93 | 8·06 | 30·35 | 0·21 | 0·05 | 0·23 | 8·46 | 1·54 | 4 25 | = 100·46 |

[a] In orig. 6·40 $Na_2O$. [b] Incl. 0·04 $Li_2O$. [c] $Mn_2O_3$. [d] $Li_2O$.

**Pyr., etc.**—B.B. at a red heat becomes brown and fuses to a black magnetic globule. Easily decomposed by hydrochloric acid, depositing silica in scales; this is an important distinguishing character.

**Obs.**—A scaly-massive mineral at Persberg in Wermland, Sweden, containing embedded prisms of hornblende, the scales half a line or so across; Langesund fiord, Norway; mica-like at Abborforss in Finland; in granite in Ireland, at Ballyellin in Co. Carlow, Leinster, at Ballygihen in Co. Donegal, and at Canton, mostly in largish crystals or plates ($\frac{1}{4}$ inch across and larger). The Donegal and Leinster micas are optically uniaxial, according to Haughton. Similar iron micas occur at Litchfield, Me., Baltimore, Md., etc.

*Annite* occurs in the Cape Ann granite, with cryophyllite, orthoclase, albite, and zircon (cyrtolite).

*Lepidomelane* is named from *λεπίς, scale*, and *μέλας, black.*

PTEROLITE *Breithaupt*, B. H. Ztg., **24**, 336. Appears to be an altered lepidomelane, of a pearly luster, and a color between olive-green and liver-brown; scaly massive in texture. It occurs in the Brevik region, Norway, with astrophyllite, wöhlerite, ægirite, etc. See further p. 403.

ALURGITE *Breith.*, B. H. Ztg., **24**, 336, 1865. Massive, consisting of scales, rarely having an hexagonal outline. Cleavage: basal eminent, as in mica. H. = 2·25–3. G. = 2·984–3 Luster pearly to vitreous. Color purple to cochineal-red; in thinnest plates rose-red; streak rose-red. Transparent to translucent. Optically uniaxial. Contains much manganese, but not analyzed. Occurs with manganese ores at St. Marcel in Piedmont. Named from *ἀλουργός, purple.* It may be identical with manganophyllite, p. 629.

HELVETAN *R. T. Simmler*, Kenng. Ueb., 135, 1865, 1868. A micaceous mineral forming part of a schist and quartzyte in the gneiss formation (Alpinyte) of the Alps. H. = 3–3·5; G. = 2·77–3·03; luster pearly or waxy; color gray to whitish, reddish, greenish, violet, and copper-red; streak grayish white to reddish. In the closed tube yields little or no water.

Analysis, Simmler, Jb. Min., 348, 1868:

$SiO_2$ 67·07 $Al_2O_3$ 13·05 FeO 4·43 CaO 2·38 MgO 2·18 $K_2O$ 7·37 $Na_2O$ 1·69 $H_2O$ 1·85=100·02

It may be muscovite, impure with quartz, etc.

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### 463. ROSCOELITE. *J. Blake*, Am. J. Sc., 12, 31, 1876. *Genth*, ib., p. 32.

In minute scales, often in stellate or fan-shaped groups. Structure micaceous.

Cleavage: basal perfect. Soft. G. = 2·92–2·94 Genth. Luster pearly. Color dark clove-brown to greenish brown, dark brownish green. Translucent. Optically biaxial, negative. Bx $\perp c$. Dispersion $\rho < v$ Dx.

**Comp.**—A vanadium mica; formula doubtful. Genth calculates $H_8K(Mg,Fe)(Al,V)_4(SiO_4)_{12}$.

**Anal.**—1, Genth (after deducting 0·85 gold, quartz, etc.), Am. Phil. Soc., **17**, 119, 1877; also earlier on less pure material, Am. J. Sc., **12**, 32, 1876. 2, 3, Roscoe, Proc. Roy. Soc., **25**, 109, 1876.

| | G. | $SiO_2$ | $V_2O_3$ | $Al_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ | FeO | MgO | CaO | $K_2O$ | $Na_2O$ | $Li_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | | 47·69 | 20·56[a] | 14·10 | — | — | 1·67 | 2·00 | — | 7·59 | 0·19 | *tr.* | 4·96= 98·76 |
| 2. | 2·902 | 41·25 | 28·85[b] | 14·34 | 1·04 | 1·45 | — | 1·96 | 0·61 | 8·25 | 0·72 | — | 0·94hygrosc.<br>[water 2·12 = 101·53 |
| 3. | | — | 28·36[b] | 13·94 | 1·23 | 0·85 | — | 2·06 | 0·62 | 8·87 | 0·92 | — | 1·22hygrosc.<br>[water 2·42 |

[a] In the earlier analyses $V_6O_{11}$ was assumed. [b] $V_2O_6$.

**Pyr., etc.**—B.B. fuses easily to a black glass. Gives with salt of phosphorus a dark yellow bead O.F., and an emerald-green bed R.F. Only slightly acted upon by acids.

**Obs.**—Occurs intimately mixed with gold in seams ($\frac{1}{10}$ to $\frac{1}{20}$ in. thick) in porphyry, and filling cavities in quartz, at the gold mine at Granite Creek, near Coloma, El Dorado Co., California; also from Big Red Ravine, near Sutter's mill, where gold was first discovered in California (*Hanks*, Min. Sc. Press, June 25, 1881). Hanks remarks that at the Granite Creek locality some 400 or 500 lbs. of the mineral have been discovered, which were wasted in the extraction of the gold.

*Genth* also describes (l. c.) a mineral occurring in the Magnolia District, Colorado, as a thin earthy incrustation, of a grayish to olive-green color on calaverite, also inclosed in quartz, and giving it a green color. An analysis of the quartz gave: Quartz 79·38, Te 1·05, Au 0·03 = 80·46; the balance (19·5 p. c.) is assumed to belong to the green mineral which forms the coloring matter. An analysis of this, after the deduction of the quartz, gave (mean of 5 partial analyses): $SiO_2$ 56·74, $Al_2O_3$ 19·62, $V_2O_3$ 7·78, FeO 3·84, MgO 2·63, $Na_2O$ 0·94, $K_2O$ 8·11 MnO,$Li_2O$ *tr.*, $H_2O$ undet. =99·66. Genth regards this as probably closely related to roscoelite, perhaps a variety.

## 2. Clintonite Group. Monoclinic.

| | | | |
|---|---|---|---|
| **464.** | **Margarite** | $H_2CaAl_4Si_2O_{12}$ | |
| **465.** | **Seybertite** | $H_3(Mg,Ca)Al_5Si_2O_{18}$ | |
| | Brandisite | | |
| **465A.** | **Xanthophyllite** | $H_8(Mg,Ca)_{14}Al_{16}Si_5O_{52}$ ? | |
| | | $\grave{a} : \bar{b} : \grave{c} = 0{\cdot}57735 : 1 : 3{\cdot}2443$ | $\beta = 90°$ |
| **466.** | **Chloritoid** | $H_2(Fe,Mg)Al_2SiO_7$ | Triclinic? |
| **467.** | **Ottrelite** | $H_2(Fe,Mn)Al_2Si_2O_9$ ? | |

The minerals here included are sometimes called the Brittle Micas (Sprödglimmer *Germ.*). They are near the micas in cleavage, crystalline form, and optical properties, but are marked physically by the brittleness of the laminæ, and chemically by their basic character.

In several respects they form a transition from the micas proper to the chlorites. Margarite, or calcium mica, is a basic silicate of aluminium and calcium, while chloritoid is a basic silicate of aluminium and ferrous iron (with magnesium), like the chlorites.

Seybertite, brandisite, and xanthophyllite are near one another, and are regarded by Tschermak and Sipöcz as isomorphous mixtures of a silicate and aluminate

$$H_2CaMg_4Si_3O_{12} \quad \text{and} \quad H_2CaMgAl_6O_{12}.$$

For xanthophyllite the ratio 5 : 8 is given; for brandisite 3 : 4; for seybertite 4 : 5. Ottrelite is sometimes assumed to be identical with chloritoid, but recent analyses give it a much higher percentage of silica. Tschermak also includes sapphirine (p. 561) in this group.

**Ref.**—Tschermak & Sipöcz, Ber. Ak. Wien, **78** (1), Nov., 1878, or Zs. Kr., **3**, 496, 1879.

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**464. MARGARITE.** Perlglimmer (fr. Sterzing) *Mohs*, Char., 1820, Grundr., 232, 1824. Margarite *Tyrolese min. dealers.* Corundellite (fr. Pa.), Clingmanite (fr. N. C.), *B. Silliman, Jr.*, Am. J. Sc., 8, 380, 383, 1849. Emerylite (fr. Asia Minor) *J. L. Smith*, ib., 8, 378, 1849, **11**, 59, 1851. Kalkglimmer *Germ.*

Monoclinic. Axial ratio near that of biotite.

**Forms:** $b$ (010, $i$-$\grave{i}$), $c$ (001, $O$), $\mathfrak{p}$ ($0{\cdot}10{\cdot}9$, $\frac{10}{9}$-$\grave{i}$), $\mathfrak{k}$ (116, $-\frac{1}{6}$)?, $o$ (112, $-\frac{1}{2}$), $q$ ($\bar{1}14$, $\frac{1}{4}$), $\mathfrak{q}$ ($\bar{3}{\cdot}3{\cdot}10$, $\frac{3}{10}$), $p$ ($\bar{3}37$, $\frac{3}{7}$).

Angles with $c$ (001) measured (Tschermak) and calculated from the biotite axes:

| | $\mathfrak{p}$ ($0{\cdot}10{\cdot}9$) | $\mathfrak{k}$ (116)? | $o$ (112) | $q$ ($\bar{1}14$) | $\mathfrak{q}$ ($\bar{3}{\cdot}3{\cdot}10$) | $p$ ($\bar{3}37$) |
|---|---|---|---|---|---|---|
| Meas. | 75° | 49° | 72° 21′–73° | 58° 22′ | 63° 8′ | 69°–70° |
| Calc. | 74° 38′ | 47° 30′ | 73° 1′ | 58° 35′ | 63° 1½′ | 70° 23′ |

Rarely in distinct crystals; habit thin tabular ‖ $c$. The basal planes often smooth and brilliant, also $b$, $q$ ($\bar{1}14$), the others uneven, and striated ‖ $c$. Twinning common according to the mica law, often repeated. Usually in intersecting or aggregated laminæ; sometimes massive, with a scaly structure.

Cleavage: basal, perfect. Laminæ rather brittle. H. = 3·5–4·5 G. = 2·99–3·08. Luster of base pearly, of lateral faces vitreous. Color grayish, reddish white, pink, yellowish. Translucent, subtranslucent.

Optically −. Ax. pl. ⊥ $b$. $Bx_a$ approximately ⊥ $c$, but varying more widely than other micas. $\mathfrak{a}\, c = +6° 27'$ Tschermak. Dispersion $\rho < v$. Axial angle large, from 100° to 120° in air. Refractive index $\beta = 1{\cdot}64$–$1{\cdot}65$ Becke.

**Comp.**—$H_2CaAl_4Si_2O_{12}$ = Silica 30·2, alumina 51·3, lime 14·0, water 4·5 = 100.

On the probable structural formula, cf. Clarke, Am. J. Sc., **38**, 391, 1889.

**Anal.**—1–3, J. L. Smith, Am. J. Sc., **11**, 59, 1851, **15**, 208, 1853. 4, Id., ib., **42**, 90, 1866. 5, Smith & Brush, ib., **15**, 209, 1853. 6–12, Genth, Am. Phil. Soc., **13**, 399, 1873, also other anals.; further, Smith, Am. J. Sc., **6**, 184, 1873. 13, 14, Chatard, quoted by Clarke, ib., **28**, 22, 1884. 15, J. S. de Benneville, quoted by Genth, Am. J. Sc, **39**, 49, 1890. 16, Id., ibid. 17, T. M. Chatard, quoted by G. H. Williams, ibid., **36**, 263, 1886. Also 5th Ed., pp. 506, 507.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Gumuch-dagh | | 29·66 | 50·88 | 1·78[a] | 13·56 | 0·50 | 1·50 | | 3·41 | = 101·29 |
| 2. Nacaria | | 30·22 | 49·67 | 1·33[a] | 11·57 | *tr.* | 2·31 | | 5·12 | = 100·22 |
| 3. Naxos | | 30·02 | 49·52 | 1·65[a] | 10·82 | 0·48 | 1·25 | | 5·55 | = 99·29 |
| 4. Chester, Mass. | | 32·21 | 48·87 | 2·50[a] | 10·02 | 0·32 | 1·91[c] | | 4·61 | $Li_2O$ 0·32, $MnO$ 0·20 = 100·96 |
| 5. Sterzing | | 28·47 | 50·24 | 1·65[a] | 11·50 | 0·70 | 1·87 | *tr.* | 5·00 | = 99·43 |
| 6 Unionville, Pa. | 3·012 | 32·19 | 49·62 | 0·91 | 7·81 | 0·41 | 4·78 | 0·57 | 3·93 | = 100·22 |
| 7. " " | | 30·70 | 49·33 | 0·39 | 11·86 | 0·76 | 0·96 | 0·65 | 5·91 | $Li_2O$ 0·36 = 100·92 |
| 8. " " | 3·047 | 30·45 | 50·86 | 0·42 | 12·13 | 0·37 | 1·72 | 0·25 | 4·48 | = 100·68 |
| 9. Cullakenee M., N. C. | 3·055 | 30·72 | 49·83 | 0·84 | 10·84 | 0·76 | 2·19 | 0·26 | 6·21 | = 101·65 |
| 10. " " | 3·064 | 29·63 | 51·32[b] | 0·59 | 11·28 | 1·09 | 1·22 | 0·20 | 4·73 | = 100·06 |
| 11. Gainesville, Ga. | 3·004 | 32·15 | 49·28 | 0·57 | 11·09 | 0·63 | 1·18 | 1·04 | 4·16 | = 100·10 |
| 12. Dudleyville, Ala. | 3·085 | 28·71 | 52·44 | 0·39 | 11·52 | 0·74 | 0·67 | 0·20 | 5·40 | $Li_2O$ 0·38 = 100·45 |
| 13. Gainesville, Ga. | | 31·72 | 50·03 | *tr.* | 11·57 | 0·12 | 2·26[c] | | 4·88 | = 100·58 |
| 14. Iredell Co., N. C. | | 31·15 | 49·51 | — | 11·13 | 0·45 | 2·74[c] | | 5·68 | = 100·66 |
| 15. Patrick Co., Va. | | 33·38 | 46·49 | 1·43 | 6·02 | — | 2·47 | 2·33 | 5·56 | gangue 1·70 = 99·38 |
| 16. " " | | 35·79 | 45·95 | 1·03 | 5·49 | — | 2·27 | 2·82 | 5·40 | gangue 2·07 = 100·82 |
| 17. Cruger's Pt., N. Y. | 3·1 | 32·73 | 46·58 | 5·12[d] | 11·04 | 1·00 | *undet.* | | 4·49 | = 100·96 |

[a] $Fe_2O_3$. [b] Incl. $Cr_2O_3$ 0·13. [c] Mainly $Na_2O$. [d] FeO.

The material of anals. 15, 16 was derived from the alteration of andalusite and probably contained other micas besides margarite.

*Corundellite* and *clingmanite* were based on an incorrect determination of the silica in the analyses.

*Diphanite* of Nordenskiöld (Bull. Ac. St. Pet., **5**, 17) is only margarite. It occurs in hexagonal prisms with perfect basal cleavage. H. = 5–5·5 G. = 3·04–3·97. Color white to bluish.

**Pyr., etc.**—Yields water in the closed tube. B.B. whitens and fuses on the edges. Slowly and imperfectly decomposed by boiling hydrochloric acid.

**Obs.**—Associated commonly with corundum, and in many cases obviously formed directly from it: thus at the emery deposits of Gumuch-dagh in Asia Minor, the islands Naxos, Nicaria, etc. Similarly in the U. S., as noted below.

Occurs in chlorite from the Mt. Greiner, Sterzing in Tyrol, where first found; at different localities of emery in Asia Minor and the Grecian Archipelago; with the corundum of Ekaterinburg, Ural. *Diphanite* is from the emerald mines of the Ural, with chrysoberyl and phenacite.

In the U. S., at the emery mine at Chester, Mass.; at Cruger's Point, near Peekskill, N. Y., as a result of contact metamorphism in mica schist with staurolite, tourmaline, etc. (2E = 114½°), corundum is similarly associated in the same region; with corundum at Village Green, Delaware Co., Pa.; coating corundum crystals at Unionville, Chester Co., Pa. (*corundellite*); with corundum, andalusite, etc., at Bull Mt., Patrick Co., Va.: at the corundum locality in Madison Co., North Carolina (*clingmanite*); rare at the Culsagee mine near Franklin, Macon Co.; in fine laminated crystals at the Cullakenee mine near Buck Creek in Clay Co.; at Gainesville, Hall Co., Georgia, surrounding a nucleus of corundum; at Dudleyville, Alabama.

Named *Margarite* from *μαργαρίτης, pearl.* The name is attributed to Fuchs, but he nowhere published it. Von Leonhard (Handb., 766, 1826) gives it as "the current name among the Tyrolese dealers in minerals."

This species, according to Dr. Krantz of Bonn (Am. J. Sc., **44**, 256, 1867), is the *original* margarite. The specimen from Sterzing analyzed by Smith & Brush was one received so labeled from Dr. Krantz.

**Alt.**—DUDLEYITE *Genth*, from Dudleyville, Alabama, is a result of the alteration of margarite, see p. 668.

An earthy mineral is associated with and forms the matrix of the margarite of Gainesville, Georgia. Structure fine granular; soft; color between isabel-yellow and flesh color. Analysis of material containing a little margarite, Genth, l. c.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $Na_2O$ | $K_2O$ | ign. | quartz | |
|---|---|---|---|---|---|---|---|---|---|---|
| G. = 2·851 | 28·84 | 39·65 | 2·12 | 14·75 | 1·26 | 0·48 | 1·60 | 10·41 | 2·17 | = 101·28 |

Formula nearly $4CaO.15Al_2O_3.12SiO_2.7H_2O$.

**Ref.**—[1] Tschermak, Ber. Ak. Wien, **76** (1), July, 1877; Dx., Min., **1**, 501, 1862.

**465. SEYBERTITE.** Bronzite (fr. Amity) *J. Finch*, Am. J. Sc., **16**, 185, 1829. Clintonite (fr. Amity) *Mather*, 1828, but unpublished; Mather's Rep. G. N. Y., 467, 1843. Seybertite (fr. Amity) *Clemson*, Ann. Mines, **2**, 493, 1832, Am. J. Sc., **24**, 171, 1833. Clintonit "*in Handel*" [= of the trade]. Chrysophan (fr. Amity) *Breith.*, Char., 92, 1832. Holmite (from Amity) *Thomson*, Rec. Gen. Sc., **3**, 335, 1836. Xanthophyllit *G. Rose*, Pogg., **50**, 654, 1840, Reis, Ural, **2**, 120, 514, 527.

Brandisit *Liebener*, in Haid. Ber., **1**, 4, 1846. Disterrit *Breith.*, in v. Kobell, J. pr. Ch., **41**, 154, 1847.

Monoclinic, near biotite in form. In tabular crystals, sometimes hexagonal in outline; also foliated massive; sometimes lamellar radiate.

Crystals usually complex twins according to the mica law.

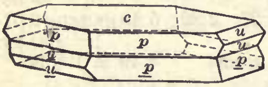
Seybertite.—Forms[1]: *c* (001, *O*), *i* (027, $\frac{2}{7}$-*ī*), *π* (056, $\frac{5}{6}$-*ī*), *y* (052, $\frac{5}{2}$-*ī*), *q* ($\bar{1}$14, $\frac{1}{4}$), *p* ($\bar{3}$37, $\frac{3}{7}$), *l* ($\bar{2}$21, 2).

Angles on *c* (001) measured (Tschermak) and calculated from the biotite axes:

| | *i* (027) | *π* (056) | *y* (052) | *q* ($\bar{1}$14) | *p* ($\bar{3}$37) | *l* ($\bar{2}$21) |
|---|---|---|---|---|---|---|
| Meas. | 43° | 70° 2′ | 83° | 59° | 70° 8′ | 85° 20′ |
| Calc. | 43° 5′ | 69° 52′ | 83° 2′ | 58° 35′ | 70° 23′ | 85° 38′ |

Brandisite.—Forms[1]: *b* (010, *i*-*ī*), *c* (001, *O*), *u* (012, $\frac{1}{2}$-*ī*), *y* (052, $\frac{5}{2}$-*ī*), *g* (091, 9-*ī*), *p* ($\bar{3}$37, $\frac{3}{7}$), *n* ($\bar{6}$67, $\frac{6}{7}$), *l* ($\bar{2}$21, 2).

Angles on *c* (001) measured (Tschermak) and calculated as above:



| | *u* (012) | *y* (052) | *g* (091) | *p* ($\bar{3}$37) | *n* ($\bar{6}$67) | *l* ($\bar{2}$1)2 |
|---|---|---|---|---|---|---|
| Meas. | 58° 30′ | 83° 9′ | 88° | 70° 8′ | 80° 41′ | 85° 42′ |
| Calc. | 58° 35′ | 83° 2′ | 88° 3′ | 70° 23′ | 79° 54′ | 85° 38′ |

The position of the forms above is that adopted by Tschermak; if, however, the + and − quadrants be reversed, then *l* ($\bar{2}$21) corresponds to the characteristic form *M* (221) of biotite, but *q* ($\bar{1}$14) no longer finds a corresponding form as now.

Cleavage: basal, perfect. Structure foliated, micaceous. Laminæ brittle. Percussion- and pressure-figure correspond in position respectively to the pressure- and percussion-figure of mica. H. = 4–5. G. = 3–3·1. Luster pearly submetallic. Color reddish brown, yellowish, copper-red. Streak uncolored, or slightly yellowish or grayish.

Pleochroism rather feeble. Optically −. Double refraction strong. Ax. pl. ⊥ *b seybertite*; ∥ *b brandisite*. $Bx_a$ nearly ⊥ *c*. Axial angles variable, but not large, see below.

**Var.**—1. The Amity *seybertite* (called also *clintonite, holmite*, and *chrysophan*) is in reddish brown to copper-red brittle foliated masses; the surfaces of the folia often marked with equilateral triangles like some mica and chlorite. G. = 3·148 Brush. Pleochroism: 𝔠 pale brownish yellow; 𝔟 do.; 𝔞 colorless. Ax. plane ⊥ *b*. Axial angle 3°–13° Tschermak. Indices:

$\alpha = 1{\cdot}646$ $\beta = 1{\cdot}657$ $\gamma = 1{\cdot}568$ Lévy-Lcx.

2. *Brandisite* (called also *disterrite*), from the Fassathal, Tyrol, is in hexagonal prisms of a yellowish green or leek-green color to reddish gray; H. = 5 of base; of sides, 6–6·5. G. = 3·042–3·051 Kobell; 3·013–3·062 Hauer; 3·01–3·06 Liebener. Ax. plane ∥ *b*. Axial angle 15°–30° Dx.: 18°–35° Tschermak. Some of it pseudomorphous, after fassaite.

**Comp.**—For seybertite $H_3(Mg,Ca)_5Al_5Si_2O_{18} = 3H_2O.10(Mg,Ca)O.5Al_2O_3.4SiO_2$ = Silica 19·3, alumina 40·9, magnesia 23·3, lime 12·2, water 4·3 = 100. Here Mg : Ca = 8 : 3.

As stated on p. 636, Tschermak regards these minerals as isomorphous mixtures of $H_2CaMg_4Si_3O_{12}$ and $H_2CaMgAl_6O_{12}$ in the ratio of 4 : 5 for seybertite, of 3 : 4 for brandisite, and perhaps of 5 : 8 for xanthophyllite.

**Anal.**—1, 2, Brush, Dana, Min., 505, 1854. 3, 4, Sipöcz, l. c. 4, Kobell, J. pr. Ch., **41**, 154, 1847. 5, Sipöcz, l. c.

*Seybertite.*

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Amity, N. Y. | | 20·24 | 39·13 | 3·27 | — | 20·84 | 13·69 | 1·04 | — | alk. 1·43, $ZrO_2$ 0·75 [= 100·39 |
| 2. " " | | 20·13 | 38·68 | 3·48 | — | 21·65 | 13·35 | 1·05 | — | alk. 1·43, $ZrO_2$ 0·68 [= 100·45 |
| 3. " " | 3·102 | 19·19 | 39·73 | 0·61 | 1·88 | 21·09 | 13·11 | 4·85 | 1·26 | = 101·72 |

*Brandisite.*

| | | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4. | Monzoni | 3·047 | 20·00 | 43·22 | 3·60 | — | 25·01 | 4·00 | 3·60 | — | $K_2O$ 0·57 = 100 |
| 5. | " | 3·090 | 18·75 | 39·10 | 3·24 | 1·62 | 20·46 | 12·14 | 5·35 | — | = 100·66 |

**Pyr., etc.**—Yields water. B.B. infusible alone, but whitens. In powder acted on by concentrated acids.

**Obs.**—*Seybertite* occurs at Amity, N. Y., in limestone with serpentine, associated with amphibole, spinel, pyroxene, graphite, etc.; also a chlorite near leuchtenbergite (Tschermak).

The seybertite was discovered in 1828 by Messrs. Finch, Mather, and Horton, and named *clintonite* by them on the spot, after De Witt Clinton, as stated by Mather in his Rep. Geol. N. Y., 1843. But the name was not published at the time by either of the discoverers; and Finch, the next year, 1829 (l. c.), announced the mineral under the name of *bronzite.* Clemson's name *seybertite,* after H. Seybert (1832, l. c.), has therefore priority of publication, and must be accepted as the name of the species.

*Brandisite* occurs on Mt. Monzoni in the Fassathal, Tyrol, in white limestone, either disseminated or in grouped crystals, in geodes, among crystals of fassaite and black spinel; it is often intimately associated with leuchtenbergite.

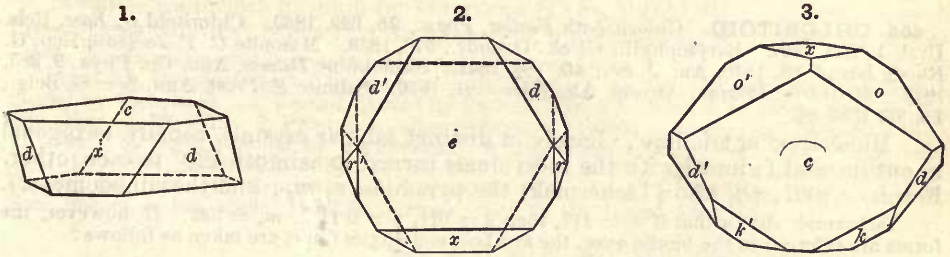
**Ref.**—[1] Tschermak, l. c. (ref. p. 636).

**465A. Xanthophyllite.** *G. Rose,* Pogg., **50**, 654, 1840. Reis, Ural, **2**, 120, 514, 527, 1248. Waluewite *Koksharov,* Zs. Kr., **2**, 51, 1877, Min. Russl., **7**, 346. P. v. Eremeyev, Vh. Min. Ges., **11**, 341, 355, 1876. Walujewit, Walouewite, Valuevite.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 0{\cdot}57735 : 1 : 3{\cdot}24427$; $\beta = 90^\circ\ 0' = 001 \wedge 100$ Koksharov[1].

$100 \wedge 110 = 30^\circ\ 0'$, $001 \wedge 101 = 79^\circ\ 54\tfrac{1}{2}'$, $001 \wedge 011 = 72^\circ\ 52'$.

**Forms:**
c (001, $O$)
L (130, $i$-$\grave{3}$)
z ($\bar{3}$08, $\tfrac{3}{8}$-$\bar{i}$)
x ($\bar{1}$02, $\tfrac{1}{2}$-$\bar{i}$)
y (018, $\tfrac{1}{8}$-$\grave{i}$)
h (0·3·16, $\tfrac{3}{16}$-$\grave{i}$)
v (029, $\tfrac{2}{9}$-$\grave{i}$)
r (014, $\tfrac{1}{4}$-$\grave{i}$)
t (013, $\tfrac{1}{3}$-$\grave{i}$)
w (119, — $\tfrac{1}{9}$)
k (118, — $\tfrac{1}{8}$)
s (116, — $\tfrac{1}{6}$)
ω ($\bar{1}$19, $\tfrac{1}{9}$)
o ($\bar{1}$18, $\tfrac{1}{8}$)
σ ($\bar{1}$16, $\tfrac{1}{6}$)
n (1·3·24, —$\tfrac{1}{8}$-$\grave{3}$)
d (134, — $\tfrac{3}{4}$-$\grave{3}$)



Figs. 1–3, Waluewite, Kk.: 2, with x ($\bar{1}$02) in front; 3, in normal position.

cz = 64° 37′
cx = 70° 24½′
cy = 22° 4½′
ch = 31° 19′
cr = 39° 3′
ct = 47° 14′
ck = 39° 3′
cs = 47° 14½′
cw = 35° 47′
co = 39° 3′
cn = 25° 5½′
cd = *70° 24½′
dd‴ = 66° 12′
kk′ = 66° 7′
oo′ = 66° 7′
ko = 36° 43′
ox = 39° 15′
od = 39° 15′
bcd = *30°

Crystals tabular ‖ c, with the faces x ($\bar{1}$02), d (134) prominent; c smooth, the other faces rough and allowing only approximate measurements. Since the angles cx, cd are nearly equal, the symmetry approximates to that of the rhombohedral system. Further, the form simulates the regular octahedron, since the angles differ but little from the octahedral angle (70° 32′), cf. above. The crystals often twins, according to the ordinary mica law, commonly made up of three individuals having the base, c, in common, the position of each differing 120° in azimuth from that of the next. Also similar trillings united in twinning position with c as comp.-face.

Cleavage: c perfect. Percussion-figure with rays parallel the edges c/x, c/d.

$c/d'$; hence occupying the same position as the pressure-figure with the true micas; while the pressure-figure corresponds in position with the percussion-figure of mica. Etching-figures on $c$ in the form of an equilateral triangle with an angle directed toward $x$. Folia brittle. H. = 4·6. G. = 3·093. Luster vitreous; on cleavage plane pearly. Color leek- to bottle-green. Transparent to translucent. Pleochroism rather feeble: $\parallel \dot{c}$ fine green; $\perp \dot{c}$ reddish brown.

Optically −. Ax. pl. $\parallel b$. Bx inclined 32′ to the normal to $c$, Bkg. Interference-figures confused, and ax. angle variable: 20½° Bkg.; 20° to 40° Dx.; 17° to 32° Tschermak. Dispersion $\rho < v$.

**Var.**—1. The original *xanthophyllite* is in crusts or in implanted globular forms, 1½ in. through, which consist of tabular crystals about a center of schist, which is also the enclosing rock. Optically negative. Ax. angle usually very small, or sensibly uniaxial, Dx.; sometimes 20°.

2. *Waluewite.* In distinct crystals showing the forms and optical characters given above. Axial angle 17° to 32°.

**Comp.**—Perhaps (Groth) $H_8(Mg,Ca)_{14}Al_{16}Si_5O_{52}$. Cf. also p. 636.

**Anal.**—1–3, Meitzendorf, Pogg., **58**, 165, 1843. 4, Nikolayev, Vh. Min. Ges., **19**, 28, 1884. 5, Id., quoted by Koksharov, l. c. 6, Id., ib., **18**, 226, 1883.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $Na_2O$. | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. *Xanthophyllite* | | 16·55 | 43·73 | — | 2·62 | 19·04 | 13·12 | 0·67 | 4·33 | = 100·06 |
| 2. " | | 16·41 | 43·17 | — | 2·23 | 19·47 | 14·50 | 0·62 | 4·45 | = 100·35 |
| 3. " | | 16·20 | 44·96 | — | 2·73 | 19·43 | 12·15 | 0·55 | 4·33 | = 100 35 |
| 4. " | 3·090 | 15·55 | 43·51 | 1·72 | *tr.* | 20·97 | 13·25 | — | 4·87 | = 99·87 |
| 5. *Waluewite* | 3·093 | 16·90 | 43·55 | 2·31 | 0·33 | 17·47 | 13·00 | — | 5·07 | = 98·63 |
| 6. " | 3·075 | 16·39 | 43·40 | 1·57 | 0·60 | 20·38 | 13·04 | — | 4·39 | = 99 77 |

*Xanthophyllite* was from the Shiskimskaya Mts. near Zlatoust in the Ural.

*Waluewite* is found with perovskite and other species in chloritic schists in the mine Nikolaye-Maximilianovsk, near Achmatovsk, in the southern Ural. Named after the Russian minister P. A von Waluew (Valuev).

**Ref.**—[1] Kk., l. c., and Min. Russl., **9**, 273.

**466. CHLORITOID.** Chloritspath *Fiedler*, Pogg., **25**, 329, 1832. Chloritoid *G. Rose*, Reis. Ural, **1**, 252, 1837. Barytophyllit *Glock.*, Grundr., 570, 1839. Masonite *C. T. Jackson*, Rep. G. Rhode Island, 88, 1840, Am. J. Sc., **40**, 186, 1841. Sismondine *Delesse*, Ann. Ch. Phys., **9**, 385, 1843. Strüverite *Brezina*, Anzeig. Ak. Wien, 101, 1876. Salmite *E. Prost*, Ann. Soc. G. Belg., **11**, 93, 1883–84.

Monoclinic or triclinic[1]. Rarely in distinct tabular crystals, usually hexagonal in outline and twinned with the individuals turned in azimuth 120° to each other. Forms: $c$ (001, $O$), also (Tschermak) the pyramids $n$, $m_x$, and the clinodomes $e$, $j$.

Tschermak shows that if $n = 111$, then $e = 011$, $j = 0 \cdot 11 \cdot 2$, $m_x = 332$. If, however, the forms are referred to the biotite axes, the symbols and angles (on $c$) are taken as follows:

| | $e$ (0·9·10) | $j$ (051) | $n$ (9·9·10) | $m_x$ (443) |
|---|---|---|---|---|
| Meas. | 71° | 86° 30′ | 80° 6′ | 83° 25′ |
| Calc. | 71° 15 | 86° 30′ | 80° 22′ | 83° 28′ |

The form $m_x$, however, may correspond to $M$ (221) of biotite which gives $cM = 85° 38'$.

Crystals grouped in rosettes. Usually coarsely foliated massive; folia often curved or bent; and brittle; also in thin scales or small plates disseminated through the containing rock.

Cleavage: basal, but less perfect than with the micas; also imperfect parallel to planes ($m_x$) inclined to the base nearly 90° and to each other about 60°; $b$ difficult. Laminæ brittle. H. = 6·5. G. = 3·52–3·57. Color dark gray, greenish gray, greenish black, grayish black, often grass-green in very thin plates. Streak uncolored, or grayish, or very slightly greenish. Luster of surface of cleavage somewhat pearly.

Pleochroism strong: $\mathfrak{c}$ yellow-green. $\mathfrak{b}$ indigo-blue, $\mathfrak{a}$ olive-green. Optically +. Double refraction feeble. Ax. pl. nearly $\parallel b$. $Bx_a$ inclined a few degrees to the normal to $c$ (001), 12° Tschermak. Dispersion $\rho > v$, large, also horizontal. Axial angles large, in air 100° to 118°, see below.

1. The original *chloritoid* (or Chloritspath) from Kosoibrod, near Ekaterinburg in the Ural, is in large curving laminæ or plates, grayish to blackish green in color, often spotted with yellow from mixture with limonite; G. = 3·55 Fiedler, 3·557 Breith.

2. The *sismondine* is from St. Marcel; it occurs also with glaucophane at Zermatt in the Valais, Switzerland, and similarly in the Val de Chisone, Piedmont. Des Cloizeaux shows that the form is probably triclinic, since the plane angles measured on $c$ between the cleavage-directions of the 60° pyramid ($m_x$) and that of $b$ (010) differ by some 4°; thus:

St. Marcel 62° 30′, 58°, Zermatt 62° 44′, 57° 27′, Chisone 62°, 58°.

The sum of these angles is sensibly 120°. Further the ax. plane is not exactly ∥ $b$, but makes an angle of 1° to 1° 30 with this direction. Axial angles:

| | | |
|---|---|---|
| St. Marcel | $2H_{a.r}$ = 64° 34′ to 74° 6′ | $2H_{a.gr}$ = 57° to 65° 38′ |
| Zermatt | $2H_{a.r}$ = 67° 1′ to 71° 17′ | $2H_{a.gr}$ = 62° 39′ to 64° 37′ |
| | $2E_r$ = 111° 50′ to 117° 48′ | $2E_{gr}$ = 108° 44′ |
| Val de Chisone | $2H_{a.r}$ = 64° 33′ | $2H_{a.gr}$ = 57° 54′ |
| | $2E_r$ = 101° 26′ | $2E_{gr}$ = 91° 22′ |

Of the above the angles in air (2E) were measured directly; those in oil (2H) are the sum of the angles with the normal to $c$, viz.:

$$2H_{a.r} = 29° \ 34' + 35° = 64° \ 34'; \text{ also } 35° \ 4' + 39° \ 2' = 74° \ 6', \text{ etc.}$$

$$2H_{a.gr} = 25° \ 0' + 32° \ 0' = 57° \ 0' \qquad 33° \ 14' + 32° \ 24' = 65° \ 38'.$$

The fact that the dispersion is greater for one axis than for the other confirms the triclinic form.

3. *Salmite* is a manganesian variety occurring in irregular masses, having a coarse saccharoidal structure and grayish color. G. = 3·38.

3. *Masonite*, from Natick, R. I., is in very broad plates of a dark grayish green color, but bluish green in very thin laminæ parallel to $c$, and grayish green at right angles to this; G. = 3·529 Kenngott; $c$ (001) on plane of cleavage = 85°, Dx. It is evidently impure, and this must have been true of the material analyzed by Jackson (anal. 15). Named after Mr. Owen Mason.

The Canada mineral is in small plates, one-fourth inch wide and half this in thickness, disseminated through a schist, and also in nodules of radiated structure, half an inch through; G. = 3·513 Hunt. That of Gumuch-dagh resembles sismondine, is dark green in thick folia and grass-green in very thin; G. = 3·52 Smith.

**Comp.**—Empirical formula for chloritoid $H_2(Fe,Mg)Al_2SiO_7$. If iron alone is present, this requires: Silica 23·8, alumina 40·5, iron protoxide 28·5, water 7·2 = 100.

In *salmite* manganese is present replacing the ferrous iron.

**Anal.**—1, Bonsdorf, quoted by Rose, l. c. 2, Kobell, J. pr. Ch., **58**, 40, 1853. 3, Sipöcz, quoted by Tschermak. 4, Renard, quoted by Barrois, Bull. Soc. Min., **7**, 42, 1884. 5, 6, Heddle, Min. Mag., **3**, 28, 1879. 7, Prost, l. c., after deducting 15·06 p. c. quartz (Rg., Min. Ch., Erg., 71, 1886). 8, Suida, quoted by Tschermak. 9, 10, Damour, Bull. Soc. Min., **7**, 80, 1884. 11, J. Lawrence Smith, Am. J. Sc., **11**, 64, 1851. 12, T. S. Hunt, ibid., **31**, 442, 1861, Rep. G. Canada, 194, 1854. 13, Genth. Am. J. Sc., **39**, 50, 1890. 14, J. D. Whitney, Proc. Nat. Hist. Soc., Boston, **3**, 100, 1849. 15, C. T. Jackson, Rep. G. Rh. Island, 88, 1840.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Kosoibrod | 3·55 | 27·48 | 35·57 | — | 27·05 | 0·30 | 4·29 | — | 6·95 | = 101·64 |
| 2. " | | 23·01 | 40·26 | — | 27·40 | — | 3·97 | — | 6·34 | = 100·98 |
| 3. Pregratten | 3·538 | 24·90 | 40·99 | 0·55 | 24·28 | — | 3·33 | — | 7·82 | = 101·87 |
| 4. Ile de Groix | | 24·90 | 40·36 | — | 26·17 | — | 2·54 | — | 6·23 | = 100·20 |
| 5. Shetland, *clove-brown* | 3·356 | 25·36 | 41·74 | 3·90 | 13·93 | 0·92 | 6·82 | 0·90 | 6·57 | = 100·14 |
| 6. " *dark green* | 3·39 | 24·47 | 41·34 | 0·38 | 18·52 | 0·91 | 6·80 | 0·30 | 6·98 | = 99·70 |
| 7. Vielsalm, *Salmite* | 3·38 | 22·52 | 39·60 | 3·97 | 15·35 | 8·40 | 2·10 | 0·35 | 7·44 | CoO 0·05 [= 99·78 |
| 8. St. Marcel, *Sismondine* | 3·42 | 26·03 | 42·33 | 4·09 | 14·32 | — | 7·30 | 0·35 | 6·56 | Alk. *tr.* [= 100·98 |
| 9. " " | 3·49 | 25·50 | 38·13 | — | 23·58 | — | 5·19 | — | 6·90 | = 99·30 |
| 10. Zermatt " | 3·36 | 24·40 | 42·80 | — | 19·17 | — | 6·17 | — | 6·90 | = 99·44 |
| 11. Asia Minor | 3·52 | 23·91 | 39·52 | — | 28·05 | — | — | — | 7·08 | = 98·56 |
| 12. Leeds, Canada | 3·513 | 26·30 | 37·10 | — | 25·92 | 0·93 | 3·66 | — | 6·10 | = 100·01 |
| 13. Patrick Co., Va., *blk. grn.* | 3·614 | 25·03 | 39·75 | — | 22·92 | 1·30 | 3·32 | 0·21 | 6·64 | Alk. 0·14 [= 99·31 |
| 14. R. Island, *Masonite* | | 28·27 | 32·16 | — | 33·72 | — | 0·13 | — | 5·00 | = 99·28 |
| 15. " " | 3·450 | 33·20 | 29·00 | — | 25·93 | 6·00 | 0·24 | — | 4·00 | = 98·37 |

The Kosoibrod chloritoid is associated with mica and cyanite. *Sismondine* occurs at St. Marcel in a dark green chlorite schist, with garnet, magnetite, and pyrites; also at Zermatt

Valais; Pregratten, Tyrol; Val de Chisone, Piedmont. Other localities of chloritoid are Ile le Groix (Morbihan); embedded in large crystals at Vanlup, Shetland; Ardennes (relatively large scales) in schists with true ottrelite; Rhode Island (*masonite*) in an argillaceous schist; Chester, Mass., in schist, with emery, diaspore, etc.; at Bull Mt., Patrick Co., Va., with corundum, cyanite, etc.; Canada, at Brome and Sutton, Brome Co., in micaceous schist, and at Leeds, Megantic Co., Quebec, in argillaceous schist; at Gumuch-dagh, Asia Minor, with emery.

**Pyr., etc.**—In a matrass yields water. B.B. nearly infusible; becomes darker and magnetic. Completely decomposed by sulphuric acid. The masonite fuses with difficulty to a dark green enamel.

**Obs.**—Occurs commonly in metamorphic schists, micaceous or argillaceous (phyllytes) in embedded crystals or scales, often grouped in fan-shaped, sheaf-like forms, also in irregular or rounded grains. Most of what has been called ottrelite probably belongs here, for the two minerals are closely related, although they cannot at present be united.

Named *Chloritoid* by Rose from the resemblance to chlorite. The name *Chloriespath*, or in English *Chlorite Spar*, has the precedence in time, but it is objectionable in form and signification, and has rightly been superseded by chloritoid. *Sismondite* was named for Prof. Sismonda of Turin.

**Ref.**—[1] Tschermak, Ber. Ak. Wien, **78** (1), Nov., 1878. Becke, Min. Mitth., **1**, 269, 1878; Foullon, Jb., G. Reichs., **33**, 220, 1883. Dx., Min., **1**, 463, 1862; Bull. Soc. Min., **7**, 80, 1884. Barrois, ibid., **7**, 37; Lcx., ibid., **9**, 42, 1886.

**467. Ottrelite.** *Des Cloizeaux* and *Damour*, Ann. Mines, **51**, 357, 1842. Phyllite *Thomson*, Ann. Lyc. N. Y., **3**, 47, 1828. Newportite *Totten*, Shepard's Min., **1**, 161, 1857. Venasquite *Damour*, Bull. Soc., Min., **2**, 167, 1879.

Monoclinic or triclinic[1]. In hexagonal crystalline scales, showing *c* (001, *O*), *b* (010, *i-ì*), *n* ($\bar{1}11$), and *j* (0·11·2). Measured angles *cn* = 79° 50′. Cf. chloritoid, p. 640. Twins as with chloritoid; simple crystals also common.

Cleavage: basal, rather perfect. H. = 6–7. G. = 3·3. Color blackish gray, greenish gray, black; streak grayish, greenish. Pleochroism not strong as with chloritoid (Dx.).

Optically +. Double refraction weak. Ax. pl. ‖ *b*. $Bx_a$ inclined to the normal to *c* (12° Tschermak). Axial angle variable. Dispersion sometimes $\rho < v$, also $\rho > v$.

**Comp.**—For ottrelite perhaps $H_2(Fe,Mn)Al_2Si_2O_9$ = Silica 38·5, alumina 32·7, iron protoxide 23·0, water 5·8 = 100. The formula, however, is doubtful, because of the difficulty of obtaining pure material, free from inclusions, for analysis. The formula $H_6(Fe,Mn)_3Al_4Si_6O_{24}$ requires: Silica 43·2, alumina 24·5, iron protoxide 25·8, water 6·5 = 100.

For *venasquite* the formula is given: $H_2FeAl_2Si_3O_{11}$ = Silica 48·4, alumina 27·4, iron protoxide 19·3, water 4·9 = 100. It occurs in masses having a lamellar and radiated crystalline structure. H. = 5·5. G. = 3·26. Color grayish black. Streak gray. Optically +. Axial angle large. Dispersion feeble. Dx.

**Anal.**—1, Damour, l. c., p. 357. 2, Thomson, l. c. 3, Klement, Bull. Mus. Belg., **1**, 45, 1882. 4, Renard, ibid., p. 46. 5, Klement, ibid., p. 47. 6, Damour, l. c.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Ottrez, *Ottrelite* | | 43·34 | 24·63 | — | 16·72 | 8·18 | — | — | 5·66 | = 98·53 |
| 2. Sterling, *Phyllite* | | 38·40 | 23·68 | 17·52 | — | 8·96 | — | — | 4·80 | = 100·16 |
| 3. Serpont | 3·266 | 41·65 | 29·47 | 4·02 | 17·87 | 0·93 | 1·57 | — | 5·84 | = 101·35 |
| 4. Lierneux | 3·266 | 40·55 | 30·80 | 3·82 | 12·46 | 6·51 | 0·45 | 1·29 | [4·12] | = 100 |
| 5. Ottrez | | 42·48 | 29·29 | 3·30 | 12·11 | 6·10 | 2·05 | *tr.* | 5·07 | = 100·40 |
| 6. *Venasquite* | 3·26 | 44·79 | 29·71 | — | 20·75 | — | 0·62 | — | 4·93 | = 100·80 |

**Pyr., etc.**—Yields water in the closed tube. Difficultly fusible to a magnetic globule. Reactions for iron with the fluxes.

**Obs.**—Occurs in small, oblong, shining scales or plates, more or less hexagonal, in argillaceous schist near Ottrez, on the borders of Luxembourg, and from the Ardennes. Ottrelite also occurs near Serravezza, Tuscany (D'Achiardi). Ottrelite schists have also been described from Tintagel in Cornwall (Hutchings, Geol. Mag., **6**, 214, 1889). *Venasquite* is from Venasque in the Pyrenees, and from Teulé, Finistère.

*Phyllite* has been described as occurring in the schist of Sterling, Goshen, Chesterfield, Plainfield, etc., in Massachusetts, and Newport, R. I., and the rock in consequence of it is called by Hitchcock (Rep. G. Mass., 4to, 594, 1841) "Spangled Mica Slate," the phyllite being the mica of the schist. The mineral in embedded scales, which is characteristic of these New England schists, is shown, however, by Wolff to be in part ilmenite (see Bull. Mus. Comp. Zool., **16**, 159, 1890). Phyllite may prove to belong to chloritoid (masonite), although the only analysis given brings it nearer to typical ottrelite.

As already remarked, analyses separate chloritoid and ottrelite widely, and the assumption that this is due to impurity of the material analyzed does not appear justified. At present it is impossible to decide to which species much so-called ottrelite belongs.

**Ref.**—[1] Dx., Min., **1**, 372, 1862, Bull. Soc. Min., **7**, 85, 1884; Renard and Poussin, Ann. Soc. G. Belg., **6**, 51, 1879. Rosenbusch, Mikr. Phys., 591, 1885. Lcx., Bull. Soc. Min., **9**, 42, 1886.

### 3. Chlorite Group. Monoclinic.

| | | | $\grave{a} : \bar{b} : \grave{c}$ | $\beta$ |
|---|---|---|---|---|
| 468. | **Clinochlore** | $H_8(Mg,Fe)_5Al_2Si_3O_{18}$ | 0·57735 : 1 : 2·2772 | 89° 40′ |
| 468A. | **Penninite** | | Pseudo-rhombohedral $\grave{c}=3{\cdot}4951$ | |
| 469. | **Prochlorite** | $H_{40}(Fe,Mg)_{23}Al_{14}Si_{13}O_{90}$ Tsch. | | |
| 470. | **Corundophilite** | $H_{20}(Fe,Mg)_{11}Al_8Si_6O_{45}$ Tsch. | | |
| | Amesite | $H_4(Mg,Fe)_2Al_2SiO_9$ Tsch. | | |

| | | |
|---|---|---|
| 471. | **Daphnite** | $H_{56}Fe_{27}Al_{20}Si_{18}O_{121}$ |
| 472. | **Cronstedtite** | $H_6(Fe,Mg)_3Fe_2Si_2O_{13}$ |
| 473. | **Thuringite** | $H_{18}Fe_8(Al,Fe)_8Si_6O_{41}$ |
| 474. | **Stilpnomelane** | |
| 475. | **Strigovite** | $H_4(Fe.Mn)_2(Fe,Al)_2Si_2O_{11}$ |
| 476. | **Diabantite** | $H_{18}(Mg,Fe)_{12}Al_4Si_9O_{46}$ |
| 477. | **Aphrosiderite** | $H_{10}(Fe,Mg)_6Al_4Si_4O_{25}$ |
| 478. | **Delessite** | $H_{10}(Mg,Fe)_4Al_4Si_4O_{23}$ |
| 479. | **Rumpfite** | $H_{28}Mg_7Al_{16}Si_{10}O_{65}$ |

The CHLORITE GROUP takes its name from the fact that a large part of the minerals included in it are characterized by the *green* color common with silicates in which ferrous iron is prominent. The species are in many respects closely related to the micas. They crystallize in the monoclinic system, but in part with distinct monoclinic symmetry, in part with rhombohedral symmetry, with corresponding uniaxial optical character. The plane angles of the base are also 60° or 120°, marking the mutual inclinations of the chief zones of forms. The mica-like basal cleavage is prominent in distinctly crystallized forms, but the laminæ are tough and comparatively inelastic. Percussion- and pressure-figures may be obtained as with the micas and have the same orientation. The etching-figures are in general monoclinic in symmetry, in part also asymmetric, suggesting a reference to the triclinic system.

The group includes a number of species which occur ordinarily in distinct crystals or plates; these are called the ORTHOCHLORITES by Tschermak; also others which are more commonly in fine scales or indistinctly fibrous forms called LEPTOCHLORITES by Tschermak.

Chemically considered the chlorites are silicates of aluminium with ferrous iron and magnesium and chemically combined water. Ferric iron may be present replacing the aluminium in small amount; chromium enters similarly in some forms, which are then usually of a pink instead of the more common green color. Manganese replaces the ferrous iron in a few cases. Calcium and alkalies—characteristic of all the true micas—are conspicuously absent, or present only in small amount. The chlorites often occur as secondary minerals resulting from the alteration of other species, as pyroxene, amphibole, biotite, garnet, vesuvianite, etc.

The exact interpretation of the composition of the chlorites is difficult, as is also the assignment of strict lines of division between them. The empirical formulas given above are in the first part of the group those of Tschermak; in the second part chiefly those of Groth.

The ORTHOCHLORITES, including Penninite, Clinochlore, Prochlorite Corundophilite, form a distinct series characterized by a nearly constant water percentage, while the decrease in silicon and magnesium (incl. ferrous iron) is accompanied by an increase of aluminium. This is explained by Tschermak by the assumption of isomorphous mixtures in varying proportions of a magnesium silicate, $H_4Mg_3Si_2O_9$, having the composition of *serpentine*, and an aluminous magnesium silicate, $H_4Mg_2Al_2SiO_9$, which is approximately represented by a little known chlorite near corundophilite, called by Shepard *amesite*. On this view the species correspond as follows·

| | | | | |
|---|---|---|---|---|
| | Penninite | $Sp_3At_2$ | to | $SpAt$ |
| | Clinochlore | $SpAt$ | to | $Sp_2At_3$ |
| | Prochlorite | $Sp_2At_3$ | to | $Sp_3At_7$ |
| | Corundophilite | $Sp_3At_7$ | to | $SpAt_4$ |
| Also | Amesite | $SpAt_4$ | to | $At$ |

To explain the composition of the other chlorites—the Leptochlorites—two other fundamental molecules are assumed by Tschermak, viz.:

| | | | |
|---|---|---|---|
| Strigovite | $H_4Mg_2Al_2Si_2O_{11}$ | or | $(MgOH)_2.H_2Al_2SiO_7.SiO_2$ |
| Chloritoid | $H_2MgAl_2SiO_7$ | or | $Mg.H_2Al_2SiO_7$ |

Furthermore, the variations in Amesite corresponding to

| | | | |
|---|---|---|---|
| $H_4Mg_2Al_2SiO_9$ | or | $(MgOH)_2. H_2Al_2SiO_7$ | At |
| $H_4MgAl_2SiO_8$ | or | $H.MgOH.H_2Al_2SiO_7$ | At′ |
| $H_4Al_2SiO_7$ | or | $H_2.H_2Al_2SiO_7$ | At″ |

The theory here reaches a degree of complexity which makes the assumptions seem artificial and difficult to accept.

Thus of the three divisions made among the Leptochlorites

| | | | |
|---|---|---|---|
| Daphnite is regarded as | | | $(At'At)_5Sp_4$ |
| Chamosite | | | $(At'At)_3Sp_4$ |
| Metachlorite | | | $(StAt_3)_2Sp_2$ |
| Klementite | | | $(StAt_2)_2Sp$ |
| Cronstedtite and Thuringite | | | $StAt$ |
| Euralite | | | $St_4At_3$ |
| Strigovite | | | $St$ |
| Diabantite | $Ct_4Sp_7$ | | |
| Aphrosiderite | $(CtAt)_6Sp_4$ | to | $(CtAt_2)_3Sp_4$ |
| Delessite | $(CtAt)_2Sp_5$ | to | $CtSp$ |
| Rumpfite | $(CtAt'')_4Sp$ | | |

On the relation of serpentine to the chlorites see further under that species.

On the history of the names, the following remarks may be made

Werner's name chlorite was shown to include more than one species by von Kobell in 1838, and the name *chlorite* was thereupon given by him to the St. Gothard and other chlorites having 25 to 27 p c. silica, and *ripidolite* to that of Schwarzenstein and Achmatovsk having 30 to 33 p c. of silica.

In 1839, G Rose reversed the names of v. Kobell (see paper on chlorite by Varrentrapp, Pogg., **48**, 193, 1839) on the ground that v. Kobell's *ripidolite* was not so characteristically fan-shaped in aggregation as the other species. But the change was unfortunate, as both species are now known to differ but little in this respect, and it has resulted in much confusion in the science. Moreover, it violated an older claim of priority; for Werner's *blättriger Chlorit* (or *Chlorites lamellosus*), the first crystallized chlorite recognized by him (in 1800 or earlier, Ludwig's Min., **1**, 118, 1803), was the hexagonal chlorite of St. Gothard, and this should therefore, in the division, have retained the name *chlorite.*

As the term *chlorite* has become the designation of a family of minerals, it seems necessary that it should have some modified form for this species, and hence the application of *prochlorite*, from προ, *before*, and *chlorite*, in allusion to its being the earliest crystallized kind recognized. Further, in view of the confusion resulting from the double use of ripidolite, this name, adopted in the 5th edition, is dropped, and the commonly employed *clinochlore* used in its place.

**Ref.**—[1] Tschermak, Die Chloritgruppe, I. Theil, Ber. Ak. Wien, **99** (1), 174–267, 1890; II. Theil, **100** (1), 29–107, 1891. Groth, Tab. Ueb., 1889. See also Clarke, Am. J. Sc., **40**, 405, 1890, **42**, 242, 1891; Clarke proposes to regard the chlorites as mixtures of the orthosilicate molecules, $R''_2(SiO_4)_2R'_4$, where R″ = Mg,Fe,Mn and R′ = H, MgOH or $Al(OH)_2$, cf. pp. 612, 613.

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**468. CLINOCHLORE.** Chlorite pt. *early authors* (for Syn., see p. 653). Hexagonal Chlorite pt. Ripidolith (fr. Achmatovsk, Schwarzenstein) *Kbl.*, J. pr. Ch., **16**, 1839. ? Tabergit pt. Clinochlore (fr. West Chester) *W. P. Blake*, Am. J. Sc., **12**, 339, 1851. Klinochlor *Germ.* Kotschubeit (fr. S. Ural) *Koksharov*, Bull. Ac. St. Pet., **5**, 369, 1861. Ripidolite *Dana*, Min., 497, 1868. Leuchtenbergit *Komonen*, Vh. Min. Ges., 64, 1842. Chlorite blanche de Mauléon *Delesse*, Ann. Ch. Phys., **9**. 396, 1843.

Monoclinic. Axes: $\breve{a} : \bar{b} : \dot{c} = 0·57735 : 1 : 2·2772$; $\beta = 89° 40' = 001 \wedge 100$ Koksharov[1].

$100 \wedge 110 = 30° 0'$, $001 \wedge 101 = 75° 27' 37''$, $001 \wedge 011 = 66° 17' 30''$.

**Forms**[2]:
$b\ (010,\ i\text{-}\grave{\imath})$
$c\ (001,\ O)$

$x\ (4\cdot0\cdot11,\ -\tfrac{4}{11}\text{-}\bar{\imath})$?
$z\ (405,\ -\tfrac{4}{5}\text{-}\bar{\imath})$
$h\ (301,\ -3\text{-}\bar{\imath})$
$y\ (\bar{2}05,\ \tfrac{2}{5}\text{-}\bar{\imath})$
$\omega\ (\bar{3}05,\ \tfrac{3}{5}\text{-}\bar{\imath})$
$r\ (\bar{5}06,\ \tfrac{5}{6}\text{-}\bar{\imath})$

$\pi\ (\bar{7}08,\ \tfrac{7}{8}\text{-}\bar{\imath})$
$i\ (\bar{1}01,\ 1\text{-}\bar{\imath})$
$\sigma\ (\bar{6}05,\ \tfrac{6}{5}\text{-}\bar{\imath})$
$q\ (\bar{1}\bar{1}\cdot0\cdot4,\ \tfrac{11}{4}\text{-}\bar{\imath})$
$\gamma\ (\bar{7}02,\ \tfrac{7}{2}\text{-}\bar{\imath})$
$f\ (\bar{4}01,\ 4\text{-}\bar{\imath})$
$\beta\ (0\cdot11\cdot24,\ \tfrac{11}{24}\text{-}\grave{\imath})$
$\delta\ (059,\ \tfrac{5}{9}\text{-}\grave{\imath})$
$\vartheta\ (0\cdot11\cdot18,\ \tfrac{11}{18}\text{-}\grave{\imath})$

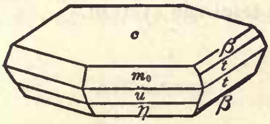
$\kappa\ (034,\ \tfrac{3}{4}\text{-}\bar{\imath})$
$k\ (011,\ 1\text{-}\grave{\imath})$
$t\ (043,\ \tfrac{4}{3}\text{-}\grave{\imath})$
$\tau\ (053,\ \tfrac{5}{3}\text{-}\grave{\imath})$
$u\ (227,\ -\tfrac{2}{7})$
$e\ (6\cdot6\cdot17\ -\tfrac{6}{17})$
$d\ (225,\ -\tfrac{2}{5})$
$m_0\ (112,\ -\tfrac{1}{2})$

$\eta\ (\bar{4}\cdot4\cdot17,\ \tfrac{4}{17})$
$\ddot{u}\ (\bar{7}\cdot7\cdot25,\ \tfrac{7}{25})$
$l\ (\bar{7}\cdot7\cdot20,\ \tfrac{7}{20})$
$n\ (\bar{2}25,\ \tfrac{2}{5})$
$\mathfrak{n}\ (\bar{5}\cdot5\cdot12,\ \tfrac{5}{12})$
$\nu\ (\bar{3}37,\ \tfrac{3}{7})$
$\mu\ (\bar{1}12,\ \tfrac{1}{2})$
$o\ (\bar{1}11,\ 1)$

$w\ (267,\ -\tfrac{6}{7}\text{-}\grave{3})$
$\rho\ (397,\ -\tfrac{9}{7}\text{-}\grave{3})$
$v\ (132,\ -\tfrac{3}{2}\text{-}\grave{3})$
$\chi\ (392,\ -\tfrac{9}{2}\text{-}\grave{3})$
$g\ (261,\ -6\text{-}\grave{3})$
$\varsigma\ (7\cdot21\cdot8,\ -\tfrac{21}{8}\text{-}\grave{3})$
$s\ (\bar{1}33,\ 1\text{-}\grave{3})$
$\epsilon\ (\bar{2}65,\ \tfrac{6}{5}\text{-}\grave{3})$

Also the complex forms, in part vicinal: $i\ (\bar{3}\bar{2}\cdot0\cdot33)$, $j\ (\bar{3}\bar{1}\cdot0\cdot30)$, $p\ (9\cdot\bar{2}\bar{7}\cdot20)$, $\psi\ (8\cdot24\cdot17)$, $\phi\ (9\cdot\bar{2}\bar{7}\cdot17)$, $\xi\ (11\cdot\bar{3}\bar{3}\cdot20)$.

1.



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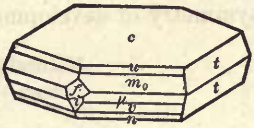

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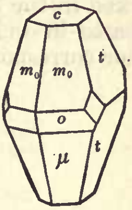

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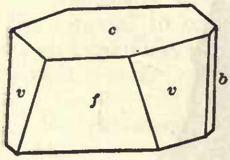

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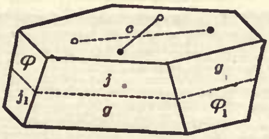

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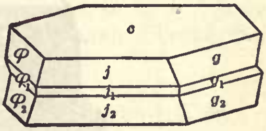

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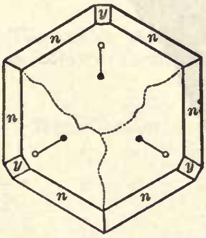
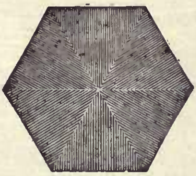
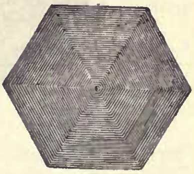


8.



9.



Figs. 1–7, Tschermak: 1, Pfitsch; 2, 3, Achmatovsk; 4, Schwarzenstein (Hbg.); 5, Zillerthal, twin, mica law; 6, do., twin, penninite law; 7, Achmatovsk, trilling. 8, 9, J. P. Cooke: 8, West Chester; 9, Texas.

$cz = 72°\ 7'$
$ch = 84°\ 50'$
$cy = 57°\ 52'$
$c\omega = 67°\ 22\tfrac{1}{2}'$
$c\pi = 74°\ 9'$
$ci = 76°\ 5'$
$cj = 81°\ 2'$
$c\sigma = 78°\ 23'$
$cf = 86°\ 42'$

$c\beta = 46°\ 13\tfrac{1}{2}'$
$c\delta = 51°\ 40\tfrac{1}{2}'$
$c\vartheta = 54°\ 18'$
$c\kappa = 59°\ 39'$
$ck = 66°\ 17\tfrac{1}{2}'$
$ct = 71°\ 46'$
$c\tau = 75°\ 14'$
$cu = 52°\ 16\tfrac{1}{2}'$
$cd = 61°\ 1'$

$cm_0 = {}^*66°\ 3'$
$cn = 61°\ 27\tfrac{1}{2}'$
$c\mu = 66°\ 32'$
$co = {}^*77°\ 53\tfrac{1}{2}'$
$cv = 75°\ 37'$
$c\chi = 85°\ 0'$
$cg = 86°\ 12\tfrac{1}{2}'$
$dd' = 51°\ 52'$

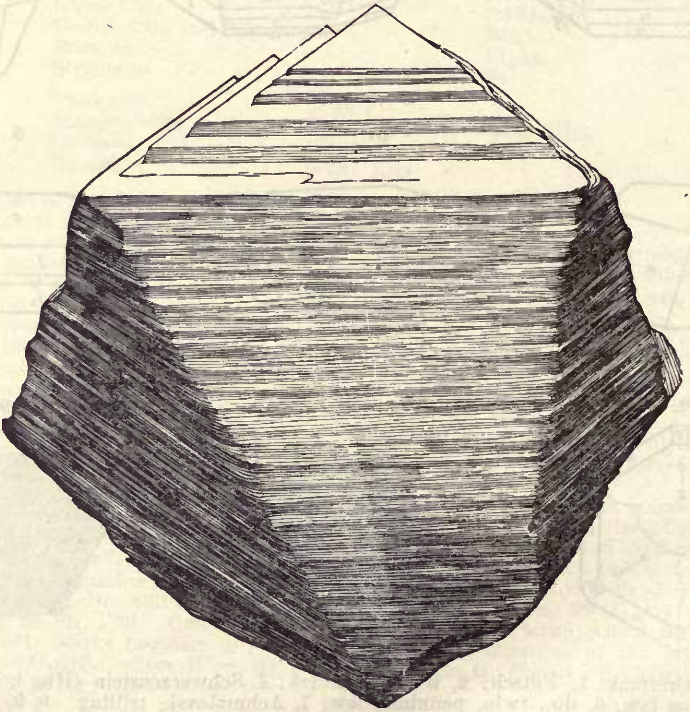
$m_0m_0' = 54°\ 23'$
$nn' = 52°\ 7'$
$\mu\mu' = 54°\ 36'$
$oo' = 58°\ 32'$
$bv = 32°\ 59'$
$bs = 35°\ 53'$
$b\epsilon = 34°\ 17'$
$bcm_0 = {}^*60°\ 0'$

Crystals usually hexagonal in form, often tabular ∥ $c$, also prismatic by development of $m_0$, or again in 12-sided prisms (Ala); also triangular and rhombohedral resembling penninite (Zillerthal), the zones $001 : \bar{1}01$, $001 : 130$, $001 : 1\bar{3}0$ alone developed. Plane angles of the basal section = 60° or 120°, and since closely similar angles are found in the zones which are separated by 60°, the symmetry, as in the case of biotite, approximates to that of the rhombohedral system. Further, a similarity in angle may also exist in zones separated 30° from each other. For example, the angles on $c$ (001) are, for

| $k$ (011) | $\mu$ ($\bar{1}12$) | Also $w$ (267) | Again $i$ ($\bar{1}01$) | $v$ (132) | Also $\tau$ (053) |
|---|---|---|---|---|---|
| 66° 17′ | 66° 32′ | 65° 56′ | 76° 5′ | 75° 37′ | 75° 14′ etc. |

This similarity in angles in different zones may lead to uncertainty in the determination of the forms, particularly when, by twinning, one zone takes the position of another. The resemblance to rhombohedral symmetry is especially marked in the Zillerthal crystals. Pyramidal faces often striated horizontally, and repeated in oscillatory combination. The planes often irregular in distribution and rather corresponding in symmetry of development to the triclinic system.

Natural size.



West Chester, Pa.

Twins: (1) *Mica law*, tw. pl. ⊥ $c$ in the zone $cm_0$; sometimes contact-twins with $c$ as comp.-face (f. 5), the one part revolved 60° or a multiple of 60° in azimuth with reference to the other; also united by an irregular face, sometimes of two individuals, more commonly of three (f. 7) and either in contact or interpenetrating each other; such trillings may thus be formed of six sectors (figs. 8, 9), but in general not separated by sharp lines. (2) *Penninite law*, tw. pl. $c$, contact-twins also united by $c$ (f. 6), here corresponding faces differ 180° in position.

Twins also occur in which the tw. pl. appears to be a plane ⊥ *c* in the zone 001 : 130, but probably to be explained as due to the combined action of the two laws above given. The face *c* often shows a bending both in the zone 001 : 100 and 001 : 130, usually at an angle for adjacent parts of 20′, 40′ or a multiple of 20′; this can be explained by twinning with *a* (100) as the tw. ~~plane in~~ one case and (130) in the other. Repeated twinning of this kind gives rise to the often observed rosette, fan-shaped, or vermicular crystal groups. Massive, coarse scaly granular to fine granular and earthy.

Cleavage: *c* highly perfect. Laminæ flexible, tough, and but slightly elastic. Percussion-figure and pressure-figures orientated as with the micas (p. 611). Etching-figures on *c* in part monosymmetric, in part also asymmetric, and then suggesting a molecular structure corresponding to the triclinic system; the former triangular with vertices (60°) directed forward, and other angles rounded; the latter equilateral trianges with one angle rounded, and either right- or left-handed. H. = 2–2·5. G. = 2·65–2·78. Luster of cleavage-face somewhat pearly. Color deep grass-green to olive-green; pale green to yellowish and white; also rose-red. Streak greenish white to uncolored. Transparent to translucent. Pleochroism not strong, for green varieties:

| | $\parallel \mathfrak{a}$ | $\parallel \mathfrak{c}$ |
|---|---|---|
| Achmatovsk | dark green | greenish yellow |
| " | " " | brownish yellow |
| Texas | emerald-green | hyacinth-red |
| " | leek-green | yellowish green |
| Pfitsch | " | greenish yellow |
| Ala | olive-green | " " |

Optically usually +. Ax. pl. in most cases ∥ *b*. $Bx_a$ inclined somewhat to the normal to *c*, forward; for Achmatovsk 2° 30′. Dispersion $\rho < v$. Axial angles variable, even in the same crystal, sometimes sensibly uniaxial. Tschermak gives:

Achmatovsk $2E = 32°$ ($\beta = 1·588$ Lévy-Lcx.) ∴ $2V = 20°$ and $c\mathfrak{c} = +2° 30'$
Also " $2E = 1°, 5°, 12°$ and intermediate values.
Texas $2E = 20°$ to $60°$ Ala 44° to 65°
West Chester $2E = 89° 41'$ [$\beta = 1·583$] ∴ $2V = 51° 30'$ $\mathfrak{c}c = 7° 10'$
Zillerthal $2E = 83° 0'$ ∴ $2V = 48° 30'$ $\mathfrak{c}c = 6° 45'$

The angles measured in certain cases, between the optic axes (*A*, *B*) and the normal to *c*, are as follows (Tschermak):

| | *Ac* | *cB* | 2E | $\beta$ |
|---|---|---|---|---|
| West Chester | 58° 5′ | 29° 40′ | 87° 45′ | 1·580 red glass |
| " | 63° 45′ | 31° 9′ | 94° 54′ | 1·593 $CuSO_4$ |
| " | ∴ *A′c* = 32° 30′ | 18° 15′ | $2V_r = 50° 45'$ | $c\mathfrak{c} = 7° 8'$ red |
| " | ∴ *A′c* = 34° 16′ | 18° 57′ | $2V_{bl} = 53° 13'$ | $c\mathfrak{c} = 7° 40'$ blue |

Indices:

$\alpha = 1·585$ $\beta = 1·588$ $\gamma = 1·596$ Lévy-Lcx.

Ax. pl. also rarely ⊥ *b*. Observed in a crystal from Texas and from Pfitsch, the latter with 2E = 48°. Bx ⊥ *c*. Other parts of the same crystal gave ax. pl. ∥ *b*, Bx oblique to *c*, and 2E = 64.

Ax. pl. also sometimes (West Chester) abnormally makes an angle of 90° or of 30° (twin) with its usual position, Bx ⊥ *c* and 2E = 50° to 60°. In some crystals parts with both the normal and this abnormal orientation are present and separated by irregular boundaries. See also below.

**Var.**—1. *Ordinary;* green clinochlore, passing into bluish green; (*a*) in crystals, as described, usually with distinct monoclinic symmetry; (*b*) foliated; (*c*) massive.

Among the varieties described by Tschermak is a "mimetic clinochlore" from the Zillerthal and Pfitschjoch. This occurs in druses of tabular crystals of distinct rhombohedral habit; often complex twins according to both the penninite and mica laws; etching-figures hexagonal, corresponding in symmetry to the rhombohedral form; optically +, uniaxial to distinctly biaxial with ax. pl. ∥ *b*, also abnormally ⊥ *b*. The maximum angle observed is 42° ($Ac = 26°$, $cB = 16°$), hence if $\beta = 1{\cdot}583$ (West Chester), $2V = 26°$, and $\mathfrak{c}\,c = 3°$. Color emerald-green to leek-green.

It is inferred that the true character is biaxial with a considerable axial angle, while the variations are due to twinning, the successive biaxial layers producing the uniaxial character (cf. p. 651). This chlorite hence occupies a place intermediate between ordinary clinochlore and penninite, but inclining to the latter. This shows, moreover, that no sharp line can be drawn between them, but they may be considered as different forms of the same species. Its composition is given in anal. 1, under penninite.

2. *Leuchtenbergite.* A variety containing usually little or no iron, see anals. 14–19. Color white, pale green, yellowish; often resembles talc. Commonly in hexagonal tables; often twins. Optically +. Ax. pl. ∥ *b*. Ax. angle small, sometimes sensibly uniaxial, again $2E = 6°$, also 0° to 15° Ural; 14°, again 10° to 29° Amity; 2°–12°, 22°, 42° Nasiamsk (with waluewite); 5°–21° Traversella.

Named after Duke Maximilian v. Leuchtenberg.

3 *Kotschubeite.* A variety containing several per cent. of chromium oxide. Crystals rhombohedral in habit. Color rose-red, often twins, sometimes trillings with six sectors, like f. 9 (California). Pleochroism strong: ∥ *c* ($\mathfrak{a}$ $\mathfrak{b}$) dark blue-violet; ⊥ *c* ($\mathfrak{c}$) bright carmine red, Ural, Tschermak; ∥ *c* purplish, ⊥ *c* yellowish red, California, Lindgren. Optically +. Ax. pl. ∥ *b* (⊥ *b* Prendel). Axial angle variable, sometimes apparently uniaxial and like the "mimetic clinochlore" (see above); also $2E = 28°–29°$ Prendel; 30° Lindgren. Named after the Russian Count P. Kochubei.

A part of the so-called kämmererite from Texas belongs here (Tschermak), being distinctly biaxial; but this is not significant since there is the same transition between the uniaxial and biaxial kinds as between the uniaxial and positive penninite and the biaxial clinochlore.

4. *Manganiferous.* Manganchlorit *Hamberg*, G. För. Förh., **12**, 580, 1890. A chlorite from the Harstig mine near Pajsberg. Sweden, is peculiar in containing 2·3 p. c. MnO (anal 9); it is also like the "mimetic clinochlore" intermediate between clinochlore and penninite. In aspect resembles manganophyllite, with which it occurs, but has a lighter reddish color. Apparent form a steep rhombohedron inclined 83° 37′ to *c*, which referred to the penninite axis has the symbol $50\bar{5}2$ $(\frac{5}{2})$, calc. 84° 20′; the subordinate forms *c* (0001) and $05\bar{5}4$ $(-\frac{5}{4})$ also observed. Optically −. Bx almost ⊥ *c*. Ax. pl. nearly ∥ *b* (010), but a variation of 8° was noted. Double refraction and pleochroism weak. Examined microscopically, some of the lamellæ prove to be distinctly doubly refracting and biaxial, and the conclusion is reached that the crystals are built up of lamellæ, corresponding to clinochlore, in twinning position (revolved 120°) to each other, and strictly asymmetric in optical character. The fact that the etching-figures on clinochlore, are often asymmetric and hence suggest a triclinic form for the species has already been noted.

**Comp.**—Normally $H_8Mg_5Al_2Si_3O_{18} = 4H_2O.5MgO.Al_2O_3.3SiO_2$ = Silica 32·5, alumina 18·4, magnesia 36·1, water 13·0 = 100. Ferrous iron usually replaces a small part of the magnesia, and the same is true of manganese rarely; sometimes chromium replaces the aluminium.

On Tschermak's view of the composition of clinochlore, see p. 643. The above formula corresponds to equal parts of $H_4Mg_3Si_2O_9$ and $H_4Mg_2Al_2SiO_9$ or SpA. For Sp : At = 2 : 3, he calculates: $SiO_2$ 30·3, $Al_2O_3$ 22·0. MgO 34·7, $H_2O$ 13·0 = 100. To this analyses 4, 14, approximate most closely. The variation, however, is in any case small.

Clarke and Schneider (Am. J. Sc., **40**, 405, 1890) found that on treating clinochlore from West Chester (anal. 13) with dry hydrochloric acid gas at 383°-412° for 19 hours the amounts of the oxides converted in chlorides were as follows:

Clinochlore MgO 13·46 $R_2O_3$ 4·24 $SiO_2$ 0·92

Another determination gave 13·36 p. c. of MgO (after 58 hours). This amount is inferred to exist as the group MgOH, the remainder of the hydroxyl combined as $Al(OH)_2$, and the conclusion is reached that clinochlore is probably a mixture of the molecules $Mg_2(SiO_4)_2(MgOH)_3H$ and $Mg_2(SiO_4)_2(Al(OH)_2)_3H$ in the ratio of 1 : 1, for which the required composition is calculated: $SiO_2$ 31·1, $Al_2O_3$ 19·8, MgO 36·3, $H_2O$ 12·8 = 100. Of the water present it was found that between 250°–300°, 0·95 p c. was driven off; 383°–412°, 0·49 p. c.; at a red heat 11·74; white heat 0·42. Hence the water is essentially all water of constitution.

**Anal.**—1, A. Ortmann, quoted by Tschermak, Ber. Ak. Wien, **100** (1), 44, 1891. 2, A. Hammerschlag, ibid. 3, Kbl., J. pr. Ch., **16**, 470, 1839. 4, Jannasch, Jb. Min., **1**, 92, 1885. 5–7, Heddle, Trans. R. Soc. Edinb., **29**, 58, 1879. 8, Id., Min. Mag., **3**, 26, 1879. 9, A. Hamberg, G. För. Förh., **12**, 580, 1890. 10, Neminar, Min. Mitth., 176 1874. 11, Burton, Dana, Min , 499, 1868. 12, Breidenbaugh, Am. J. Sc., **6**, 208, 1873. 13, Clarke and Schneider, Am. J. Sc.. **40**, 405, 1890.

14, Leuchtenberg, Vh. Min. Ges., **1**, 33, 1866. 15, Clarke and Schneider, l. c. 16, Mgc.. Ann. Ch. Phys., **10**, 430, 1844. 17, 18, Hermann, J. pr. Ch., **40**, 13, 1847. 19, Delesse, Ann. Ch. Phys.. **9**, 396, 1843. 20. L. Sipöcz, quoted by Tschermak, l. c 21, 23, Leuchtenberg, Vh. Min. Ges., **3**, 289, 1868, and Min. Russl., **5**, 369. 22, 24, 25, Zinin, ibid. 26, W. H. Melville, quoted by W. Lindgren, Proc. Cal. Acad., **2**, Dec. 1887; also U. S. G. Surv., Bull. **61**, 27, 1890.

For earlier anals. see 5th Ed., p. 499. Schlaepfer (Recherches comp. Micas and Chlorites, Bâle, 1889) gives analyses of clinochlore from West Chester and Brewster, also of penninite; these, unlike other analyses, all show upwards of 2 p. c. alkalies; their accuracy is seriously impugned by Tschermak.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Achmatovsk | 2·648 | 31 31 | 18·34 | 2·10 | 0·77 | — | 34·25 | *tr.* | 13·33 | $Na_2O$ 0·17, [$K_2O$ 0·06 = 100·33 |
| 2. Kariaet | | 30·34 | 16·86 | 1·86 | 4·53 | — | 31·82 | 0·61 | 12·70 | $Na_2O$ 0·37 [= 99·09 |
| 3. Schwarzenstein | | 32·68 | 14·57 | — | 5·97 | 0·28 | 33·11 | — | 12·10 | insol. 1·02 [= 99·73 |
| 4. Mussa Alp | 2·555 | 29·31 | 21·31 | 0·07 | 3·24 | — | 31·28 | — | 14·58 | $Na_2O$ 0·43 [= 100·22 |
| 5. Hillswick | | 32·55 | 13·95 | 0·97 | 5·28 | 0·16 | 32·78 | 0·79 | 13·17 | Alk. 0·54 [= 100·19 |
| 6. C. Wrath | 2·823 | 31·03 | 14·85 | 5·73 | 17·42 | 1 00 | 17·42 | 0·36 | 12·48 | = 100·29 |
| 7. Blair Athol | | 30·30 | 19·40 | — | 8·23 | 0·37 | 29·10 | — | 13·07 | = 100·47 |
| 8. Shetland | | 32·55 | 13·95 | 0·97 | 5·28 | 0·16 | 32·78 | 0·79 | 13·17 | Alk. 0·54 [= 100·19 |
| 9. Pajsberg | | 33·71 | 13·80 | 1·64 | — | 2·28 | 35·88 | 0·33 | 13·11 | = 100·75 |
| 10. Chester Co., Pa | 2·705 | 31·08 | 18·85 | 1·55 | 2·33 | — | 33·50 | 0·81 | 11·53 | $Cr_2O_3$ 1·09 [= 100·74 |
| 11. Willimantic | | 31·86 | 15·80 | — | 4·77 | — | 34·30 | 1·30 | 12·72 | = 100·75 |
| 12. Brewster, N. Y. | | $\frac{2}{2}$ 32·33 | 14·56 | — | 5·29 | — | 33·74 | 1·04 | 12·02 | Alk. 1·41 [= 100·39 |
| 13. West Chester | | 29·87 | 14·48 | 5·52 | 1·93 | 0·17[a] | 33·06 | — | 13·60 | $Cr_2O_3$ 1·56 [= 100·19 |

[a] NiO.

*Leuchtenbergite.*

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 14. Zlatoust | 2·89 | $\frac{2}{2}$ 30·46 | 19·74 | — | 1·99 | 34·52 | 0·11 | 12·74 | = 99·56 |
| 15. " | | 32·27 | 16 05 | 4·26 | 0·28 | 29·75 | 6·21 | 11·47 | = 100·29 |
| 16. " | 2·672 | 30·27 | 19·89 | — | 4·42 | 33·13 | — | 12·54 | = 100·25 |
| 17. " *white* | 2·603 | 30·80 | 17·27 | 1·37 | — | 37·08 | — | 12·30 | = 98·82 |
| 18. " | | 32·35 | 18·00 | — | 4.37 | 32·29 | — | 12·50 | = 99·51 |
| 19. Mauléon, *white* | | 32·1 | 18·5 | — | 0·6 | 36·7 | — | 12·1 | = 100 |
| 20. Amity | 2·680 | 30·28 | 22·13 | — | 1·08 | 34·45 | — | 12·61 | = 100·55 |

*Kotschubeite.*

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Cr_2O_3$ | FeO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 21. Ufaleisk | $\frac{2}{2}$ 32·73 | 13·43 | 2·15 | 4·19 | — | 35·40 | 12·63 | = 100·53 |
| 22. " | 33·31 | 12·60 | 2·30 | 4·04 | — | 35·62 | 12·62 | = 100·49 |
| 23. Lake Itkul | 32·55 | 19·74 | | | | 35·83 | 12·61 | = 100·73 |
| 24. " " | 32·2 | 19·5 | | | | 36·0 | 12·6 | = 100·3 |
| 25. Shushinsk mine | 32·5 | 13·3 | 2·3 | 4·0 | — | 35·6 | 12·6 | = 100·3 |
| 26. Green Valley, Cal. | 31·74 | 6·74 | — | 11·39 | 1·72[a] | 35·18 | 12·68[b] | $H_2O$ 0·36[c], CaO 0·18 [= 99·99 |

[a] Incl. NiO 0·49. [b] Above 105°. [c] At 105°.

**Pyr., etc.**—Yields water. B.B. in the platinum forceps whitens and fuses with difficulty on the edges to a grayish black glass. With borax, a clear glass colored by iron, and sometimes chromium. In sulphuric acid wholly decomposed. A variety from Willimantic, Ct., exfoliates in worm-like forms, like vermiculite.

**Obs.**—Occurs in connection with chloritic and talcose rocks or schists and serpentine; sometimes in parallel position with biotite or phlogopite (cf. Tschermak, l. c., p. 256). Observed as a result of the alteration of vesuvianite from Zlatoust, Tschermak, Ber. Ak. Wien, **49** (1), 348, 1864.

Prominent localities are: Achmatovsk in the Ural; Ala in Piedmont; the Zillerthal; Zermatt in Switzerland; Marienberg in Saxony; massive, granular at Zöptau, Moravia; coarse to fine granular at Felling in Lower Austria; also chlorite schists from various localities; Markt Leugast, Bavaria. A manganesian variety occurs at Pajsberg, Sweden.

In the U. States, at West Chester, Penn., in large crystals and plates; also Unionville and Texas, Penn.; at the magnetic iron mine at Brewster, N. Y., in part changed to serpentine.

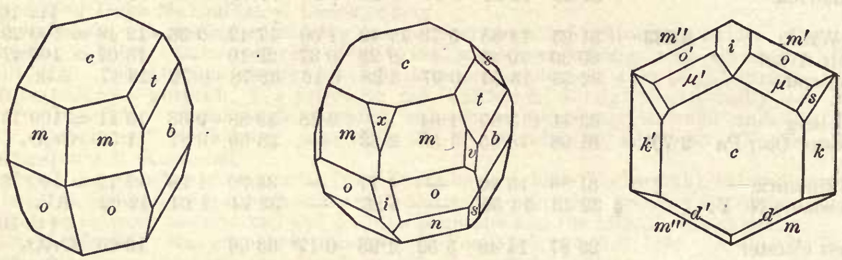
*Leuchtenbergite* comes from the Shishimskaya Mts. near Zlatoust in the Ural; it is partly in large crystals, and partly quite small, embedded in steatite; the crystals are mostly opaque and altered externally, and contain in this outer part from 9·30 to 10·75 p. c. of water. The mineral contains minute garnets and some other crystals as impurities. A similar variety of clinochlore occurs with amphibole, phlogopite, fluorite, graphite at Amity, N. Y.; also with the seybertite of Amity and the xanthophyllite of Nasiamsk, Ural; with fassaite and brandisite from the Fassathal; with magnetite at Traversella. The white chlorite from Mauléon also belongs here.

*Kotschubeite* is from the district of Ufaleisk in the southern Ural.

**Ref.**—[1] Achmatovsk, Min. Russl., **2**, 7 *et seq.*, 1857. The position is that of Tschermak, and the fundamental angles are those taken by him. With Koksharov, $m_0 = 110$, $o = \bar{1}11$, etc., and from the fundamental angles $001 \wedge 110 = 66° 3'$, $110 \wedge 1\bar{1}0 = 54° 23'$, $001 \wedge \bar{1}11 = 77° 53\frac{1}{2}'$ the axial ratio in this position is calculated, viz.:

$$\grave{a} : \bar{b} : \acute{c} = 0{\cdot}57738 : 1 : 0{\cdot}85312; \qquad \beta = 62° 50\tfrac{5}{6}'$$

Figs. 11–13 show the Achmatovsk clinochlore in the position referred to.



Figs. 11–13, Achmatovsk, Kk.

Naumann made $m_0 = \bar{1}11$ and $o = 110$; other positions have been taken by Mallard (cf. Tschermak). Tschermak's position brings out the relation between the micas and chlorites, the lateral axes being the same and the vertical axes for biotite and clinochlore in the ratio of 10 : 7.

[2] Cf. Tschermak, l. c., also Kk., l. c., and ibid., **10**, 5. 35 (Kotschubeite), 1888. Cf. earlier Dx., Alps. Min., **1**, 442, 1862, N. R., 127, 1867; Hbg., Zillerthal, Min. Not., **7**, 28, 1886; J. P. Cooke, Am. J. Sc., **44**, 203, 1867; Schrauf, Min. Mitth., 161, 1874; Mallard, relation to penninite (see beyond), Ann. Mines. **10**, 151, 1876; Prendel, Zs. Kr., **15**, 81, 1888. On the comparison in form between clinochlore and biotite see Laspeyres, Zs. Kr., **17**, 541, 1890.

**468A. Penninite.** Chlorite pt. Hydrotalc (= Wasserglimmer of Morin) *Necker*, Min., 1835. Pennine *J. Fröbel & E. Schweizer*, Pogg., **50**, 523, 1840. Kämmererite *Nd.*, Act. Soc. Sc. Fenn., **1**, 483, 1841, and Årsberät., 193, 1843. Rhodochrom *Fiedler*, Rose, Reise Ural, **2**, 1842, and Pogg., **59**, 1843. Chromchlorit *Herm.*, J. pr. Ch., **53**, 21, 1851. Rhodophyllite *Genth*, Proc. Ac. Philad., 118, 121, 1852. Penninite *Dana.*

Rhombohedral in form, but strictly pseudorhombohedral and monoclinic Mallard, Tschermak[1]. Taken as rhombohedral, axis $\acute{c} = 3{\cdot}4951$, $0001 \wedge 10\bar{1}1 =$ *76° 5′ Cooke[2].

**Forms**[2]: y ($20\bar{2}5$, $\frac{2}{5}$) v ($26{\cdot}0{\cdot}\overline{26}{\cdot}27$, $\frac{26}{27}$) s ($90\bar{9}8$, $\frac{9}{8}$) q ($17{\cdot}0{\cdot}\overline{17}{\cdot}6$, $\frac{17}{6}$)
c (0001, *O*) p ($5{\cdot}0{\cdot}\bar{5}{\cdot}12$, $\frac{5}{12}$) r ($10\bar{1}1$, *R*) ε ($60\bar{6}5$, $\frac{6}{5}$) γ ($60\bar{6}1$, 6)
a ($11\bar{2}0$, *i*-2) μ ($40\bar{4}7$, $\frac{4}{7}$) j ($31{\cdot}0{\cdot}\overline{31}{\cdot}30$, $\frac{31}{30}$) σ ($50\bar{5}4$, $\frac{5}{4}$) ω ($13{\cdot}0{\cdot}\overline{13}{\cdot}1$, 13)
φ ($4{\cdot}0{\cdot}\bar{4}{\cdot}13$, $\frac{4}{13}$) ψ ($9{\cdot}0{\cdot}\bar{9}{\cdot}10$, $\frac{9}{10}$) ξ ($33{\cdot}0{\cdot}\overline{33}{\cdot}31$, $\frac{33}{31}$) η ($21{\cdot}0{\cdot}\overline{21}{\cdot}4$, $\frac{21}{4}$)

Also ρ ($11\bar{2}4$, $\frac{1}{2}$-2) and χ ($11\bar{2}2$, 1-2); z ($10\bar{1}3$, $\frac{1}{3}$).

Further, on kämmererite, if $\rho = 30\bar{3}1$ and $c\rho =$ *84° $35\frac{1}{3}'$: $\acute{c} = 3{\cdot}0475$; $0001 \wedge 10\bar{1}1 = 74° 8\frac{1}{6}'$ Kk.

Forms: c, m, u ($30\bar{3}4$), x ($50\bar{5}4$), y ($40\bar{4}3$), z ($30\bar{3}2$), ρ ($30\bar{3}1$), $m_x$ ($40\bar{4}1$), s ($50\bar{5}1$).

Referred to the penninite axis, ρ becomes $13{\cdot}0{\cdot}\overline{13}{\cdot}5$, and the other symbols are correspondingly complex.

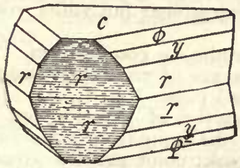
The penninite forms, as shown by Tschermak (l. c., p. 70), may be referred to the clinochlore axes. Thus r ($10\bar{1}1$) corresponds to $\bar{1}01$, for which we have: $001 \wedge \bar{1}01 = 76° 5'$, while $0001 \wedge 10\bar{1}1 = 76° 5'$ penninite; similarly for other forms. Moreover, on penninite forms occur in the same zone which in clinochlore belong to three different zones, as is true of the "mimetic clinochlore" from the Zillerthal. Furthermore, as all possible intermediate degrees are observed between the distinctly monoclinic, biaxial clinochlore and the apparently rhombohedral, uniaxial penninite, the conclusion is reached that the two are essentially the same. The form and optical characters of penninite are then due to the twinning of lamellæ grouped, according to the mica law, in positions making angles of 60° or 120° with one another.

The fact that three sections of a biaxial mica placed one over the other with their axial planes at angles, respectively, of 60° yield a uniaxial interference-figure is well known (cf. Reusch, Cooke, ref. on p. 614); a similar grouping will explain the optical properties of penninite.

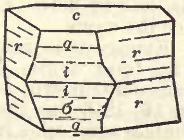
As the matter stands at present, therefore, although it is convenient to discuss clinochlore and penninite separately, they must be regarded as essentially the same species. This conclusion was earlier reached by Mallard, but from a somewhat different standpoint.

Tschermak argues from the facts stated that in these chlorites there are present two isomorphous substances, one of which is optically − with dispersion $\rho > v$, the other + with dispersion $\rho < v$; in the optically − penninite the former predominates. This optically negative substance is regarded as probably serpentine (see further that species).

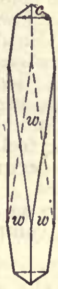
**1.**



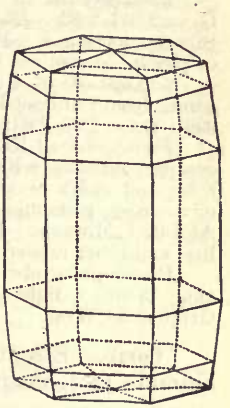
**3.**



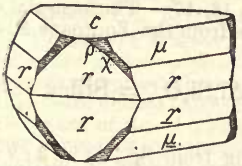
**5.**



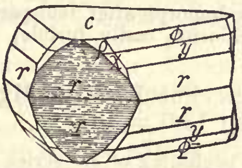
**6.**



**2.**



**4.**



Figs. 1, 2, 4, Texas, Penn., Pirsson. 3, Zermatt, Tschermak. 5, Zillerthal, Id.
6, *Kämmererite*, Kk.

$c\phi = 51° \; 9'$ $c\psi = 74° \; 36\frac{1}{2}'$ $c\sigma = 78° \; 47'$ $c\omega = 88° \; 54\frac{1}{2}'$

$cy = 58° \; 13\frac{1}{2}'$ $cr = {}^*76° \; 5'$ $cw = 85° \; 17'$ $c\rho = 60° \; 13'$

$cp = 59° \; 16'$ $cs = 77° \; 35'$ $c\gamma = 87° \; 38'$ $c\chi = 74° \; 2'$

$c\mu = 66° \; 33\frac{1}{2}'$ $c\epsilon = 78° \; 20'$

Twins very common, according to the *penninite law:* tw. pl. *c*, cf. f. 1–4. Habit rhombohedral: sometimes thick tabular with *c* prominent, again steep rhombohedral; also in tapering six-sided pyramids. Rhombohedral faces often horizontally striated. Crystals often in crested groups. Also massive, consisting of an aggregation of scales; also compact cryptocrystalline.

Cleavage: *c* highly perfect. Laminæ flexible. Percussion-figure and pressure-figure as with clinochlore but less easy to obtain; not elastic. Etching-figures hexagonal or triangular; seldom monosymmetric or asymmetric. H. = 2–2·5. G. = 2·6–2·85. Luster of cleavage surface pearly; of lateral plates vitreous, and sometimes brilliant. Color green, emerald-green, apple-green, grass-green, grayish green, leek-green, olive-green; also reddish, violet, rose-red, pink, grayish red; occasionally yellowish and silver-white. Transparent to subtranslucent.

Pleochroism distinct: on olive-green crystals, ∥ *c* emerald-green; ⊥ *c* brownish red, brown, or yellow; on leek-green crystals, blue-green and yellow; on kämmererite, ∥ *c* violet, ⊥ *c* hyacinth-red, Tschermak. Optically +, also −, and sometimes both in adjacent laminæ of the same crystal. Usually sensibly uniaxial, but sometimes distinctly biaxial, occasionally 2E = 61°. Dispersion, when biaxial, $\rho < v$ for + crystals, $\rho > v$ for − crystals. Uniaxial and biaxial portions seen in the same section. Axial figure generally wanting in sharpness, and often quite indistinct. Sometimes a sharply-outlined kernel which is uniaxial while the border is biaxial with 2E = 36°, the latter probably to be referred to clinochlore.

Indices 1·576 and 1·579 Lévy-Lcx.

**Var.**—1. *Penninite.* As first named, it included a green crystallized chlorite from the Pennine Alps.

*Hydrotalc* of Necker is penninite from the Binnenthal, in the Valais. Optically positive, Dx. Most of the penninite from Zermatt, and that of the Binnenthal and Tyrol, is optically negative; some crystals of Zermatt, and those of Ala, positive; and some plates from Zermatt consist of positive and negative laminæ united, Dx.

2 *Kämmererite.* In hexagonal forms bounded by steep six-sided pyramids, cf. above. Color kermes-red; peach-blossom-red. Pleochroism distinct. Optically − from Bisersk, + Texas. Uniaxial or biaxial with axial angle up to 20°. Crystals from Texas are often mixed with clinochlore, and sometimes a crystal is traversed by a band of clinochlore whose optic-axial angle is 60° to 70° Dx.

The original kämmererite was a reddish violet micaceous mineral from L. Itkul, Bisersk, Perm, Russia, partly in 6-sided prisms. Named after the mining director A. Kämmerer of St. Petersburg.

*Rhodophyllite* of Genth and *chrom-chlorite* of Hermann are the same, from Texas, Pa. G. = 2·617–2·62. *Rhodochrome* is a compact or scaly-granular variety, originally from L. Itkul, Siberia, having a splintery fracture, with G. = 2·66–2·67. Color deep green; but violet, rose or peach-blossom-red in thin splinters, whence the name.

3. *Loganite* of Hunt (= *Pseudophite* of Kenngott) is near penninite in composition. It comes from Calumet Falls, Canada, and has the form, angles, and cleavage of amphibole (see p. 398); G. = 2·60–2·64; color clove-brown to chocolate-brown; luster dull (anal. 18).

*Pseudophite* of Kenngott (Ber. Ak. Wien, **16**, 1855) has the composition of loganite, but is compact massive, without cleavage, and resembles serpentine (whence the name from *πσεύδός*, *false*, and *ophite* or serpentine); H. = 2·5; G. = 2·75–2·77; luster weak; color grayish green, olive-green, pistachio-green; feel unctuous. It forms the gangue of enstatite. Berg Zdjar in Aloisthal, Moravia. In the occurrence of a massive form, penninite is thus like talc, pyrophyllite, and other related species.

Pseudophite also occurs as a pseudomorph after feldspar (anal. 16, 17). The material of anal. 19 was a light green compact chlorite, easily fusible; it was from the Zoutpans Mts., Griqualand West.

**Comp.**—Essentially the same as clinochlore, $H_8(Mg,Fe)_5Al_2Si_3O_{18}$ = Silica 32·5, alumina 18·4, magnesia 36·1, water 13·0 = 100.

Tschermak places penninite at the beginning of the series, varying from Sp : At = 3 : 2 to SpAt. The latter corresponds to the empirical formula above; the former requires: $SiO_2$ 34·8, $Al_2O_3$ 14·6, MgO 37·5, $H_2O$ 12·4 = 100.

**Anal.**—1, Ludwig, quoted by Tschermak, Ber. Ak. Wien, **100** (1), 16, 1891. 2, Rumpf, Min. Mitth., 33, 1873. 3, Hamm, ib., 260, 1872. 4, 5, Fellenberg, Jb. Min., 746, 1868. 6, 7, Heddle, Trans. R. Soc. Edinb., **29**, 60, 1879.

8, 9, Hermann, J. pr. Ch., **53**, 22, 1853. 10, 11, Smith & Brush, Am. J. Sc., **16**, 47, 1853; also Genth, l. c. 12, 13, Heddle, Trans. R. Soc. Edinb., **29**, 62, 1879.

14, Hauer, Ber. Ak. Wien, **16**, 170, 1855. 15, Van Werweke, Zs. Kr., **1**, 510, 1877. 16, Drasche, Min. Mitth., 125, 1873. 17, Gintl, ib., 7, 1874. 18, Hunt, Rep. G. Canada, 491, 1863. 19, Van Riesen, quoted by Cohen, Jb. Min., **2**, 11 ref., 1888.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 1. Zillerthal | 2·678 | 33·83 | 12·95 | 2·25 | 3·02 | 34·94 | — | 13·11 = 100·10 |
| 2. " | | 34·24 | 12·62 | 1·64 | 3·35 | 34·86 | 0·30 | 14·14 = 101·15 |
| 3. Zermatt | | 33·71 | 12·55 | 2·74 | 3·40 | 34·70 | 0·66 | 12·27 = 100·03 |
| 4. " | 2·693 | $\frac{2}{2}$ 33·12 | 13·25 | 1·52 | 4·69 | 34·04 | — | 12·87 $Cr_2O_3$ 0·60 = 100·07 |
| 5. " | 2·649 | 33·97 | 11·66 | 2·49 | 1·81 | 37·60 | — | 13·57 = 101·10 |
| 6. Scalpa | 3·099 | 30·41 | 11·58 | 2·34 | 11·90[a] | 30·63 | — | 11·74 $Na_2O$ 1·32 0·01 [$K_2O$ = 99·92 |
| 7. Glen Lochy | 2·895 | 34·31 | 13·64 | 0·36 | 10·53[b] | 18·04 | 8·97 | 12·41 $Na_2O$ 0·13 $K_2O$ 1·36 [= 99·75 |

*Kämmererite.*

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Cr_2O_3$ | FeO | MgO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| 8. L. Itkul, *cryst.* | | 30·58 | 15·94 | — | 4·99 | 3·32 | 33·45 | — | 12·05 = 100·33 |
| 9. *Rhodochrome* | 2·65 | 34·64 | 10·50 | 2·00 | 5·50 | — | 35·47 | — | 12·03 = 100·14 |
| 10. Texas | | $\frac{2}{2}$ 33·28 | 10·60 | — | 4·72 | 1·60 | 36·00 | — | 12·95 Alk. 0·35 = [99·50 |
| 11. " | | 32·98 | 11·11 | — | 6·85 | 1·29 | 35·22 | — | 13·12 Alk. 0·38 = [100·95 |
| 12. Unst, *mass.* | 3·099 | 29·89 | 12·93 | — | 5·97 | 1·96 | 29·93 | 3·54 | 13·27 $Na_2O$ 0·97, [$K_2O$ 1·16 = 99·62 |
| 13. " *cryst.* | | 32·31 | 7·50 | — | 7·89 | 2·08 | 32·15 | 3·83 | 14·25 = 100.01 |

[a] Incl. 1·19 MnO. [b] 0·23 Mno.

*Pseudophite.*

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 14. Zdjar Mt. | $\frac{2}{2}$ | 33·42 | 15·42 | — | 2·58 | 34·04 | — | 12·68 = 98·14 | [100·18 |
| 15. Markirch | | 32·84 | 17·34 | 3·29 | 1·04 | 30·48 | 0·75 | 12·16 hygr. $H_2O$ | 2·28 = |
| 16. Plaben, *pseud.* | | 34·63 | 17·13 | — | 1·61 | 33·38 | — | 13·93 = 100·68 | |
| 17. Ckyn " | | 35·31 | 18·28 | 1·26 | 0·83 | 31·61 | — | 13·26 = 100·55 | |
| 18. *Loganite* | 2·62 | 33·28 | 13·30 | 1·92 | — | 35·50 | — | 16·00 = 100 | |
| 19. S. Africa | 2·647 | 32·38 | 18·75 | 0·80 | 2·39 | 31·64 | *tr.* | 14·15 = 100·15 | |

**Pyr., etc.**—In the closed tube yields water. B.B. exfoliates somewhat and is difficultly fusible. With the fluxes all varieties give reactions for iron, and many varieties react for chromium. Partially decomposed by hydrochloric and completely by sulphuric acid.

**Obs.**—Occurs with serpentine in the region of Zermatt, Valais, near Mt. Rosa, especially in the moraines of the Findelen glacier; crystals from Zermatt are sometimes 2 in. long and 1½ in. thick; also at the foot of the Simplon; at Ala, Piedmont, with clinochlore; at Schwarzenstein in Tyrol; at Taberg in Wermland; at Snarum greenish and foliated, called *steatite of Snarum*. In the green schists of the Höhenzug which separates the Zillerthal from the Pfitschthal in Tyrol.

*Kämmererite* is found at the localities already mentioned; also near Miask in the Ural; at Haroldswick in Unst, Shetland Isles. In large crystals up to 2 cm. in length enclosed in the talc in crevices of the chromite from Kraubat, Styria. Abundant at Texas, Lancaster Co., Pa., along with clinochlore, some crystals being embedded in clinochlore, or the reverse. Also in N. Carolina, with chromite at Culsagee, Macon Co.; Webster, Jackson Co.; Hampton's, Mining Creek, Yancey Co.; Bakersville, Mitchell Co., and other points.

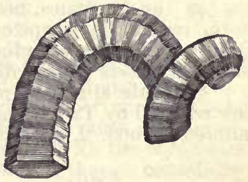
**Ref.**—[1] Texas, Penn., Am. J. Sc., **44**, 201, 1867. Dx. gives for Zermatt penninite $cr =$ 76° 10′–20′; Tschermak obtained 76° 5′. [2] Dx., l. c.; Cooke, l. c.; Mallard, Ann. Mines, **10**, 151, 1876; Tschermak, Ber. Ak. Wien, **99** (1), 240, 1890; Pirsson, Am. J. Sc., **42**, 408, 1891. Cf. also Mld. (ref. p. 650) on the relation of clinochlore and penninite.

TABERGITE *Scheerer*, Pogg., **71**, 448, 1847. From Taberg, Wermland (*Blue talc* of Werner, and called also *mica-chlorite*); a bluish green or green chlorite near penninite. According to Des Cloizeaux's optical observations, it is in part uniaxial and positive like true penninite. But in other cases uniaxial and biaxial plates are combined and negative and positive also; and the axial divergence of the biaxial plates varies from 1° to 33°. Tschermak (Ber. Ak. Wien, **99** (1), 262, 1890) concludes that it represents an intimate mixture of clinochlore or penninite and phlogopite. Analysis, A. Paltauf, quoted by Tschermak, ib., **100** (1), 45, 1891:

| G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ | F |
|---|---|---|---|---|---|---|---|---|---|---|
| 2·79 | 38·04 | 12·62 | 2·53 | 2·93 | 29·45 | 0·48 | 2·73 | 4·17 | 6·25 | 0·51 = 99·71 |

**469. PROCHLORITE.** Mica pt., Telgsten pt.?, Lapis colubrinus lamellosus (fr. Salberg), *Wall.*, Min., 130, 1747. Talgsten pt., Specksten pt., *Cronst*, Min., 89, 1758. Chlorite pt. (fr. St. Gothard, Tolfa, Altenberg), *Wern.*, Bergm. J., **1**, 376 and 391, 1789. Blättriger Chlorit (fr. St. Gothard) *Wern.*, 1800, Ludwig Min., **1**, 118, 1803. Chlorite *v. Kobell*, J. pr. Ch., **16**, 1839. Hexagonal Chlorite. Ripidolite *G. Rose*, and *Dana*, Min., 1854. Lophoit, Ogkoit, *Breith.*, Handb., **1**, 381, 383, 1841. Helminthe *G. O. Volger*, Entw. Min., 142, 1854. Grengesite (fr. Dalarne) *Hisinger*, Suckow's Erz- u. Gesteinlager schwed. Geb., 50, 1831 = Strahlige Grüneisenerde v. Dalarne. Prochlorite *Dana*, Am. J. Sc., **44**, 258, 1867. Fächerstein *Germ.*

Monoclinic. In six-sided tables or prisms, the side planes strongly furrowed and dull. Crystals often implanted by their sides, and in divergent groups, fan-shaped, vermicular, or spheroidal. Also in large folia. Massive, foliated, or granular.



H. = 1–2. G. = 2·78–2·96. Translucent to opaque; transparent only in very thin folia. Luster of cleavage surface feebly pearly. Color green, grass-green, olive-green, blackish green; across the axis by transmitted light sometimes red. Streak uncolored or greenish. Laminæ flexible, not elastic.

Pleochroism distinct: vibrations $\parallel c$ yellow-green; $\perp c$ brownish. Optically + in most cases, rarely — (Floitenthal). Bx inclined to the normal to $c$ some 2°. Axial angle small, often nearly uniaxial; again 2E = 23°, 30°. Dispersion $\rho < v$.

**Comp.**—According to Tschermak to be regarded as a molecular mixture of $H_4(Mg,Fe)_3Si_2O_9$ and $H_4(Mg,Fe)_2Al_2SiO_9$ in the ratio of 2 : 3 to 3 : 7; the empirical formula on page 643 corresponds to the former ratio. Ferrous iron is usually, but not always, present in large amount.

Cf. also Clarke & Schneider, Am. J. Sc., **40**, 405, 1890.

**Anal.**—1, Egger, Min. Mitth., 244, 1874. 2, Klement & Ludwig, quoted by Tschermak. 3, Rg., Min. Ch., 538, 1860. 4, J. Vuylsteke, quoted by Tschermak, l. c. 5, Fellenberg, Jb. Min., 746, 1868. 6, Jacobs (Tschermak). 7, 8, Mgc., Ann. Ch. Phys., **14**, 59, 1845. 9–11, Heddle, Trans. R. Soc. Edinb., **29**, 75, 1879. 12, Smith, Am. J. Sc., **11**, 65, 1851. 13, Clarke, Am. J. Sc., **28**, 24, 1884. 14, Clarke & Schneider, Am. J. Sc., **40**, 406, 1890. 15, M. Bird, Am. Ch. J., **7**, 181, 1885. 16, Genth, Am. J. Sc., **28**, 250, 1859. 17, 18, Id., Am. Phil. Soc., **13**, 393, 1873. 19, 20, Chatard, quoted by Genth, l. c.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Zillerthal | 2·955 | 26·02 | 20·16 | 1·07 | 28·08 | 15·50 | 0·44 | 9·65 | = 100·92 |
| 2. " | | 25·84 | 19·58 | 2·13 | 28·05 | 13·57 | — | 11·34 | = 100·51 |
| 3. St. Gothard | | 25·12 | 22·26 | 1·09 | 23·11 | 17·41 | — | 10·70 | = 99·69 |
| 4. Fusch | 2·923 | 27·03 | 20·07 | 4·72 | 16·47 | 18·90 | — | 11·78 | $Na_2O$ 0·72, $K_2O$ 1·22 = 100·91 |
| 5. Massaschlucht | 2·946 | 24·85 | 20·70 | 1·00 | 25·00 | 15·31 | 0·60 | 12·05 | $TiO_2$ 0·45 = 99·96 |
| 6. Ascherskoppe | | 25·53 | 20·49 | 1·68 | 20·85 | 18·60 | 0·06 | 12·26 | $TiO_2$ 0·15, $P_2O_5$ 0·08, alk. 0·16, organ. 0·04 = 99·90 |
| 7. St. Cristophe | | 26·88 | 17·52 | — | 29·76 | 13·84 | — | 11·33 | = 99·33 |
| 8. Mtn. Sept Lacs | | 27·14 | 19·19 | — | 24·76 | 16·78 | — | 11·50 | = 99·37 |
| 9. Girdleness | 3·038 | 24·77 | 20·16 | 1·38 | 27·98[a] | 13·34 | 0·90 | 12·05 | = 100·58 |
| 10. Portsoy | 2·792 | 26·71 | 20·42 | 3·47 | 13·99 | 23·90 | 0·73 | 11·17 | = 100·39 |
| 11. Lude | 2·852 | 24·66 | 23·19 | 0·64 | 20·87[b] | 17·79 | 0·40 | 12·12 | = 100·67 |
| 12. Gumuch-dagh | | 27·20 | 18·62 | — | 23·21 | 17·64 | — | 10·61 | = 97·28 |
| 13. Washington | 2·835 | 25·45 | 17·88 | *und.* | 24·98 | 15·04 | — | 14·43 | $Na_2O$ 0·67 = 98·45 |
| 14. " | | 25·40 | 22·80 | 2·86 | 17·77 | 19·09 | — | 12·21 | F *tr.*, MnO 0·25 = 100·38 |
| 15. Virginia | 3·05 | 23·52 | 22·35 | 1·92 | 28·78 | 10·79 | 0·39 | 11·28 | MnO 0·32 = 99·35 |
| 16. Montgomery Co., N. C. | | 24·90 | 21·77 | 4·60 | 24·21 | 12·78 | — | 10·59 | MnO 1·15 = 100 |
| 17 Culsagee | | 27·56 | 22·75 | 2·56 | 5·73[a] | 28·47 | — | 13·80 | = 100·87 |
| 18. " | | 29·48 | 22·22 | 0·70 | 5·58[b] | 30·99 | — | 11·63 | = 100·60 |
| 19. " | | 27·28 | 22·11 | 2·50 | 5·84[c] | 28·34 | — | 14·50 | = 100·57 |
| 20. " | | 27·17 | 22·35 | 2·71 | 5·69[d] | 27·73 | — | 14·36 | = 100·01 |

[a] MnO 0·61. [b] MnO 0·29. [c] (Ni,Co)O 0·30 p. c. [d] Do., 0·11, MnO 0·17.
[e] Do., 0·41. [f] Do., 0·26.

The *helminthe* of Volger occurs in slender vermiform crystallizations like fig. 1 (whence the name), transversely foliated, penetrating quartz and feldspar. The figure is from a New Hampshire specimen described by O. P. Hubbard, and may be one of the other species of chlorite.

**Pyr., etc.**—Same as for clinochlore.

**Obs.**—Like other chlorites in modes of occurrence. Sometimes in implanted crystals, as at St. Gothard, enveloping often adularia, etc.; Mt. Greiner in the Zillerthal, Tyrol; Rauris in Salzburg; Traversella in Piedmont; at Mtn. Sept Lacs and St. Cristophe in Dauphiné; in Styria, Bohemia. Also massive in Cornwall, in tin veins (where it is called *peach*); at Arendal in Norway; Salberg and Dannemora, Sweden; Dognacska, Hungary. Occasionally formed from amphibole (Tschermak, Ber. Ak. Wien, **53** (1), 521, 1866). In Scotland at various points (anal. 9–11); other specimens (l. c.) with but 24 p. c. $SiO_2$ approximate to corundophilite

In the U. States, near Washington (anal. 13, 14); on Castle Mt., Batesville, Va., a massive form resembling soapstone, color grayish green, feel greasy; Steele's mine, Montgomery Co., N. C; also with corundum at the Culsagee mine, in broad plates of a dark green color and fine scaly; it differs from ordinary prochlorite in the small amount of ferrous iron.

Chloritic alteration-products of pyrope described by Lemberg (Zs. G. Ges., **27**, 531, 1875) are referred by Tschermak (l. c., p. 87) to penninite. Lemberg's analyses are as follows: 1, unaltered pyrope; 2, enclosing chloritic shell; 3–5, complete pseudomorphs:

| | $SiO_2$ | $Al_2O_3$ | $Cr_2O_3$ | $Fe_2O_3$ | MgO | Ca | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. | 40·60 | 22·70 | — | 9·34 | 21·47 | 4·23 | 1·66 | = 100 |
| 2. | 33·78 | 16·76 | — | 8·44 | 28·54 | 0·52 | 11·96 | = 100 |
| 3. | 33·82 | 13·58 | 1·97 | 5·15 | 32·93 | 0·37 | 10·42 | = 98·24 |
| 4. | 33·19 | 15·29 | — | 6·04 | 33·13 | — | 12·64 | = 100·29 |
| 5. | 33·63 | 14·17 | — | 5·26 | 33·65 | — | 13·29 | = 100 |

*Grengesite* from Grängesberg in Dalarne, Sweden, occurs partly in hexagonal crystallizations, more or less radiately grouped, and probably results, Erdmann observes (Lärobok Min., 374, 1853).

from the alteration of pyroxene. Erdmann spells the name *Grängesite.* Specific gravity 3·1; color dark green. An analysis by Hisinger gave:

$SiO_2$ 27·81 $Al_2O_3$ 14·31 FeO 25·63 MnO 2·18 MgO 14·31 $H_2O$ 12·55 = 96·79

GROCHAUITE *Websky*, Zs. G. Ges., **25**, 395, 1873.
Monoclinic? In small six-sided, tabular crystals, rough and allowing no measurements, the edges being rounded off by irregular planes. Cleavage basal easy, forming thin soft plates. Optically biaxial, axial angle 20° to 30°. Double refraction weak, probably positive. In composition near prochlorite, but containing chiefly magnesium instead of ferrous iron. Websky calculates $H_8R_5AlSiO_7$. Cf. anals. 16–19 above. Analysis, Beck, quoted by Websky:

$SiO_2$ 28·20 $Al_2O_3$ 24·56 FeO 5·27 MgO 30·94 $H_2O$ 12·15 = 101·12

Occurs mixed with a chromic spinel (magnochromite (p. 228), also crystallized in cavities in serpentine at Grochau, south of Frankenstein, in Silesia.

**470. CORUNDOPHILITE.** *Shepard* (fr. N. Car.), Am. J. Sc., **12**, 211, 1852; (fr. Chester, Mass.) *id.*, ib., **44**, 112, 1865. Clinochlore (fr. Chester) *J. P. Cooke*, Am. J. Sc., **44**, 206, 1867.
Amesite *C. U. Shepard;* Pisani, C. R., **83**, 166, 1876.

Monoclinic, Dx. In six-sided or twelve-sided tables or low prisms. Twins, according to the mica law, proved optically.

Cleavage: basal, eminent. Laminæ somewhat more brittle than those of clinochlore. Percussion- and pressure-figures as with clinochlore. The former show planes of parting in the zone *bc* inclined 64° to *c* (089)?, and in the zone *cm* inclined at the angles 71° (223), 75° (445), 37° ($\bar{1}16$), 62° ($\bar{2}25$). Etching-figures monosymmetric in form. H. = 2·5. G. = 2·90, Chester, Brush. Luster of cleavage surface somewhat pearly. Color olive-green, leek-green, grayish green. Transparent to nearly opaque. Laminæ flexible, somewhat elastic.

Optically +. Ax. pl. ‖ *b*. Bx somewhat oblique to *c*. Dispersion $\rho < v$. Axial angle rather large.

$Ac = 56°$ $Bc = 24°$ $2E = 80°$ $[\beta = 1·583]$ $\therefore$ $2V = 46° 40'$ $\mathfrak{c}\,c = 8° 20'$
Also 64° 59′ and 68° at 200° Dx. 32°, 45°, 71½°, 73½° Cooke

**Comp.**—As interpreted by Tschermak, a molecular mixture of $H_4Mg_3Si_2O_9$ and $H_4Mg_2Al_2SiO_9$ in the ratio of 1 : 4 giving the empirical formula $H_{20}Mg_{11}Al_8Si_6O_{45}$, which requires: Silica 23·9, alumina 27·1, iron protoxide 17·5, magnesia 19·5, water 12·0 = 100. Here Fe : Mg = 1 : 2.

**Anal.**—1, Eaton, quoted by Shepard, Am. J. Sc., **46**, 257, 1868. 2, Pisani, ibid. 3, Obermayer, quoted by Tschermak, l. c.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Chester, Mass. | 2·83 | 24·77 | 25·52 | — | 15·19 | 21·88 | 11·98 | = | 99·34 |
| 2. " " | | 24·0 | 25·9 | — | 14·8 | 22·7 | 11·9 | = | 99·3 |
| 3. " " | 2·87 | 23·84 | 25·22 | 2·81 | 17·06 | 19·83 | 11·90 | = | 100·66 |

**Obs.**—Occurs with corundum or emery; its low percentage of silica accords with this association. The species was instituted on a chlorite found with the corundum of Asheville, N. C., whence the name, from corundum, and *φίλος, friend.* The above description is from specimens occurring abundantly, and sometimes in large and small crystals, at the emery mine of Chester, Mass., which Shepard has referred to corundophilite; the chlorite occurring with the corundum of North Carolina is higher in silica and is classed with prochlorite (Genth), though containing relatively but little iron, cf. anals. 17–20, p. 654.

AMESITE *C. U. Shepard*, Pisani, C. R., **83**, 166, 1876.
In hexagonal plates, foliated, resembling the green talc from the Tyrol. H. = 2·5–3. G. = 2·71. Color apple-green. Luster pearly on cleavage face. Optically +, sensibly uniaxial. Composition approximating to $H_4(Mg,Fe)_2Al_2SiO_9$.
Anal.—Pisani, l. c.

$SiO_2$ 21·4 $Al_2O_3$ 32·3 FeO 15·8 MgO 19·9 $H_2O$ 10·9 = 100·3

Occurs with diaspore at Chester, Mass.

**471. DAPHNITE.** *Tschermak*, Ber. Ak. Wien, **100** (1), 38, 1891. Monoclinic. In small spherical or botryoidal aggregates showing a concentric and at the same time radiate-foliated structure.

Cleavage: basal, perfect. Laminæ somewhat flexible. Luster pearly. Color dark green; though the basal plane olive-green, normal to this direction yellow. Streak green. Optically —, nearly uniaxial.

**Comp.**—According to Tschermak, $H_{56}Fe_{27}Al_{20}Si_{18}O_{121}$. Cf. p. 644.

**Anal.**—R. Zeynek.

| G. | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 3·172 | 23·62 | 22·26 | 38·97 | 0·98 | 1·09 | 0·29 | 1·10 | 0·28 | 11·16 | = 99·75 |

**Pyr., etc.**—B.B. becomes black, but does not exfoliate and fuses easily to a steel-gray bead. Easily decomposed by warm hydrochloric acid with the separation of flocculent silica.

**Obs.**—Observed on a specimen from Penzance, Cornwall, obtained in 1840; it occurs as an incrustation on quartz and arsenopyrite.

Named from Daphne, *bay tree*, in allusion to the form.

METACHLORITE. *List*, Zs. G. Ges., **4**, 634, 1852. Foliated columnar, like chlorite, vitreous to pearly in luster, color dull leek-green. H. = 2·5. Anal.—1, List, l. c. 2, Zeynek, quoted by Tschermak.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | | 23·78 | 16·43 | — | 40·37 | 3·10 | 0·74 | 1·38 | 0·08 | 13·76 | = 99·64 |
| 2. | 3·173 | 24·29 | 17·85 | 4·65 | 37·85 | 4·26 | 0·57 | 0·09 | 0·30 | 10·19 | = 100·04 |

B.B. fuses on the edges to a dark enamel. Gelatinizes in the cold with hydrochloric acid. Forms small veins in a green rock at Büchenberg near Elbingerode, in the Harz.

KLEMENTITE *Tschermak*, Ber. Ak. Wien, **100** (1), 40, 1891.

In thin scales in quartz veins at Vielsalm in Belgium. Probably monoclinic. G. = 2·835. Color dark olive-green. Optically +. Biaxial, axial angle small, Tschermak.

Anal.—C. Klement, Bull. Mus. Belg., **5**, 162, 1888.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| G. = 2·835 | $\frac{2}{2}$ 27·13 | 24·70 | 5·84 | 9·72 | 1·98 | 20·52 | 11·35 | = 101·24 |

B.B. exfoliates and fuses to a dark glass. In powder partially decomposed by hydrochloric acid with the separation of flocculent silica. Named after Dr. C. Klement of Brussels.

---

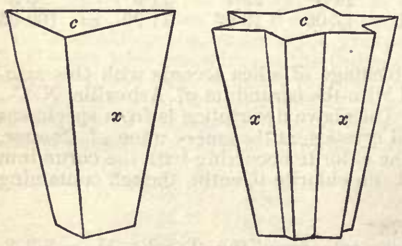
**472. CRONSTEDTITE.** Cronstedtit *Steinmann*, Schw. J., **32**, 69, 1821. Chloromelan *Breith.*, Char., 33, 184, 1823. Sideroschisolite *Wernekink*, Pogg., **1**, 387, 1824.

Rhombohedral; hemimorphic. Axis $\dot{c} = 3·2559$; $0001 \wedge 10\bar{1}1 = 75° \ 6\frac{1}{3}'$ Zepharovich[1].

**Forms:** *c* (0001, *O*); *r* ($10\bar{1}1$, 1), *x* ($20\bar{2}1$, 2); *y* ($30\bar{3}1$, 3).

Angles: $cr = 75° \ 6'$, $cx = 82° \ 25\frac{1}{2}'$, $cy = {}^*84° \ 56'$.

Twins: tw. ax. $\dot{c}$, united symmetrically by a prismatic face or interpenetrating and forming a six-rayed base. Occurs in hexagonal pyramids, tapering toward one extremity, or adhering laterally, and vertically striated; also in fibrous diverging groups, cylindroidal and reniform; also amorphous.



Příbram, Zeph.

Cleavage: basal, highly perfect. Not brittle. Thin laminæ elastic. H. = 3·5. G. = 3·34–3·35. Luster brilliantly vitreous. Color coal-black to brownish black; by transmitted light in thin scales emerald-green; also on the edges brown or brownish yellow. Streak dark olive-green. Nearly opaque. Optically —; uniaxial.

**Comp.**—Perhaps $H_8\overset{II}{Fe}_4\overset{III}{Fe}_4Si_3O_{20} = 4FeO.2Fe_2O_3.3SiO_2.4H_2O$ = Silica 20·9, iron sesquioxide 37·2, iron protoxide 33·5, water 8·4 = 100. Magnesium may be present in small amount.

Rg. gives $3FeO.Fe_2O_3.2SiO_2.3H_2O$ = Silica 21·8, iron sesquioxide 29·1, iron protoxide 39·3, water 9·8 = 100.

**Anal.**—1, E. Ludwig, quoted by Tschermak, Ber. Ak. Wien, **100** (1), 1891. 2, Janovsky, Ber. Ch. Ges., **8**, 939, 1875. 3, Rosam, Vrba, Ber. Ak. Böhm., p. 13, Jan. 15, 1886. 4, Maskelyne and Flight, Ber. Ch. Ges., **3**, 938, 1870.

| | | $SiO_2$ | $Fe_2O_3$ | FeO | MnO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Přibram | | $\frac{2}{2}$ 22·21 | 37·49 | 25·28 | 1·20 | 5·23 | 8·27 | = 99·68 |
| 2. " | G. = 3·351 | 21·30 | 32·34 | 29·23 | 1·25 | 4·51 | 11·90 | = 100·53 |
| 3. Kuttenberg | G. = 3·445 | 17·34 | 43·05 | 30·27 | 0·16 | — | [9·18] | = 100 |
| 4. Cornwall | | 18·55 | 32·75 | 38·57 | — | — | 10·13 | = 100 |

An analysis by Field (Phil. Mag., **5**, 52, 1878) of a dark green compact mineral accompanying the Cornwall cronstedtite gave:

$SiO_2$ 31·72 $Fe_2O_3$ 18·51 FeO 39·46 $H_2O$ 11·02 = 100·71

Sp. grav. = 3. The formula $3FeO.Fe_2O_3.3SiO_2.3H_2O$ is deduced.

**Pyr., etc.**—B.B. froths and fuses on the edges, yielding in R.F. a magnetic gray or black globule. With borax gives reactions for iron and manganese. Gelatinizes in concentrated hydrocloric acid.

**Obs.**—Accompanies limonite and calcite in veins containing silver ores at Přibram in Bohemia, and also at Kuttenberg; also at Wheal Maudlin and in Cornwall, in diverging groups. In Brazil at Conghonas do Campo (*sideroschisolite*).

Named after the Swedish mineralogist and chemist, A. Fr. Cronstedt.

**Ref.**—[1]Brazil, Ber. Ak. Wien, **71** (1), 276, 1875. Maskelyne (J. Ch. Soc., Jan. 1871) gives for Cornwall crystals *cy* = 85° 12′; exact measurements are impossible. Cf. also Vrba, Ber. Böhm. Ges., p. 13, Jan. 15, 1886. The doubtful scalenohedron $\frac{1}{4}^{\frac{9}{2}}$ ($11 \cdot 7 \cdot \bar{18} \cdot 16$) is added by Zepharovich.

**473. THURINGITE.** Thuringit *Breith.*, Char., 95, 1832. Owenite *Genth*, Am. J. Sc., **16**, 167, 1853.

Massive; an aggregation of minute scales; compact.

Cleavage of scales distinct in one direction. Fracture subconchoidal. Very tough. Feel of powder greasy. H. = 2·5. G. = 3·15–3·19; 3·118 Böttcher. Luster of scales pearly; of mass glistening or dull. Color olive-green to pistachio-green. Streak paler. Optically —. Uniaxial to distinctly biaxial.

**Comp.**—$H_{18}Fe_8(Al,Fe)_8Si_6O_{41} = 8FeO.4(Al,Fe)_2O_3.6SiO_2.9H_2O$ = Silica 22·8, alumina 17·2, iron sesquioxide 13·5, iron protoxide 36·3, water 10·2 = 100.

**Anal.**—1, Rg., Min. Ch., 851, 1860. 2, J. L. Smith, Am. J. Sc., **18**, 376, 1854. 3, Keyser, ibid., p. 411. 4, Gintl, quoted by Zepharovich, Zs. Kr., **1**, 372, 1877. 5, Genth, l. c. 6, 7, Smith, l. c. 8, F. L. Sperry, Am. J. Sc., **32**, 307, 1886.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. *Thuringite* | | 22·35 | 18·39 | 14·86 | 34·34 | 1·25 | — | — | 9·81 | = 101 |
| 2. " | | 22·05 | 16·40 | 17·66 | 30·78 | 0·89 | 0·14 | | 11·44 | = 99·36 |
| 3. " | | $\frac{3}{3}$ 23·55 | 15·63 | 13·79 | 34·20 | 1·47 | *tr.* | *tr.* | 10·57 | = 99·21 |
| 4. Zirm See | 3·177 | $\frac{2}{2}$ 22·65 | 18·92 | 8·12 | 38·49 | — | — | — | 10·78 | = 98·96 |
| 5. Harper's Ferry | | 23·21 | 15·59 | 13·89 | 34·58 | 1·26 | 0·41 | 0·08 | 10·59 | CaO 0·36 = 99·97 |
| 6. " | 3·191 | 23·58 | 16·85 | 14·33 | 33·20 | 1·52 | 0·46 | *tr.* | 10·45 | MnO 0·09 = 100·48 |
| 7. Arkansas | 3·184 | 23·70 | 16·54 | 12·13 | 33·14 | 1·85 | 0·32 | | 10·90 | MnO 1·16 = 99·74 |
| 8. L. Superior | | $\frac{2}{2}$ 22·35 | 25·14 | — | 34·39 | 6·41 | — | — | 11·25 | = 99·54 |

**Pyr., etc.**—In the closed tube yields water. B.B. fuses at 3 to an iron-black magnetic globule. With the fluxes reacts for iron. Gelatinizes with hydrochloric acid.

**Obs.**—Thuringite is from Reichmannsdorf and Schmiedeberg, near Saalfeld, in Thuringia (cf. Loretz, Zs. Kr., **13**, 52, 1887); at Zirm See in Carinthia (Zeph., l. c.); Hot Springs, Arkansas; from the metamorphic rocks on the Potomac, near Harper's Ferry (owenite); forms the matrix (anal. 8) enclosing garnet crystals altered to a chlorite near aphrosiderite (p. 660) in the Lake Superior iron region; at French Creek mines, Chester Co., Penn., the chalcopyrite and pyrite crystals are embedded in a compact mineral which Penfield suggests is probably allied to thuringite

*Owenite* was named after the geologist, Dr. D. D. Owen.

**Chamosite.** Mine de fer oxydé en grains agglutinés *Gueymard*, J. Mines, **35**, 29, 1814; Chamoisite *Berthier*, Ann. Mines, **5**, 393, 1820. Chamosite. Minerai de fer en grains *Berthier*, Ann. Ch. Phys., **35**, 258, 1827. Berthierine *Beud.*, Tr., 128, 1832. Bavalite *Huot*, Min., 290, 1841.

*Chamosite*, as originally described, occurs compact or oölitic, with H. about 3; G. = 3–3·4; color greenish gray to black; streak lighter; opaque; feebly attracted by a magnet. *Berthierine* is similar in structure, has H. = 2·5; color bluish gray, blackish, or greenish black; streak dark greenish gray; and strongly attracted by the magnet. Anal.—1, Berthier, l. c. 2, id., Ann, Ch. Phys., **35**, 258, 1827:

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. *Chamosite* | $SiO_2$ 14·3 | $Al_2O_3$ 7·8 | FeO 60·5 | $H_2O$ 17·4 | = | 100 |
| 2. *Berthierine* | 12·4 | 7·8 | 74·7 | 5·1 | = | 100 |

Chamosite fuses easily, and also gelatinizes. Berthierine fuses with difficulty to a black magnetic globule, and gelatinizes. The latter is mixed with 50 p. c. or more of siderite and calcite; Berthier found 40·3 of the former in the material he examined.

Chamosite forms thick beds of rather limited extent in a limestone containing ammonites, at Chamoson, near St. Maurice, in the Valais; and a similar substance is reported from Mettenberg in the Bernese Oberland; Banwald in the Vosges; in the Windgälle; with iron carbonate and titanic iron at Schmiedefeld in the Thüringerwald; in Bohemia, from the oölitic iron ore of Chrustenic in dark bluish gray elliptical grains. *Berthierine* constitutes a valuable bed of iron ore at Hayanges, Dept. of Moselle, and also occurs in the ores of Champagne, Bourgogne, Lorraine.

The chloritic mineral associated with the iron ore of Chamoson has been investigated by Boricky, Loretz, and Schmidt and shown to have a composition approximating to thuringite. Berthier's results above are unreliable as giving the composition of the silicate.

Anal.—1, Boricky, as quoted by Schmidt, after deducting 5·5 p. c. Ca,Fe carbonate. 2, C. Schmidt, Zs. Kr., **11**, 601, 1886; also recalculated. 3, Loretz, Zs. Kr., **13**, 52, 1887.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|
| 1. *Chamosite* | 25·60 | 18·72 | — | 42·31 | 2·13 | 11·24 | = | 100 |
| 2. | 25·23 | 19·97 | — | 37·51 | 4·39 | 12·90 | = | 100 |
| 3. Schmiedefeld | 27·29 | 17·13 | 4·06 | 39·42 | — | 13·10 | = | 100 |

An oölitic mineral, apparently near chamoisite, described by Pouillon Boblaye (Mem. Mus., 15), has been called *Bavalite*. It has H. about 4; G. = 3·99 Delesse; color greenish black, bluish, or grayish; powder greenish gray or black, to reddish brown; and B.B. fusible with difficulty to a black magnetic scoria. Forms beds in old schistose rocks in different parts of Brittany, especially in the forest of Lorges, a locality that supplies furnaces at Pas near Quintin, in the vicinity of St. Brieuc, Dept. Côtes-du-Nord; also at the Chapel St. Oudon, near Segré, Dept. Maine-et-Loire; and elsewhere. Huot and others derive the name *bavalite* from Bavalon, a locality of it; but Des Cloizeaux says no such place exists in Brittany; but that a depression in the region where it is explored is called the *bas vallon*—an absurd origin for a name. See 5th Ed., p. 796, for analyses.

**474. STILPNOMELANE.** *Glocker*, Zs. f. Min., Jan., 1828, Handb., 572, 1831. Chalcodite *Shep.*, Rep. Am. Assoc., **6**, 232, 1851.

Foliated plates, sometimes hexagonal, sometimes radiated. Also fibrous, or as a velvety coating even or tufted.

Cleavage easy in one direction. H. = 3·4, when in solid plates. G. = 2·769 Breith.; 2·96, chalcodite, Genth. Luster of cleavage surface between pearly and vitreous, sometimes submetallic or brass-like. Color black, greenish black, yellowish bronze, and greenish bronze.

**Var.**—1. *Ordinary*, in plates or massive. Glocker gives G. = 3–3·4.

2. *Chalcodite*, in velvety coatings of brass-like or submetallic luster, consisting of minute flexible scales.

**Comp.**—Uncertain, perhaps (Brush, Rg.) $2(Fe,Mg)O.(Fe,Al)_2O_3.5SiO_2.3H_2O$.

Genth calculates for his analysis $8(Fe,Mg)O.(Fe,Al)_2O_3.10SiO_2.6H_2O$.

**Anal.**—1, Rg., Pogg., **43**, 127, 1838, Min. Ch., 880, 1860. 2, Siegert, Rg., Min. Ch., 880, 1860. 3, L. J. Igelström, J. pr. Ch., **81**, 396, 1860. 4, G. J. Brush, Am. J. Sc., **25**, 198, 1858. 5, Genth, Am. Phil. Soc., **23**, 44, 1885.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $K_2O$ | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. **Obergrund** | | $\frac{4}{4}$ 45·96 | 5·84 | — | 35·60 | 1·78 | 0·19 | 0·75 | 8·63 | = | 98·75 |
| 2. **Weilburg** | | 45·07 | 4·92 | — | 37·78 | 0·94 | 1·67 | — | 8·47 | = | 98·85 |
| 3. **Nordmark** | | 45·61 | 5·00 | — | 37·70 | 3·00 | — | — | 9·14 | = | 100·45 |
| 4. ***Chalcodite*** | 2·76 | $\frac{2}{2}$ 45·29 | 3·62 | 20·47 | 16·47 | 4·56 | 0·28 | *tr.* | 9·22 | = | 99·91 |
| 5. " | 2·957 | 44·75 | 4·36 | 4·99 | 30·34 | 5·47 | — | — | 9·18 | = | 99·09 |

Brögger refers here the mineral which in the form of inclusions gives the abnormal composition upon which the supposed variety of natrolite from the Brevik region called iron-natrolite (Eisennatrolith) has been based; cf. p. 602. Its composition could not be definitely settled. Zs. Kr., **16**, 626, 1890.

**Pyr.**, etc.—Yields much water. B.B. fuses easily to a black, shining, magnetic globule. With the fluxes gives the reactions for iron. Chalcodite is completely decomposed by hydrochloric acid.

**Obs.**—Stilpnomelane occurs at Obergrund and elsewhere in Silesia, with calcite and quartz, sometimes intermixed with pyrite and magnetite. Also in Moravia, near Brokersdorf; near Sternberg, in a bed of limonite, in a clay slate, probably of the Devonian age, and often associated with chlorite, magnetite, and calcite; at Frederic mine near Weilburg, Nassau, in a bed of iron ore; at Pen Mine, Nordmark, Sweden, radiated foliated with actinolite, in veins sometimes 4 inches thick.

*Chalcodite* occurs at the Sterling Iron mine, in Antwerp, Jefferson Co., N. Y., coating hematite and calcite, and sometimes constituting pseudomorphs (anal. 5), having the form of hollow rectangular tables; the yellow variety resembles in color mosaic gold.

Named *Stilpnomelane* from στιλπνός, *shining*, and μέλας, *black;* and *Chalcodite* from χαλκός, *brass* or *bronze*. Melanglimmer *Germ.* includes this species, Cronstedtite, etc.

**475. STRIGOVITE.** *Becker & Websky*, Jb. Min., 236, 1869. *Websky*, Zs. G. Ges., **25**, 388, 1873.

In minute crystals, showing hexagonal prisms under the microscope; sometimes in balls of aggregated crystals.

H. = 1. G. = 3·144. Color dark green (on alteration changing to brown). Streak green to grayish green. Optically uniaxial or nearly so.

**Comp.**—$H_4Fe_2(Al,Fe)_2Si_2O_{11} = 2FeO.(Fe,Al)_2O_3.2SiO_2.2H_2O$ (at 100°), or with $3H_2O$ (air-dried).

**Anal.**—1, Becker, l. c. 2, Websky, l. c., 1869. 3, Websky (and Poleck), l. c., 1873 (at 100°).

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | | 32 62 | 16·66 | 16·04 | 16·74 | — | 3·16 | 2·02 | 12·37 | = | 99·61 |
| 2. | 2·788 | 32 60 | 14·08 | 21·94 | 12·47 | — | 3·82 | — | 14·81 | = | 99·72 |
| 3. | 3·144 | 28·43 | 16·60 | 11·43 | 26·21 | 7·26 | 0·36 | 0·36 | 9·31 | = | 99·96 |

**Pyr.**, etc.—Easily decomposed by acid with the separation of silica in powder. In closed tube gives off water. B.B. fuses with difficulty to a black glass without coloring the flame.

**Obs.**—Occurs as a fine coating over the minerals in druses or cavities in the granite west and northwest of Striegau in Silesia.

**476. DIABANTITE.** Diabantachronnyn, *Liebe*, Jb. Min., 1, 1870. Diabantite *G. W. Hawes*, Am. J. Sc., **9**, 454, 1875.

Monoclinic? Massive, compact, fibrous or with a foliated, radiated, and concentric structure.

Cleavage: basal, perfect. H. = 2–2·5. G. = 2·79–2·93. Color dark green to greenish black. Strongly pleochroic.

**Comp.**—$H_{18}(Fe,Mg)_{12}Al_4Si_9O_{45}$ or $12(Fe,Mg)O.2Al_2O_3.9SiO_3.9H_2O$ = Silica 34.2, alumina 12·9, iron protoxide 27·4, magnesia 15·2, water 10·3 = 100.

**Anal.**—1–5, Liebe, l. c. 6, 7, Hawes, l. c.

| | | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Reinsdorf | 2·83 | 30·27 | 11·16 | — | 26·94 | — | 21·22 | — | — | 10·20 | =99·79 |
| 2. | Landesfreude | 2·93 | 29·37 | 12·00 | — | 25·63 | — | 21·01 | — | — | 11·27 | =99·28 |
| 3. | Höllethal | 2·91 | 29·85 | 9·07 | — | 26·60 | — | 17·92 | — | — | 15·81 | =99·25 |
| 4. | Trilloch | | 31·25 | 10·03 | 3·47 | 23·52 | — | 19·73 | — | — | 11·37 | =99·37 |
| 5. | Gräfenwart, *fibrous* | | 31·56 | 12·08 | — | 21·61 | — | 22·44 | — | — | 11·78 | =99·47 |
| 6. | Farmington | 2·79 | 33·24 | 11·07 | 2·26 | 25·11 | 0·41 | 16·51 | 1·11 | 0·25 | 9·91 | =99·87 |
| 7. | " | | 33·68 | 10·84 | 2·86 | 24·33 | 0·38 | 16·52 | 0·73 | 0·33 | 10·02 | =99·69 |

**Pyr.**—Fuses easily on the edges, forming a dark gray glass somewhat magnetic. Dissolves in hydrochloric acid, leaving a skeleton of silica.

Occurs in the diabase of Voigtland and Frankenwald, and contributes to the green color of the rock. It is found in seams and clefts, sometimes in amygdules and lining cavities in the rock. In some occurrences of diabase it forms the chief binding or cementing material, and is apparently a product of the alteration of the augitic constituent of the diabase.

A similar mineral occurs filling amygdaloidal cavities in the diabase of the Farmington Hills, Conn., and at other points in the same region, as at Turner's Falls, Mass., and elsewhere.

The center cavities are often occupied by calcite, and this and the associated prehnite are often impregnated by it; the diabantite was thus the first product of the decomposition of the diabase (Emerson).

The diabantite is sometimes altered by hydration and oxidation of the iron, forming masses of a straw-, gold-, or bronze-yellow. It then becomes a diabantite-vermiculite, as it is called by Emerson, Am. J. Sc., **24**, 198–201, 1882.

**477. APHROSIDERITE.** *Sandberger*, Ueb. Geol. Nassau, 97, 1847.

Massive; in fine scales, hexagonal in form.

Soft. G. = 2·8–3·0. Color dark olive-green. Transparent to translucent.

**Comp.**—Perhaps (Websky) $H_{10}Fe_6(Fe,Al)_4Si_4O_{26}$.

**Anal.**—1, Sandberger, l. c. 2, Igelström, J. pr. Ch., **84**, 480, 1861. 3, Erlenmeyer, JB. Ch., 773, 1860. 4, Hauer, Jb. G. Reichs., **4**, 79, 1854. 5, Nies, Jb. Min., 321, 1873, after deducting $CaCO_3$. 6, Rg., quoted by Websky, Zs. G. Ges., **31**, 212, 1879. 7, Woitschach, Zs. Kr., **7**, 82, 1882. 8–10, Penfield & Sperry, Am. J. Sc., **32**, 308, 310, 1886. 11, Niedzwiedzki, Min. Mitth., 162, 1872.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Weilburg | 2·8 | 26·45 | 21·25 | — | 44·24 | 1·06 | — | 7·74 | = 100·74 |
| 2. Guistberg | | 25·0 | 20·6 | — | 32·0 | 14·3 | — | 7·6 | = 99·5 |
| 3. Bouscheuer | 2·991 | 25·72 | 20·69 | 4·01 | 27·79 | 11·70 | — | 10·05 | = 99·96 |
| 4. Styria | | 26·08 | 20·27 | — | 32·91 | 10·00 | — | 10·06 | = 99·32 |
| 5. Dillenburg | | 24·63 | 25·25 | 8·50 | 30·61 | 1·82 | — | 9·19 | = 100 |
| 6. Striegau | | 24·78 | 18·69 | 6·45 | 36·17 | 4·52 | — | 9·09 | = 99·70 |
| 7. Königshain | | 27·06 | 19·56 | 11·71 | 28·91 | 1·18 | 0·38 | 9·73 | = 98·53 |
| 8. L. Superior, *garnet pseud.* | 3·21 | 27·45 | 19·53 | 6·26 | 29·42 | 6·04 | — | 7·50 | $Na_2O$ 0·42, $K_2O$ 2·64 = 99·26 |
| 9. " " " | | 29·08 | 19·94 | 3·91 | 30·68[a] | 5·56 | 0·25 | 6·53 | $Na_2O$ 0·29, $K_2O$ 3·66 = 99·90 |
| 10. Salida, Col., " " | | 28·20 | 22·31 | — | 19·11 | 17·68 | 0·48 | 10·90 | $Na_2O$ 0·72, $K_2O$ 1·03 = 100·43 |
| 11. Saualpe | 2·98 | 25·19 | 21·66 | 9·09 | 14·22 | 18·73 | — | 11·53 | = 100·42 |

[a] Incl. MnO 0·20.

Analyses 8–10, by Penfield & F. L. Sperry, are of a chlorite forming the coating of almandite garnets (anal. 6, 7, p. 441) and derived from their alteration. Color of 8, 9, dark green; 10, light green, optically uniaxial. Anal. 11, by Niedzwiedzki, is of a similar chlorite, forming a coating about a like garnet from the Saualpe, Carinthia; magnetite may be present in the material analyzed.

**Obs.**—Aphrosiderite occurs at Weilburg, Nassau, at the Gelegenheit mine. A similar mineral, but more magnesian, has been found in gneiss at Guistberg in Wermland; in hematite at Bouscheuer near Muttershausen, Nassau; at Bulduinstein on the Lahr; and in mica schist with hematite at several places in Upper Styria, consisting of microscopic scales of a clear green color.

**478. DELESSITE.** Chlorite ferrugineuse *Delesse*. Ann. Mines, **12**, 195, 1847, and **16**, 520, 1849. Delessite *Naum.*, Min., 1850. Eisenchlorit. Subdelessit *Weiss*, Zs. G. Ges., **31**, 801, 1879

Massive, with a short fibrous or scaly feathery texture, often radiated.

H. = 2·5. G. = 2·89. Color olive-green to blackish green. Powder gray or green.

**Comp.**—Perhaps (Groth) $H_{10}(Mg,Fe)_4(Al,Fe)_4Si_4O_{23}$.

**Anal.**—1–3, Delesse, l. c. 4–8, Heddle, Trans. R. Soc. Edinb , **29**, 81, 1879. 9, Weiss, l. c.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Mielen | | 31·07 | 15·47 | 17·54 | 4·07 | 19·14 | 0·46 | 11·55 | = 99·30 |
| 2. Oberstein | | 29·08 | 42·00 | | — | 12·23 | 3·70 | 12·99 | = 100 |
| 3. Zwickau | | 29·45 | 18·25 | 8·17 | 15·12 | 15·32 | 0·45 | 12·57 | = 99·33 |
| 4. Bowling | 2·573 | 32·00 | 17·33 | 1·19 | 12·45 | 20·42 | 1·57 | 15·45[a] | = 100·41 |
| 5. Dumbuck | 2·598 | 32·01 | 18·87 | 1·18 | 12·09 | 19·64 | 1·39 | 15·46[a] | = 100·64 |
| 6. Long Craig | 2·656 | 30·93 | 15·32 | 3·16 | 15·31 | 18·65 | 1·38 | 14·69[a] | MnO 0·38 = 99·82 |
| 7. Elie | 2·672 | 30·69 | 12·83 | 1·63 | 18·32 | 18·60 | 1·59 | 13·77[a] | MnO 1·00, alk. 1·68 = 100·11 |
| 8. St. Cyrus | 2·652 | 32·69 | 13·44 | 4·40 | 6·62 | 28·77 | 0·86 | 13·24[a] | = 100·02 |
| 9. *Subdelessite* | 2·836 | 28·79 | 16·74 | 4·83 | 18·61[b] | 16·62 | 0·98 | 12·25 | $TiO_2$ 0·18, alk. 0·52, $P_2O_5,SO_3,CO_2$ 0·69 = 100·21 |

[a] Loss at 100°· 4, 5·70 p. c; 5, 6·30; 6, 4·68; 7, 3·39; 8, 2·77. [b] Incl. 0·31 MnO.

**Pyr., etc.**—In a matrass yields water and becomes brown. B.B. fuses with difficulty on the edges. Easily soluble in acids, affording a deposit of silica.

**Obs.**—The original delessite occurs coating or filling the cavities of amygdaloid, or amygdaloidal porphyry, at Oberstein, Zwickau, La Grève near Mielen. Similar minerals occur at various points in Scotland, anals. 4–8; also in Nova Scotia (How, Phil. Mag., **37**, 267, 1869).

Named after Delesse, of Paris.

*Subdelessite* (anal. 10) is a blackish green chloritic mineral, filling cavities in eruptive rocks in the Thüringer Wald.

### 479. RUMPFITE. *G. Firtsch,* Ber. Ak. Wien, **99** (1), 417, 1890.

Massive; granular, consisting of very fine scales from 0·05–0·15 in diameter and 1 mm. in length. Form of scales hexagonal, united in vermicular shapes resembling some kinds of clinochlore.

Cleavage: basal, perfect. H. = 1·5. G. = 2·675. Color greenish white. Translucent on the edges. Optically uniaxial or nearly so; sometimes 2E = 10°.

**Comp.**—A basic silicate of aluminium and magnesium; Firtsch calculates the formula: $H_{28}Mg_7Al_{16}Si_{10}O_{65}$ or $7MgO.8Al_2O_3.10SiO_2.14H_2O$.

**Anal.**—Firtsch, l. c.

$SiO_2$ 30·75 $Al_2O_3$ 41·66 FeO 1·61 MgO 12·09 CaO 0·89 $H_2O$ 13·12 = 100·12

The loss of water was as follows:

| 150° | 200°–360° | red ht. (600°) | ign. (Bunsen burner.) | ign. (blast lamp). |
|---|---|---|---|---|
| $\frac{2}{2}$ 0·16 | 0 | 8·73 | 12·51 | 12·79 |

**Pyr., etc.**—B.B. infusible, but becomes brown. Not decomposed by acids, but after ignition the iron compound is dissolved, the rest not decomposed.

**Obs.**—Occurs with talc in crevices in the magnesium carbonate rock (pinolite, p. 274) near St. Michael in Upper Styria.

Named for Professor Johann Rumpf of Graz.

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## The following are other chloritic minerals, more or less imperfectly defined.

TALC-CHLORITE OF TRAVERSELLA occurs in large hexagonal plates regularly grouped, and presents, according to Des Cloizeaux, the optical characters of clinochlore. The plates are twins, consisting of six triangular sections; at center they are translucent and blackish green, and optically −, and exteriorly clear green and transparent, and optically +. Marignac regards it as between talc and chlorite. He obtained, anal. 1–3, Ann. Ch. Phys., **14**, 60, 1845. 4, Heddle, Trans. R. Soc. Edinb., **29**, 78, 1879.

| | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Traversella | 38·45 | 11·75 | 12·82 | — | 28·19 | — | 8·49 | = 99·70 |
| 2. " | 39·81 | 12·56 | 11·10 | — | 28·41 | — | 7·79 | = 99·67 |
| 3. " | 41·34 | 11·42 | 10·09 | — | 29·67 | — | 7·66 | = 100·18 |
| 4. Hillswick | 39·81 | 11·43 | 7·97 | 0·26 | 25·65 | 2·80 | 7·91 | $Na_2O$ 3·15. KO [1·20 = 100·19$_2$ |

It may be ripidolite impure from mixture with talc, which view would account for the high percentage of silica. Occurs at Traversella, Piedmont, with magnetite and ripidolite; also (anal. 4) a similar mineral at Hillswick in Shetland.

At Traversella there is still another *talc-chlorite,* soft and of a silvery-white luster, having a single optical axis, or two very slightly divergent; the hexagonal plates are opaque at center and transparent toward the borders. It affords much water in a matrass, and fuses with difficulty on the edges to a white enamel. This may be identical with the leuchtenbergite, noted by Tschermak from Traversella.

EPICHLORITE *Rammelsberg,* Pogg., **77**, 237, 1849.

Fibrous or columnar, between schiller spar and chlorite in its characters. H. = 2–2·5; G. = 2·76; color dull leek-green; streak white to greenish; luster greasy; in thin columns translucent and of a bottle-green color. Anal.—1, Rg., l. c. 2, Liebe, Jb. Min., 17, 1870.

| | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | | 40·88 | 10·96 | 8·72 | 8·96 | 20·00 | 0·68 | 10·18 | = 100·38 |
| 2. | G. = 2·79 | 41·52 | 8·60 | — | 19·26 | 19·78 | — | 10·05 | = 99·21 |

B.B. fuses only in thin fibers with difficulty. With the fluxes reaction for silica and iron. Forms veins in a rock resembling serpentine near Harzburg. Named in allusion to its being near chlorite in characters.

Liebe's mineral (anal. 2) is the coloring mineral in the black titanic-iron diabase of the Voigtland and Frankenwald. He regards it as containing only ferrous iron, and argues the same for the mineral from the Harz.

EURALITE *F. J. Wiik*, Jb. Min., 357, 1869. A chloritic mineral occurring in seams in clefts of hyperyte in the parish of Eura, Finland. It is apparently amorphous, but breaks under the hammer into prismatic fragments. H. = 2·5. G. = 2·62. Color dark green to black. B.B. fuses easily to a magnetic globule. Soluble in hydrochloric acid. Analysis, Wiik:

$SiO_2$ 33·68 $Al_2O_3$ 12·15 $Fe_2O_3$ 6·80 FeO 15·66 MgO 17·92 CaO 1·34 $H_2O$ 11·49 = 99·04

Apparently related to diabantite, p. 659.

EPIPHANITE. Epifanit *Igelström*, Öfv. Ak. Stockh., **25**, 32, 1868. A chlorite-like mineral from Tvärån in Wermland. Sweden. Analysis, Igelström:

$SiO_2$ 37·11 $Al_2O_3$ 21·13 FeO 20·00 MgO 14·03 $H_2O$ 7·83 MnO *tr.* = 100·10

CHLOROPHÆITE *Macculloch*, Western Isles, 1, 504, 1825.

Granular massive, embedded, or as a coating in geodes, fissures, or amygdaloidal cavities. Cleavage in two directions. H. = 1·5–2. G. = 2·02, Macculloch; 2·28 Heddle. Luster sub-resinous, rather dull. Color dark green, olive-green, changing rapidly to dark brown or black on exposure. In composition somewhat near delessite; cf. also hisingerite. Anal.—1, 2, Heddle, Trans. R. Soc. Edinb., **29**, 84, 1879.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Scuir Mohr | | 36·00 | — | 22·80 | 2·46 | 0·50 | 9·50 | 2·52 | 26·46 | alk. *tr.* = 100·24 |
| 2. Giant's Causeway | 2·278 | 35·99 | 10·49 | 11·89 | 1·63 | 0·08 | 10·52 | 5·15 | 23·20 | alk. 1·10 = 100·04 |

$H_2O$ at 100°: in 1, 19·23; in 2, 14·16.

From the Western Isles of Scotland. at Scuir Mohr in the island of Rum, and from Fifeshire, occurring in amygdaloid; also from the Färöer. Reported also as incrusting chalcedony in Antrim, and in small botryoidal groups in the amygdaloid at Down Hill. But the chemical identity of the original chlorophæite of Macculloch from Scuir Mohr with that of the Färöer or the other localities has not yet been ascertained. Named from χλωρός, *green*, and φαιός, *brown*.

HULLITE *E. T. Hardman*, Proc. Roy. Irish Acad., 3, 161, 1878.

Massive. H. = 2. Color velvet-black. Luster waxy but dull. Near delessite and chlorophæite, but not a homogeneous mineral (cf. Lcx., Bull. Soc. Min., **8**, 432, 1885). Anal.—1, Hardman, l. c. 2, Heddle, Trans. R. Soc. Edinb., **29**, 89, 1879.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Carnmoney Hill | 39·44 | 10·35 | 20·72 | 3·70 | 7·47 | 4·48 | 13·62 | = 99·78 |
| 2. Kinkell | 38·59 | 17·34 | 15·97 | *undet.* | 8·65 | 3·94 | 13·48 | MnO 1·56, $K_2O$ 0·67 = 100·20 |

$H_2O$ lost at 100° in 2, 8·04 p. c.

Occurs filling and coating vesicular cavities in the basalt of Carnmoney Hill, near Belfast, Ireland. A similar mineral occurs in the basalt at Kinkell, in Fifeshire, Scotland.

MELANOLITE *Wurtz*, Dana, Min., 679. 1850. It is black, opaque, with streak dark olive-green; H. = 2; G. = 2·69. Surface of the mineral often striated, or with an imperfectly columnar aspect. Analysis.—H. Wurtz, excluding 12·77 $CaCO_3$:

$SiO_2$ 35·24 $Al_2O_3$ 4·48 $Fe_2O_3$ 23·13 FeO 25·09 $Na_2O$ 1·85 $H_2O$ 10·21 = 100.

From Milk-Row quarry, near Somerville, Mass., incrusting the sides of a fissure. Cf. hisingerite, p. .

EKMANNITE *L. J. Igelström*, Öfv. Ak. Stockh., **22**, 607, 1865, B. H. Ztg., **26**, 21, 1867.

Foliated. chlorite-like. Also foliated columnar and asbestiform, radiated; also granular massive, consisting of minute scales. Hardness and luster as in common kinds of chlorite. Color grass-green, leek-green, grayish white; also black.

Anal.—1–6, Igelström :

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Fol.-mass., *grass-gn.* | 34·30 | *tr.* | 4·97 | 35·78 | 11·45 | 2·99 | — | 10·51 | = 100 |
| 2. Fol.-col., *gyh.-w.* | 36·42 | 1·07 | 4·79 | 24·27 | 21·56 | *tr.* | *tr.* | 9·91 | = 98·02 |
| 3. Fol.-mass., *leek-gn.* | 40·30 | 5·08 | 3·60 | 25·54 | 7·13 | 7·64 | — | 10·74 | = 100 |
| 4. Gran.-mass., *grass-gn.* | 37·07 | 5·85 | — | 38·20 | | 6·32 | 2·73 | 9·71 | = 99·88 |
| 5. Asbestif., *green* | 37·69 | — | — | 36·07[a] | 14·74 | | — | 11·50 | = 100 |
| 6. Fol.-mass., *green* | 36·82 | 3·63 | — | 31·09 | 9·29 | 7·53 | *tr.* | 10·71 | = 99·07 |

[a] With perhaps some alumina.

On heating yields water, becomes black, submetallic, and after ignition strongly magnetic. B.B. fuses to a black slag. Soluble in hydrochloric acid, with a deposition of silica.

From a mine of magnetite at Grythytte, in Sweden, filling cavities in the ore, penetrating it extensively, and constituting nodular masses and beds. Becomes black on exposure, through oxidation. Anal. 4 is of the green interior of a nodule which was black externally. Some of it contains calcium carbonate, and some affords when heated a bituminous odor. Named after G. Ekman, proprietor of the mine, hence properly *ekmanite*. See p. 1033.

BERLAUITE *A. Schrauf*, Zs. Kr., **6**, 383, 1882. An alteration-product occurring at Krems, Bohemia, at the contact between serpentine and granulyte. Occurs in aggregates of small scales of a dark grass-green color. Axial angle nearly zero. On ignition does not change form, but becomes light yellowish brown with pearly luster resembling mica. Analysis, 1*a*, air-dried; 1*b*, dried at 100°.

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | ign. | |
|---|---|---|---|---|---|---|---|
| 34·38 | 12·69 | 6·33 | 3·71 | 23·79 | 2·59 | 16·79 | $Cr_2O_3$,MnO,$K_2O$ *tr.* = 100·28 |
| 37·25 | 13·75 | 6·86 | 4·02 | 25·77 | 2·81 | 9·82 | |

Schrauf (ibid.) uses the name *parachlorite* for chlorites whose composition he refers to the orthosilicate formula $m(Al_4Si_3O_{12}).n(R_2SiO_4).pH_2O$; while he applies the name *protochlorite* to those which he explains as $m(Al_2SiO_5).n(R_2SiO_4).p(H_2O)$.

STEATARGILLITE *E. E. Schmid*, Ber. Ges. Jena, **14**, July 9, 1880. A doubtful substance, filling, with quartz and ferrite, small amygdaloidal cavities in the porphyritic rocks of the Höllekopf, at Kammerberg, and of the Tragberg, at Langewiesen, near Ilmenau. Massive, earthy. H. = 1·25. G. = 2·29–2·46. Color white to light green. Feel greasy. B.B. fuses to a greenish gray-black specked enamel; yields much water in the tube, becoming black, and giving a bituminous odor. Analyses: 1–3, after deducting 6 p. c. insol. from 1, and 2 p. c. from 3.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Höllekopf, *grn.* | 2·287 | 37·20 | 8·09 | 25·56 | 3·78 | 15·56 | 0·98 | 8·70[a] | = 99·36 |
| 2. Tragberg, *wh.* | 2·465 | 32·77 | 11·12 | 17·73 | 12·51 | 14·19 | 0·91 | 9·77[b] | = 99·00 |
| 3. Höllekopf, *grn.* | 2·307 | 38·67 | 10·69 | 24·72 | 0·95 | 12·95 | 1·36 | 9·65[c] | = 98·99 |

[a] In vacuo, at ordinary temperature, 1·91; at 100° 3·90. [b] Do. 4·55, 2·52. [c] Do. 0·70, 7·27.

PATTERSONITE *I. Lea*, Proc. Ac. Philad., 45, 1867. A micaceous mineral from Unionville, Chester Co., Penn. An analysis by Genth (Am. Phil. Soc., **13**, 1873) gave:

| G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | $K_2O$ | $Na_2O$ | ign. |
|---|---|---|---|---|---|---|---|---|
| 2·81 | 29·90 | 27·59 | 3·12 | 9·17 | 17·10 | 2·33 | 0·58 | 11·51 = 101·30 |

It is hence near thuringite. An earlier, less accurate, analysis is given by S. P. Sharples Am. J. Sc., **47**, 319, 1869.

A CHLORITE-LIKE mineral from Webster, N. C., in crystals, micaceous in structure, of a dark bluish to brownish green color, afforded Genth, Am. J. Sc., **33**, 200, 1862:

| $SiO_2$ | $Al_2O_3$ | $Cr_2O_3$ | FeO | NiO | MgO | CaO | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| $\frac{2}{3}$ 31·45 | 13·08 | 4·16 | 4·88 | 0·16 | 43·10 | 0·17 | 0·06 | 3·29 = 100·35 |

It is remarkable for the small amount of water and iron, and the large proportion of magnesia; a constitution which may have an explanation in its being a mixture of talc and chlorite. It is associated with talc which Genth found to be nearly anhydrous.

CHLORITE-LIKE MINERAL, from the *Keuper* of Altenburg, *Haushofer*, J. pr. Ch., **99**, 239, 1866. Color dark leek-green. Stated to be B.B. infusible. Analysis gave: $SiO_2$ 29·51, $Al_2O_3$ 11·54, $Fe_2O_3$ 18·26, FeO 25·26, CaO 0·52, $H_2O$ 14·81 = 99 90.

BALTIMORITE. "Baltimorite," so called from Baltimore, afforded Hauer (Jb. G. Reichs., 1853): $SiO_2$ 27·15, $Al_2O_3$ 18·54, CaO 15·08, MgO 26·00, $H_2O$ 13·23 = 100. Hermann found in "Baltimorite" of a bluish color: $SiO_2$ 33·26. $Al_2O_3$ 7·23, $Cr_2O_3$ 4·34, FeO 2·89, MgO 38·56, $H_2O$ 12·44, $CO_2$ 1·30. Thomson, who instituted the species (Phil. Mag., **22**, 193, 1843) found for it the composition essentially of serpentine (see 5th Ed., anal. 77, p. 467). It is a good example of the indefinite mixtures that exist between serpentine and allied minerals.

DUMASITE *Delesse*, Dufr. Min., **3**, 790, 1847, **3**, 286, 1859. A chlorite lining cavities or fissures in certain melaphyres in the Vosges; color green; soft, and somewhat resembling clinochlore.

PRASILITE *T. Thomson*, Phil. Mag., **17**, 416, 1840. A leek-green fibrous mineral, soft as Venetian talc, from Kilpatrick Hills, the fibers loosely cohering, with G. = 2·311. Stated to consist of silica, magnesia, iron sesquioxide, and alumina, with probably soda, and 18 p. c. of water. Analysis not given. Probably a chlorite of some kind.

GRASTITE *J. B. Pearse*, Am. J. Sc., 37, 221, 1864. A chlorite from Texas, Lancaster Co., Penn., with 28·62 p. c. $SiO_2$; probably simply clinochlore, perhaps impure. Named in allusion to the color from *γράστις, grass.* See further 5th Ed., p. 501.

VIRIDITE *Vogelsang*, Zs. G. Ges., 24, 529, 1872. A collective name proposed for all the indeterminate *green* compounds of secondary origin observed in rocks, to be regarded as hydrous silicates of ferrous iron and magnesium. They are generally in scaly or fibrous forms and are often the result of the decomposition of amphibole, pyroxene, chrysolite, etc. The name is also used by Dathe (ib., **26**, p. 10), who discusses its relation to Liebe's diabantachronnyn (diabantite, p. 659) and Sandberger's aphrosiderite (p. 660); but cf. Rosenbusch, Mass. Gesteine, 183, 1886–87. "Viridite," as ordinarily used, probably includes several kinds of chlorite and perhaps also serpentine.

Gümbel has similarly used *chloropite* for the green chloritic constituent of much diabase.

## APPENDIX TO THE MICA DIVISION.—VERMICULITES.

The VERMICULITE GROUP includes a number of micaceous minerals, all hydrated silicates, in part closely related to the chlorites, but varying somewhat widely in composition. They are alteration-products chiefly of the micas, biotite, phlogopite, etc., and retain more or less perfectly the micaceous cleavage, and often show the negative optical character and small axial angle of the original species. Many of them are of a more or less indefinite chemical nature, and the composition varies with that of the original mineral and with the degree of alteration.

The laminæ in general are soft, pliable, and inelastic; the luster pearly or bronze-like, and the color varies from white to yellow and brown. Heated to 100°–110° or dried over sulphuric acid most of the vermiculites lose considerable water, up to 10 p. c., which is probably hygroscopic; at 300° another portion is often given off; and at a red heat a somewhat larger amount is expelled. Connected with the loss of water upon ignition is the common physical character of exfoliation; some of the kinds especially show this to a marked degree, slowly opening out, when heated gradually, into long worm-like threads. This character has given the name to the group, from the Latin *vermiculari, to breed worms.* The name was first given by T. H. Webb, see below.

The composition of the vermiculites has been discussed by Cooke, Proc Am. Acad., **9**, 44, 1874, **10**, 453, 1875. Tschermak, Ber. Ak. Wien, **100** (1), 92 *et seq.*, 1891. who ranks them as chlorites; Clarke & Schneider, Am. J. Sc., **40**, 452, 1890, **42**, 242, 1891. See further beyond.

### 480. JEFFERISITE.

Vermiculite? *G. J. Brush*, Am. J. Sc., **31**, 369, 1861. Jefferisite, *id.*, ib., **41**, 248, 1866. Culsageeite *J. P. Cooke*, Proc. Am. Acad., 48, 1874.

In broad crystals or crystalline plates. Surface of plates often triangularly marked, by the crossing of lines at angles of 60° and 120°.

Cleavage: basal, eminent. Flexible, almost brittle. H. = 1·5. G. = 2·30. Luster pearly on cleavage surface. Color dark yellowish brown and brownish yellow; light yellow by transmitted light; also greenish yellow. Optically biaxial, Dx.

**Comp.**—A hydrated mica, formula (Cooke) approximately $2\overset{II}{R}O.\overset{III}{R}_2O_3.5SiO_2.5H_2O$.

Cooke shows that the oxygen ratio, $\overset{II}{R} + \overset{III}{R} : Si : H = 1 : 2 : 2$, holds nearly true for a number of the vermiculites, as dried at 100°.

Clarke and Schneider deduce the empirical formula $H_{70}\overset{II}{R}_{53}\overset{III}{R}_{42}Si_{57}O_{255} + 82H_2O$; this is interpreted as approximately $\overset{I}{R}_3(AlO_2)MgSiO_4.3H_2O + H_2Mg_2Al_2(SiO_4)_3.3H_2O$, or a mixture in equal ratios of a *hydro-clintonite* and a *hydro-biotite*, both trihydrated, i.e., taking the mineral as air-dried.

**Anal.**—1, Brush, l. c. 2. Koenig, quoted by Genth. 3, Chatard, quoted by Genth, l. c. 4, Clarke & Schneider, Am. J. Sc., 40, 452, 1890. 5, Koenig, ib. 6, Chatard, ibid. 7, Cooke, l. c. 8, Id., Proc. Am. Acad., 454, 1875.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. West Chester | | 37·10 | 17·57 | 10·54 | 1·26 | 19·65 | 13·76 | CaO 0·56, $K_2O$ 0·43 = 100·87 |
| 2. " | | 33·35 | 17·78 | 7·32 | 2·11 | 19·26 | 19·87 | = 99·69 |
| 3. " | | 34·40 | 16·63 | 8·00 | 2·11[a] | 19·30 | 19·03 | = 99·47 |
| 4. " | | 34·20 | 16·58 | 7 41 | 1·13 | 20·41 | 21·14 | = 100·87 |
| *Culsageeite.* | | | | | | | | |
| 5. Culsagee | | 33·93 | 17·38 | 5·42 | 0·52 | 23·43 | 19·17 | NiO 0·35 = 100·18 |
| 6. " | | 33·77 | 17·56 | 5·61 | 0·50[a] | 22·48 | 20·30 | = 100·22 |
| 7. " | | $\frac{3}{3}$ 37·37 | 19·90 | 5·95 | 0·58 | 25·26 | 11·09 | = 100·15 |
| 8. *Pelhamite* | 2·16 | $\frac{3}{3}$ 41·27 | 15·19 | 4·14 | — | 28·25 | 11·32 | = 100·17 |

[a] Koenig's determination.

Anal. 1 and 7 on material dried over sulphuric acid; anal. 2–6 on air-dried material, deducting the hygroscopic moisture, these analyses agree with 1 and 7, as shown by Cooke.

Loss of water for anal. 1 and 4:

| | $H_2SO_4$ | 100° | 220° | red heat | wh. heat |
|---|---|---|---|---|---|
| 1. | 4·19 | 3·74 | 4·17 | 5·85 | |
| | | | 250°–300° | | |
| 4. | 10·56 | | 4·20 | 6·18 | 0·20 |

Clarke and Schneider found that gaseous hydrochloric acid at 383° to 412° after 32 hours removed 3·98 MgO and 1·38 $R_2O_3$. After strong ignition and subsequent digestion in acid for three days, 51·08 p. c. of insoluble residue remained, which gave: $SiO_4$ 45·08, $Al_2O_3$ 22·82, $Fe_2O_3$ 10·01, MgO 21·48 = 99·39.

**Pyr., etc.**—When heated to 300° C. exfoliates very remarkably (like vermiculite, see below); B.B. in forceps after exfoliation becomes pearly-white and opaque, and ultimately fuses to a dark gray mass. With the fluxes reactions for silica and iron. Decomposed by hydrochloric acid.

**Obs.**—Occurs in veins in serpentine at West Chester, Pa. Plates often several inches across. Named after W. W. Jefferis of West Chester, Pa.

*Culsageeite* is from the Culsagee corundum mine, near Franklin, Macon Co., N. Carolina.

*Pelhamite* is from Pelham, Mass., color greenish yellow.

A foliated mineral similarly exfoliating occurs coarse-granular massive, according to R. Pumpelly, in Japan, in the mountains of the peninsula of Kadzusa, S.E. of Yedo.

A "vermiculite-granite" is described by Parke as occurring in Walney Is., N. Lancashire, England, Proc. Yorkshire G. Soc., **4**, 254, 1877.

VERMICULITE *T. H. Webb*, Am. J. Sc., **7**, 55, 1824.

Occurs in small foliated scales, distributed through a steatitic base, and hence scaly-massive. H. = 1–2; G. = 2·756 Crossley; luster somewhat talc-like; color grayish, somewhat brownish. Anal.—Crossley, Dana Min., 3d Ed., 291, 1850.

| $SiO_2$ | $Al_2O_3$ | FeO | MgO | $H_2O$ | |
|---|---|---|---|---|---|
| 35·74 | 16·42 | 10·02[a] | 27·44 | 10·30 | = 99·94 |

[a] The iron is probably mostly present as $Fe_2O_3$, Cooke.

When heated exfoliates remarkably, the scales opening out into long, worm-like threads, made up of the separate folia. Exfoliation commences at 500° to 600° F., and takes place with so much force as often to break the test-tube in which the mineral may be confined. B.B. fuses at 3·5 to a grayish black glass.

Occurs at Milbury, near Worcester, Mass.

KERRITE *Genth*, Am. Phil. Soc., **13**, 396, 1873.

In fine scales, presenting no definite shape under the microscope. Very soft. G. = 2·303 Chatard. Color pale greenish yellow, with tint of brown; luster pearly.

Anal.—1, Chatard, quoted by Genth, l. c. 2, Clarke & Schneider, Am. J. Sc., **40**, 452, 1890.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | (Ni,Co)O | MgO | ign. | |
|---|---|---|---|---|---|---|---|---|
| 1. | $\frac{2}{2}$ 38·29 | 11·41 | 1·95 | 0·32 | 0·25 | 26·40 | 21·25 | = 99·87 |
| 2. | 38·13 | 11·22 | 2·28 | 0·18 | 0·48[a] | 27·39 | 20·47 | = 100·15 |

[a] CoO *tr.*

Anal. 2 on air-dried material. Loss of water as follows:

| $H_2SO_4$ | 105° | 250°–300° | red heat | wh. heat |
|---|---|---|---|---|
| 9·62 | 0·24 | 4·10 | 6·27 | 0·24 |

For a discussion of the composition see Clarke & Schneider, l. c., who show that it is essentially a trihydrated phlogopite, with alkalies replaced by hydrogen; over $H_2SO_4$ it becomes monohydrated.

Exfoliates upon heating, but not to such an extent as jefferisite. B.B. fuses to a white enamel. Decomposed by hydrochloric acid with separation of silica in pearly scales. Found as an apparent result of the alteration of chlorite at the corundum locality, Culsagee mine, near Franklin, Macon Co., N. Carolina. Named from Prof. W. C. Kerr (d. 1885), State Geologist of North Carolina.

LUCASITE *T. M. Chatard*, Am. J. Sc., **32**, 375, 1886.

Foliated, compact, and disseminated; folia small. G. = 2·613. Luster submetallic, bronze-like. Color yellowish brown. Optically biaxial. Axial angle small.

Anal.—Chatard, l c. 1, air-dried material; 2, calculated for dried at 110°.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Cr_2O_3$ | FeO | MnO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$(rd.ht.) | $H_2O$(110°) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\frac{2}{2}$ | 39·81 | 12·99 | 5·29 | 0·54 | 0·11 | 0·05 | 24·83 | 0·14 | 5·76 | 0·20 | 6·98 | 3·78 = 100·48 |
| | 41·17 | 13·43 | 5·47 | 0·56 | 0·11 | 0·05 | 25·68 | 0·14 | 5·96 | 0·21 | 7·22 | — = 100 |

Exfoliates largely upon ignition. Easily decomposed by hydrochloric acid, leaving the silica in pearly scales. Occurs with actinolite at Corundum Hill, Macon Co., N. C. Named for Dr. H. S. Lucas, prominently connected with the development of corundum mines in Massachusetts and N. Carolina.

LENNILITE. Lernilith (wrong orthogr.) *Schrauf*, Zs. Kr., **6**, 350, 1882.

A vermiculite from Lenni, Delaware Co., Penn. Also a similar mineral from the serpentine region of Bohemia at Krems (or Křemže) is included here. The Lenni mineral is in part silver-white (anal. 3), also bronze-brown (anal. 4), and dark green, resembling clinochlore (anal. 5).

Anal.—1, Schrauf, l. c. 2, Gooch, quoted by Cooke, Proc. Am. Acad., 453, 1875. 3–5, Clarke & Schneider, Am. J. Sc., **42**, 245, 1891.

| | | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Cr_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1*a*. Krems | | 35·83 | — | 12·39 | 2·97 | *tr.* | 2·35 | — | 26·33 | 0·42 | 19·60 = 99·89 |
| 1*b*. " | | 38·88 | — | 13·45 | 3·22 | — | 2·55 | — | 28·57 | 0·45 | 12·75 = 99·87 |
| 2. Lenni, Pa. | $\frac{3}{3}$ | 38·03 | — | 12·93 | 7·02 | — | 0·50 | — | 29·64 | — | 11·68 = 99·80 |
| 3. " " | | 36·72 | 0·18 | 10·06 | 5·37 | 0·26 | 0·12 | 0·51[a] | 29·40 | — | 17·77 = 100·39 |
| 4. " " | | 35·09 | 0·58 | 12·05 | 6·67 | 0·46 | 0·11 | 0·47[a] | 27·62 | *tr.*[c] | 16·90 = 99·95 |
| 5. " " | | 34·90 | 0·10 | 10·60 | 8·57 | 0·23 | 0·22 | 0·36[b] | 28·21 | — | 16·47 = 99·66 |

[a] Incl. 0·20 NiO. [b] 0·19 NiO. [c] BaO.

Anal. 1*a*, on air-dried material; 1*b*, dried at 100°; 3, 4, 5, on material dried over $H_2SO_4$.

| | $H_2SO_4$ | Also 105° | 250°–300° | red ht. |
|---|---|---|---|---|
| 3. | 6·92 | 6·40 | 2·68 | 8·69 |
| 4. | 5·84 | 5·70 | 1·98 | 9·22 |
| 5. | 5·21 | 4·99 | 1·60 | 9·88 |

For a discussion of the composition, see Clarke and Schneider, l. c.

HALLITE *Leeds*, Journ. Frank. Inst., **62**, 70, 1871. *J. P. Cooke*, Proc. Am. Ac. Boston, 59, 1874.

Occurs in large rough six-sided prisms with easy micaceous cleavage. Color in some varieties green, in others yellow. G. = 2·40. Exhibits asterism, and shows symmetrically arranged inclusions under the microscope.

Anal.—1, 2, C. E. Munroe, quoted by Cooke, l. c. 3, Clarke and Schneider, Am. J. Sc., **42**, 244, 1891.

| | G. | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. *Green* | 2·402 | $\frac{2}{2}$ | 35·89 | 7·45 | 8·78 | 1·13 | — | 31·45 | 0·46 | 14·33 = 99·49 |
| 2. *Yellow* | 2·398 | $\frac{3}{2}$ | 35·26 | 7·58 | 9·68 | 0·32 | *tr.* | 31·51 | 0·61 | 14·78 = 99·74 |
| 3. *Bl. green* | | | 35·54 | 9·74 | 9·07 | 0·28[a] | 0·41 | 30·05 | — | 14·78 $TiO_2$ *und.* = 99·87 |

[a] Incl. 0·16 NiO.

In anal. 3, $H_2O$ at 105°, 2·64 p. c.; 250°–300°, 1·23; red ht., 10·91.

For a discussion of composition, see Clarke and Schneider, l. c.

Found at East Nottingham, 3 miles south of Oxford, Chester Co., Penn., in nests or pockets in the serpentine formation. Named after Mr. John Hall, of Philadelphia.

PAINTERITE *Jefferis;* Clarke and Schneider, Am. J. Sc., **42**, 247, 1892.

Includes a dull green vermiculite with axial angle of 25°; from the Corundum mine in Newlin township, Chester Co., Penn. Also a golden yellow mineral, strongly exfoliating, found on the farm of James Painter, Middletown, Delaware Co., Penn.

Anal.—1–3, Clarke and Schneider, Am. J. Sc., **42**, 248, 1891.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | NiO | MgO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 1. Newlin | 31·23 | 17·52 | 4·84[a] | 1·20 | 0·20 | 0·33 | 31·36 | 13·63 = 100·31 |
| 2. Middletown | 34·86 | 11 64 | 3·78 | 0·20 | — | 0·14 | 31·32 | 18·42 CaO 0·07 = 100·43 |
| 3. " | 33·95 | 12·52 | 4·40 | 0·20 | *tr.* | 0·23 | 30·56 | 18·61 = 100·47 |

[a] Incl. 0·14 $Cr_2O_3$.

Water determinations:

| | 105° | 250°–300° | ignition. |
|---|---|---|---|
| 1. | 1·08 | 0·40 | 12·15 |
| 2. | 1·64 | 1·03 | 15·75 |
| 3. | 1·56 | 0 59 | 16·46 |

On the results of treatment with HCl gas and a discussion of composition, see Clarke and Schneider, l. c., who show that painterite should probably be classed as a chlorite.

PHILADELPHITE *H. C. Lewis*, Proc. Ac. Philad., Dec. 22, 1879.

In contorted and wrinkled plates, with micaceous structure. Laminæ inelastic. H. = 1·5. G. = 2·80. Luster pearly. Color brownish red. Axial angle 31° 20′ to 39° 30′.

Anal.—1, Haines, quoted by Lewis. 2, Lewis, l. c.

| G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 2·87 | $\frac{2}{2}$ 38·79 | 14·78 | 20·30 | 2·04 | — | 11·40 | 1·03 | 0·77 | 6·75 | 4·27 = 100·13 |
| 2·80 | $\frac{2}{2}$ 35·73 | 15·77 | 19·46 | 2·18 | 0·64[a] | 11·56 | 1·46 | 0·90 | 6·81 | 4·34 $TiO_2$ 1·03, [$V_2O_5$ 0·37, $P_2O_5$ 0·11 = 100·36 |

[a] Incl. 0·06 (Ni,Co)O, 0·08 CuO.

Material for above dried at 100°; hygroscopic water 3·28 in 1, and 3·24 in 2.

B.B. exfoliates largely; on heating (150°–160°) expanded to ten times its volume; a small fragment exfoliating raised 50,000 times its own weight. Slowly dissolved in hydrochloric acid.

From the hornblendic gneiss near Philadelphia on Germantown Avenue near Wayne Station.

PROTOVERMICULITE *G. A. König*, Proc. Ac. Nat. Sc. Philad., 269, 1877.

Micaceous structure. H. = 2. G. = 2·269. Color yellowish silvery to bronze. Optic-axial angle small. From Magnet Cove, Arkansas; a similar hydrobiotite from Henderson Co., N. Carolina, has been examined by Clarke and Schneider.

Anal.—1, Koenig, l. c. 2, 3, Clarke and Schneider, Am. J. Sc., **42**, 242, 1891.

| | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Magnet Cove | 33·28 | *tr.* | 14·88 | 6·36 | 0·57 | *tr.* | 21·52 | — | — | 23·90 = 100·51 |
| 2. " | 34·03 | *und.* | 14·49 | 7·71 | 0·14 | 0·09 | 20·89 | 1·88 | — | 21·19 = 100·42 |
| 3. Henderson Co. | 38·18 | 1·68 | 14·02 | 13·02 | 2·22 | 0·38 | 14·62 | 0·23[a] | 5·88[b] | 10·52 = 100·75 |

[a] Incl. 0 06 BaO. [b] 0 48 $Na_2O$.

Anal. 1, on air-dried material which lost 20·54 over $H_2SO_4$. The material of 2 and 3 dried over $H_2SO_4$ having lost: 2, 11·34 p. c. 3, 3·20 p. c. Also

| | 105° | 250°–300° | Above 300° |
|---|---|---|---|
| 2. | 11·23 | 4·55 | 5·41 |
| 3. | 3·20 | 2·52 | 4·80 |

Clarke and Schneider conclude that protovermiculite is essentially a trihydrated hydrophlogopite and hydroclintonite in the ratio of 1 : 1. The Henderson Co. mineral is a biotite about half way transformed into a vermiculite.

VAALITE *Maskelyne* and *Flight*, Q. J. G. Soc., **30**, 409, Nov., 1874.

In hexagonal prisms. Axial angle very small. Bx nearly ⊥ *c*. Color drab, in spots fine blue. Analysis:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MgO | $Na_2O$ | $H_2O$[a] | $CO_2$ | $Cr_2O_3$ |
|---|---|---|---|---|---|---|---|
| 40·83 | 9·80 | 6·84 | 31·34 | 0·67 | 9·72 | *tr.* | *tr.* = 99·20 |

[a] Lost at a low red heat; also from 125°–130°, 1·95 p. c.

Expands on heating on a platinum foil to six times its original size; in powder no expansion at all. Loses no water at 100° C. Occurs in an altered peridotyte from the diamond-diggings, called Du Toit's Pan, S. Africa (cf. p. 5). Named after the Vaal river.

MACONITE *Genth*, Am. Phil. Soc., **13**, 396, 1873.

In irregular scales, resembling a variety of jefferisite. Soft, but slightly harder than kerrite.

G. = 2·827 Chatard. Color dark brown; luster pearly, inclining to sub-metallic. Anal.—Chatard and Genth, l. c.

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | (Ni,Co)O | MgO | $K_2O$ | $Na_2O$ | $Li_2O$ | ign. |
|---|---|---|---|---|---|---|---|---|---|
| $\frac{2}{2}$ 34·22 | 21·53 | 12·41 | 0·32 | 0·12 | 14·46 | 5·70 | 0·51 | *tr.* | 11·85 = 101·12 |

Exfoliates largely on heating, and fuses with difficulty to a brown glass; easily decomposed by hydrochloric acid, with separation of silica in scales.

Contains numerous fragments of corundum, and some microscopic reddish brown crystals which may be titanite. Found, as an apparent result of the alteration of chlorite, at the corundum locality, Culsagee Mine, near Franklin, Macon Co., N. Carolina.

**Dudleyite** *Genth*, Am. Phil. Soc., 13, 404, 1873.

Has the form of margarite, from the alteration of which it has been made. Color soft bronze, or brownish yellow; luster pearly. Anal.—Genth, l. c.

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | $Li_2O$ | $Na_2O$ | $K_2O$ | ign. |
|---|---|---|---|---|---|---|---|---|
| 32·42 | 28·42 | 4·99 | 1·72 | 16·87 | 0·19 | 1·52 | 0·56 | 13·43 = 100·12 |

Exfoliates slightly on heating, and fuses with difficulty to a brownish yellow blebby mass. Easily decomposed by hydrochloric acid with separation of silica in scales. Found at the Cullakenee Mine, Clay Co., N. Carolina, and in larger quantity with margarite at Dudleyville, Alabama.

**Pyrosclerite.** Pyrosklerit *v. Kobell*, J. pr. Ch., 2, 53, 1834.

Cleavage: basal eminent or micaceous; in a transverse direction at right angles to the former, in traces. H. = 3. G. = 2·74. Luster of cleavage surface weak pearly. Color apple- to emerald-green.

Anal.—1, Kobell, l. c. 2, Leeds, Am. J. Sc., 6, 22, 1873.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | Alk. | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 1. Elba | 2·74 | 37·03 | 13·50 | 1·43[a] | 3·52 | 31·62 | — | 11·00 = 98·10 |
| 2. Bare Hills, Md. | 2·558 | $\frac{2}{2}$ 35·99 | 9·52 | 5·35 | 1·08 | 32·94 | 0·41 | 14·60 = 99·89 |

[a] $Cr_2O_3$

B.B. fuses at 3·8–4 to a grayish glass. With the fluxes reacts for chromium and iron. Decomposed by hydrochloric acid with gelatinization.

Occurs with chonicrite, constituting seams in serpentine, near Porto Ferrajo, Elba. It is probably derived from some form of pyroxene (diallage), the cleavage of which it retains in part. Named from πῦρ, *fire*, and σκληρός, *hard* (refractory).

A related mineral occurs at the "Magnesia mines" of the Bare Hills, Maryland, in grayish to bronze-yellow folia; optically biaxial. Forms a vertical seam between deweylite on one side and talc on the other. Cf. anal. 2.

For analysis also of another related mineral from St. Marie-aux-Mines, Alsace, see Knop, Jb. Min., 70, 1875.

**Roseite.** A much altered mica found by Dr. Rose in East (or West) Nottingham, Chester Co., Penn. Soft, like talc; luster pearly; color nearly pale brownish yellow. Analysis, quoted by A. J. Moses, Sch. Mines Q., 12, 73, 1891.

$SiO_2$ 35·38 $Al_2O_3$ 30·30 MgO 14·66 $H_2O$ 19·88 = 100·32

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Some other alteration-products of biotite, allied to the vermiculites (voigtite, etc.), are mentioned on p. 632.

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**Willcoxite** *Genth*, Am. Phil. Soc., 13, 397, 1873.

In scales white to greenish or grayish white, with pearly luster, resembling talc. Anal.—Koenig, quoted by Genth, l. c.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | $Li_2O$ | $Na_2O$ | $K_2O$ | ign. |
|---|---|---|---|---|---|---|---|---|---|
| 1. Shooting Creek | 28·96 | 37·49 | 1·26 | 2·44 | 17·35 | *tr.* | 6·73 | 2·46 | 4·00 = 100·69 |
| 2. Cullakenee M. | 29·50 | 37·56 | 1·40 | 2·38 | 17·20 | *tr.* | 6·24 | 2·42 | 3·32 = 100·02 |

B.B. fuses in fine splinters with difficulty to a white enamel, coloring the outer flame yellow. In hydrochloric acid decomposed with difficulty, with separation of silica in scales. Occurs as a coating about a nucleus of corundum, and resulting from its alteration, at Shooting Creek and Cullakenee Mine, Clay Co., No. Carolina.

Named after Col. Joseph Willcox.

## III. Serpentine and Talc Division.

The leading species belonging here, Serpentine and Talc, are closely related to the Chlorite Group of the Mica Division preceding, as noted beyond. Some other magnesium silicates, in part amorphous, are included with them.

| | | |
|---|---|---|
| 481. Serpentine | $H_4Mg_3Si_2O_9$ | Monoclinic |
| 482. Deweylite | $H_4Mg_4(SiO_4)_3 + 4H_2O$ | |
| 483. Genthite | $H_4Mg_2Ni_2(SiO_4)_3 + 4H_2O$ | |
| Garnierite | | |
| 484. Talc | $H_2Mg_3(SiO_3)_4$ | Monoclinic |
| 485. Sepiolite | $H_4Mg_2Si_3O_{10}$ | |
| 486. Connarite | $H_4Ni_2Si_3O_{10}$ | |
| 487. Spadaite | $H_8Mg_5Si_6O_{21}$ | |

| | | |
|---|---|---|
| 488. Saponite | | |
| 489. Celadonite | | |
| 490. Glauconite | | |
| 491. Pholidolite | $H_{10}K_2(Fe,Mg)_{12}Al_2Si_{13}O_{52}$ | Monoclinic? |

**481. SERPENTINE.** *'Οφίτης* pt. *Dioscor.*, **5**, 161. Ophites pt. *Vitruv.*, *Plin.* Ophitæ, Serpentaria, *Agric.*, Foss., 304, 309, 1546. Marmor Serpentinum, M. Zeblicium, Serpenstein Germanice, Lapis Serpentinus, *B. de Boot*, 1636, pp. 502, 504. Telgsten pt., Ollaris pt., Marmor Serpentinum, M. Zöblizense, Lapis Colubrinus, *Wall.*, 135, 1747. Serpentine *Fr. Trl.* Wall, 1753. Serpentin, Zöblitzer S., *Cronst.*, 76, 1758.

VARIETIES.—Retinalite *Thomson*, Min., **1**, 201, 1836. Vorhauserite *Kenngott*, Min. Forsch., p. 71, 1856–57. Bowenite *Dana*, Min., 265, 1850; Nephrite *Bowen*, Am. J. Sc., **5**, 346, 1822. Antigorite *Schweizer*, Pogg., **49**, 595, 1840 Williamsite *Shepard*, Am. J. Sc., **6**, 249, 1848. Marmolite *Nuttall*, Am. J. Sc., **4**, 19, 1822; *Vanuxem*, J. Acad. Sc. Philad., **3**, 133, 1823. Thermophyllite *A. E. Nordenskiöld*, Beskr. Fin. Min., 160, 1855; *Hermann*, J. pr. Ch., **73**, 213, 1858. Chrysotile *Kobell*, J. pr. Ch., **2**, 297, 1834, **30**, 467, 1843; Schillernder Asbest, Amianthus pt Bostonite. Picrolite *Hausmann*, Moll's Efem., **4**, 401, 1808. Metaxite *Breithaupt*, Char., 113, 326, 1832 Baltimorite *Thomson*, Phil. Mag., **22**, 191, 1843. Zermattite *N. Nordenskiöld*, At. Ch. Min. Syst., 132, 1848.

Monoclinic. In distinct crystals, but only as pseudomorphs. Sometimes foliated, folia rarely separable; also delicately fibrous, the fibers often easily separable, and either flexible or brittle. Usually massive, but microscopically finely fibrous and felted, also fine granular to impalpable or cryptocrystalline; slaty. Crystalline in structure but often by compensation nearly isotropic; amorphous.

Cleavage *b* (010), sometimes distinct; also prismatic (50°) in chrysotile (Brauns). Fracture usually conchoidal or splintery. Feel smooth, sometimes greasy. H. = 2·5–4, rarely 5·5. G. = 2·50–2·65; some fibrous varieties 2·2–2·3; retinalite, 2·36–2·55. Luster subresinous to greasy, pearly, earthy; resin-like, or wax-like; usually feeble. Color leek-green, blackish green; oil- and siskin-green; brownish red, brownish yellow; none bright; sometimes nearly white. On exposure, often becoming yellowish gray. Streak white, slightly shining. Translucent to opaque.

Pleochroism feeble. Optically −, perhaps also + in chrysotile. Double refraction weak. Ax. pl. $\parallel a$ (100). Bx $(\mathfrak{a}) \perp b$ (010) the cleavage surface; $\mathfrak{c} \parallel$ elongation of fibers. Biaxial, angle variable, often large: 2E = 16° to 98° Tschermak. 2V = 20° to 90° Lévy-Lcx. Dispersion $\rho > v$.

*Antigorite*, $2E = 27°$, $\beta = 1·574$ Dx.
*Chrysotile* 2V variable, up to 30° Lévy-Lcx.
" Reichenstein $2E = 16° 30'$ Reusch, 24° Hare Amelose $2E = 50°$ Brauns.

Indices:
*Antigorite* $\alpha = 1·560$ $\beta = 1·570$ $\gamma = 1·571$ $\gamma - \alpha = 0·011$ Lévy-Lcx.

Statements in regard to the optical character, axial angle, etc., are somewhat conflicting, cf. Rosenbusch, Lévy-Lcx. *et al.* (ref. p. 674).

Hussak describes a pale green foliated mineral making up the mass of the serpentine of Sprechenstein, Sterzing, Tyrol, which yields folia with basal cleavage; pleochroism rather strong; optically −; Bx ⊥ cleavage; axial angle small (20° Tsch.). Tschermak regards this variety as intermediate between normal serpentine and penninite; chemically it contains 3·8 p. c. $Al_2O_3$, anal. 32.

**Var.**—Many unsustained species have been made out of serpentine, differing in structure (massive, slaty, foliated, fibrous), or, as supposed, in chemical composition; and these now, in part, stand as varieties, along with some others based on variations in texture, etc.

A. In CRYSTALS—PSEUDOMORPHS. The most common have the form of chrysolite. Other kinds are pseudomorphs after pyroxene, amphibole, spinel, chondrodite, garnet, phlogopite, titanite, chromite, etc.

Thus at the Tilly Foster magnetite mine, Brewster, N. Y., serpentine occurs on a large scale both massive and distinctly pseudomorphous, the latter after enstatite, chondrodite, amphibole, clinochlore, biotite, brucite; probably also after calcite, apatite, dolomite; further in forms showing a perfect cubic parting (anal. 12, 13), and assumed to be pseudomorphous after an unknown mineral (periclase?, Tschermak). G. Friedel has examined these cubic forms (Bull. Soc. Min., **14**, 120, 1891) and shows that the serpentine is in part crystalline (opt. −, biaxial, $\gamma - \alpha = 0·005$), in part amorphous, and argues that the pseudo-cubic structure belongs to the serpentine itself and is not due to some other original mineral.

*Bastite* or *Schiller Spar* is enstatite (hypersthene) altered more or less completely to serpentine. See description on p. 351.

B. MASSIVE. 1. *Ordinary massive.* (*a*) *Precious* or *Noble Serpentine* (Edler Serpentin *Germ.*) is of a rich oil-green color, of pale or dark shades, and translucent even when in thick pieces; and (*b*) *Common Serpentine,* when of dark shades of color, and subtranslucent. The former has a hardness of 2·5–3; the latter often of 4 or beyond, owing to impurities.

2. *Resinous. Retinalite.* Massive, having honey-yellow to light oil-green colors, and waxy or resin-like luster and aspect. H. = 3·5; G. = 2·47–2·52, Grenville, Hunt, 2·36–2·38, Calumet Id., Hunt. It much resembles deweylite. It affords, on analysis, 3 p. c. more of water than ordinary serpentine; and the mineral may be a mixture of serpentine and deweylite. *Vorhauserite* is similar, though brown to greenish black in color. H. = 3·5; G. = 2·45. From the Fleimsthal, Tyrol.

3. *Porcellanous; Porcellophite.* The "meerschaum" of Taberg and Sala is a soft earthy serpentine, resembling meerschaum in external appearance (Berlin, Ak. H. Stockh., 1840). This variety is sometimes very soft when first taken out. A variety resembling compact lithomarge occurs at Middletown, Delaware Co., Pa. It has a smooth, porcelain-like fracture; H. = 3·5; G. = 2·48.

4. *Bowenite* (Nephrite *Bowen*). Massive, of very fine granular texture, and much resembles nephrite, and was long so called. It is apple-green or greenish white in color; G. = 2·594–2·787, Bowen; and it has the unusual hardness 5·5–6. From Smithfield, R. I.

A serpentine from New Zealand is referred here by Berwerth (l. c. and anal. 26). It is bright green, translucent; hardness = 5·5–6, on a polished surface; G. = 2·60. Used by the Maoris for objects of ornament and called by them *Tangiwai.*

A similar serpentine is described by C. A. McMahon (Min. Mag., **9**, 187, 1890) as used at Bhera, in the Shahpur district of the Punjab, for the manufacture of various small articles; it is called in Persian *Sang-i-yashm.* H. = 5. G. = 2·59. Color dark greenish gray to pale sea-green mottled with white; also said to be delicate apple-green. Structure finely fibrous, as seen under the microscope and as developed by digestion in sulphuric acid; extinction parallel, the greater axis corresponding with the direction of the fibers (anal. 27). Occurs in place in rock masses in one of the mountain gorges which run from the Safed Koh in the valley of the Kâbul river, Afghanistan.

C. LAMELLAR.

5. *Antigorite.* Thin lamellar in structure, easily separating into translucent or subtransparent folia; H. = 2·5; G. = 2·622; color brownish green by reflected light, and leek-green by transmitted; feel smooth, but not greasy. Optical characters more distinct than with most other varieties (see above). Named from the locality, Antigorio valley, Piedmont.

6. *Williamsite* Shepard. A lamellar impure serpentine, of apple-green color, with H. = 4·5 and G. = 2·59–2·64, from Texas, Pa. Graduates into a massive granular variety.

C. THIN FOLIATED.

7. *Marmolite.* Thin foliated: the laminæ brittle but easily separable, yet graduating into a variety in which they are not separable. G. = 2·41; luster pearly; colors greenish white, bluish white to pale asparagus-green. From Hoboken, N. J.

8. *Thermophyllite* occurs in small scaly crystals aggregated into masses, with an amorphous steatite-like base. B.B. crystals exfoliate like vermiculite or pyrophyllite. H. = 2·5; G. = 2·61. Luster of cleavage surface pearly; color light brown to silver-white and yellowish brown. From Hopansuo, Finland.

D. FIBROUS.

9. *Chrysotile.* Delicately fibrous, the fibers usually flexible and easily separating; luster silky, or silky metallic; color greenish white, green, olive-green, yellow, and brownish;

G. = 2·219. Often constitutes seams in serpentine. It includes most of the silky *amianthus* of serpentine rocks and much of what is popularly called *asbestus* (asbestos). The Canadian chrysotile is often called in the trade *Bostonite*. The original chrysotile was from Reichenstein.

10. *Picrolite*. Columnar, but fibers or columns not easily flexible, and often not easily separable, or affording only a long splintery fracture; color dark green to mountain-green, greenish, gray, and brown. The original was from Taberg, Sweden. *Metaxite*, picrolite, consisting of separable but brittle columns, of a greenish white color, and weak pearly luster; H. = 2–2·5; G. = 2·52. From Schwarzenberg. Passes into a laminated variety. *Baltimorite* is picrolite from Bare Hills, Md., of a grayish green color; silky luster, opaque, or subtranslucent, with H. = 2·5–3.

F. SERPENTINE ROCKS. Serpentine often constitutes rock-masses. It frequently occurs mixed with more or less of dolomite, magnesite, or calcite, making a rock of clouded green, sometimes veined with white or pale green, called *verd-antique*, *ophiolite*, or *ophicalcite*. Serpentine rock is sometimes mottled with red, or has something of the aspect of a red porphyry; the reddish portions containing an unusual amount of oxide of iron. Any serpentine rock cut into slabs and polished is called *serpentine marble*. Verde di Prato is a variety from near Florence.

Microscopic examination has established the fact that serpentine in rock-masses has been largely produced by the alteration of chrysolite, and many apparently homogeneous serpentines show more or less of this original mineral. In other cases it has resulted from the alteration of pyroxene or amphibole. Sections of the serpentine derived from chrysolite often show a peculiar structure, like the meshes of a net; the lines marked by grains of magnetite, following the original cracks and cleavage-directions of the chrysolite. The serpentine from pyroxene and amphibole commonly shows a characteristic grating structure.

**Comp.**—A magnesium silicate, $H_4Mg_3Si_2O_9$ or $3MgO.2SiO_2.2H_2O$ = Silica 44·1, magnesia 43·0, water 12·9 = 100. Iron protoxide often replaces a small part of the magnesium; nickel in small amount is sometimes present. The water is chiefly expelled at a red heat and hence must be all chemically combined, see below. The formula has also been written $H_2Mg_3Si_2O_8 + H_2O$, or as a hydrous orthosilicate.

Clarke and Schneider obtained on the serpentine of analyses quoted below, for the loss of water·

| | 105° | 250° | 383°–412° | 498°–527° | red ht. | white ht. |
|---|---|---|---|---|---|---|
| Anal. 16*a* | 0·96 | 0·55 | 0·27 | 0·23 | 12·37 | 0·28 |
| " 2 | 1·20 | 0·55 | | 13·01 | | |
| " 43 | 2·04 | 0·71 | 0·27 | 0·56 | 11·81 | 0·25 |
| " 38 | 1·53 | 0·44 | 0·62 | — | 10·58 | 0·04 |
| " 18 | 2·26 | 1·01 | 0·98 | 0·42 | 11·32 | 0·17 |

Further the same authors have determined the amount of bases, MgO and $R_2O_3$, removed as chlorides after heating from 41 to 78 hours at 383° to 412°, in dry hydrochloric acid gas, thus:

MgO 10·14 16·73 9·98 11·38 15·25. Also of $R_2O_3$ 0·43 0·66 0·51

It is inferred that the magnesium thus removed is present in the mineral as the group MgOH, and hence the formula is written $H_3(MgOH)Mg_2(SiO_4)_2$. Am. J. Sc., **40**, 308, 1890.

Tschermak, however, argues for the presence of two magnesium hydroxyl groups, giving the formula $H_2(MgOH)_2MgSi_2O_7$.

Serpentine is closely related to the chlorites, both optically (as noted above) and chemically as urged by Wartha, Földt. Közl., **16**, 79, 1886, Clarke and Schneider, l. c., and more particularly by Tschermak, Ber. Ak. Wien, **99** (1), 80, 1890, **100** (1), 32, 1891. Cf. also p. 643 *et seq.*

The following are typical analyses commencing with the massive varieties; many others are given in 5th Ed., pp. 466, 467; see also references below, p. 673.

In general the analyses agree remarkably well with the theoretical values considering the pseudomorphous character of the material. Alumina is often present, especially when the original mineral was aluminous; it is possible, as urged by Tschermak in the case of the Sprechenstein mineral, that the aluminous kinds are sometimes intermediate forms between serpentine and penninite, but this is not as yet sufficiently proved.

**Anal.**—1, Petersen, JB. Ch., 931, 1866. 2, Clarke and Schneider, Am. J. Sc., **40**, 308, 1890. 3, Helland, Pogg., **148**, 329, 1873. 4, Hudleston, Q. J. G. Soc., **33**, 925, 1877. 5–7, Collins, Q. J. G. Soc., **40**, 467, 1884. 8, J. A. Phillips, Phil. Mag., **41**, 101, 1871. 9, Breidenbaugh, Am. J. Sc., **6**, 210, 1873. 10, 11, Burt, ibid. 12, Allen, ib., **8**, 375, 1874. 13, G. Friedel, Bull. Soc. Min., **14**, 120, 1891. 14, Hunt, Rep. G. Canada, 483, 1853. 15, 16, Catlett, Proc. U. S. Mus., 109, 1888. 17, B. J. Harrington, Can. Rec. Sc., **4**, 93, 1890. 16*a*, 18, Clarke & Schneider, l. c. 19, Catlett, quoted by Merrill, Proc. Nat. Mus., **12**, 596, 1889. 20, 21, H. F. Keller, quoted by Genth, Am. Phil. Soc., **23**, 42, 1885. 22–24, Becker, U. S. G. Surv., Min., **13**, 110, 111, 1888. 25, Smith and Brush, Am. J. Sc., **15**, 212, 1853. 26, Berwerth, Ber. Ak. Wien, **80** (1), 116, 1879. 27, G. T. Prior, quoted by McMahon, Min. Mag., **9**, 187, 1890. 28, Burton, Dana, Min., 467, 1868. 29, Œllacher, Jb. G. Reichs., **7**, 360, 1857. 30, Brush, Am. J. Sc., **24**, 128, 1857. 31, Kobell, Ber. Ak. München, **4**, 166, 1874. 32, Hussak, Min. Mitth., **5**, 68, 1882. 33, Smith and Brush, Am. J. Sc., **15**, 212, 1853. 34, Garrett, Dana Min., 692, 1850. 35, Northcote, Phil. Mag., **16**, 263, 1858. 36, Friederici, Jb. Min., **1**, 163, 1882. 37, Rg., Min. Ch., 526. 1860. 38, Clarke and Schneider, l. c. 39, Melville, quoted by Wadsworth, Bost. Soc. N. H., **20**, 287, 1879. 40, Kobell, J. pr. Ch., **2**, 297, 1834. 41, Brauns, Jb. Min. Beil., **5**, 299, 1887. 42, Reakirt, Am. J. Sc., **18**, 410, 1854. 43, Clarke & Schneider, ibid., **40**, 308, 1890. 44, Brush, Dana, Min., 283, 1854. 45, 46, E. G. Smith, ib., **29**, 32, 1885. 47, Terreil, C. R., **100**, 251, 1885. 48–50, J. T. Donald, Eng. Mng. J., **51**, 741, 1891.

| | | G. | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| 1. | Newburyport, *prec.* | 2·804 | | 41·76 | *tr.* | — | 4·06 | 41·40 | 13·40 = 100·62 |
| 2. | " | | | 41·47 | 1·73 | | 0·09 | 41·70 | 15 06 = 100·05 |
| 3. | Snarum | 2·53 | | 42·72 | — | 0·06[a] | 2·25 | 42·52 | 13 39 = 100·94 |
| 4. | Cadgwith, *black* | 2·587 | | 38·50 | 1·02 | 4·66 | 3·31 | 36·40 | 12·35 CaO 1·97, NiO 0·59, [insol.. $FeS_2$ 1·78 = 100·58 |
| 5. | Porthalla, *grass-green* | 2·65 | | 38·60 | 0·10 | 11·55 | | 33·62 | 12·82 alk. and loss 3·31 [= 100 |
| 6. | " *oil-green* | 2·56 | | 37·15 | 5·60 | 1·10 | 8·80 | 32·80 | 14·16 CaO 0·10, alk. and [loss 0·29 = 100 |
| 7. | " *red-brown* | 2·545 | | 39·50 | 5·08 | 8·12 | | 34·65 | 12·55 alk. [0 10] = 100 |
| 8. | Lizard, *dark red* | | | 38·86 | 2·95 | 1·86 | 5·04 | 34·61 | 15·52 $Cr_2O_3$ 0·08, NiO [0·28, alk. 1·10 = 100·30 |
| 9. | Brewster, *white* | | $\frac{3}{2}$ | 42·28 | 0·86 | — | 2·57 | 40·29 | 12·52 CaO 1·35, $Na_2O$ [0·48 = 100·35 |
| 10. | " *green* | | $\frac{2}{2}$ | 41·43 | — | — | 2·10 | 40·18 | 13·81 CaO 0·95 = 98·49 |
| 11. | " *gray* | 2·4 | | 39·38 | 1·56 | — | 13·87 | 32·25 | 11·90 alk. 0·17 = 99·13 |
| 12. | " *cubic pseud.* | | | 41·87 | 2·30 | | — | 42·43 | 13·40 = 100 |
| 13. | " " " | 2·48 | | 41·98 | — | — | 2·87 | 41·38 | 13·78 = 100·01 |
| 14. | Calumet Id., *Retinalite* | | | 41·20 | — | 0·80 | | 43·52 | 15·40 = 100·92 |
| 15. | Montville, *green* | | | 40·23 | 2·18 | 4·02 | *tr.* | 39·46 | 14·24 = 100 13 |
| 16. | " *yellow* | | | 42·38 | 0·07 | 0·97 | 0·17 | 42·14 | 14·12 = 99·85 |
| 16*a*. | " *green* | | | 42·05 | — | 0·30 | 0·10 | 42·57 | 14·66 CaO 0·05 = 99·73 |
| 17. | Coleraine | 2·514 | | 43·13 | — | — | 0·37 | 42·05 | 13·88 Ca, Mn, NiO *tr.* = [99·43 |
| 18. | Corundum Hill, N. C. | | | 41·90 | 0·71 | 0·91 | *und.* | 40·16 | 16·16 NiO 0·10 = 99·94 |
| 19. | Port Henry, N. Y. | | | 42·17 | 0·30 | 1·57 | 0·64 | 41·33 | 13·72 = 99·73 |
| 20. | Berks Co., Pa. | | | 42·14 | — | — | 2·06 | 41·61 | 14·20 = 100·01 |
| 21. | " " | | | 41·46 | — | — | 0·99 | 44·68 | 14·07 = 101·20 |
| 22. | New Idria, Cal. | | | 41·54 | 2·48 | — | 1·37 | 40·42 | 14·17 NiO 0·04 = 100·02 |
| 23. | Sulphur Bank, *dark* | | | 39·64 | 1·59[b] | — | 7·76 | 37·13 | 13·81 NiO 0·33, MnO [0·12 = 100·38 |
| 24. | " " *light* | | | 41·86 | 0·93[c] | — | 4·15 | 38·63 | 14·16 NiO *tr.*, MnO 0·20 [= 99·93 |
| | *Bowenite.* | | | | | | | | |
| 25. | Smithfield, *yellow* | 2·57 | $\frac{3}{2}$ | 42·29 | *tr.* | — | 1·21 | 42·29 | 12·96 CaO 0·63 = 99·38 |
| 26. | New Zealand | 2·61 | | 44·77 | — | — | 3·35 | 39·17 | 12·94 = 100·23 |
| 27. | Afghanistan | 2·59 | | 44·73 | 0·32 | — | 0·33 | 42·64 | 12·21 CaO *tr.* = 100·23 |
| 28. | Middletown, *Porcellophite* | | $\frac{2}{2}$ | 44·08 | 0·30 | — | 1·17 | 40·87 | 13·70 CaO 0·37 = 100·49 |
| 29. | Monzoni, *Vorhauserite* | | | 41·21 | — | — | 1·72 | 39·24 | 16·16 MnO 0·30, apatite [0·96 = 99·59 |
| 30. | Antigora, *Antigorite* | | | 41·58 | 2·60 | — | 7·22 | 36·80 | 12·67 $Cr_2O_3$, NiO *tr.* = [100·87 |
| 31. | Zermatt, " | | | 42·73 | 1·33 | — | 7·20 | 36·51 | 11·66 $Cr_2O_3$, NiO *tr.* = [99·43 |
| 32. | Sprechenstein | | | 41·14 | 3·82 | 3·01 | — | 39·16 | 11·85 CaO 0·40 = 99·38 |
| 33. | *Williamsite* | | | 42·60 | *tr.* | — | 1·62 | 41·90 | 12·70 NiO 0·40 = 99·22 |
| 34. | Hoboken, *Marmolite* | | | 42·32 | 0·66 | — | 1·28 | 42·23 | 13·80 = 100 29 |
| 35. | Finland, *Thermophyllite* | 2·61 | $\frac{2}{2}$ | 41·48 | 5·49 | — | 1·59 | 37·42 | 10·88 $Na_2O$ 2·84 = 99·70 |
| 36. | Reichenstein, *Metaxite* | 2·549 | | 42·73 | *tr.* | — | 2·79 | 40·37 | 12·17 CaO 0·40, alk. 1·52 [= 99·98 |
| | *Picrolite.* | | | | | | | | |
| 37. | Texas, Pa. | 2·557 | | 43·79 | — | — | 2·05 | 41·03 | 12·47 = 99·34 |
| 38. | Buck Cr., N. C. | | | 42·94 | 1·72 | 3·33 | 1·88 | 36·53 | 13·21 NiO 0·61 = 100·22 |
| 39. | Florida, Mass. | | | 44·22 | 0·53 | 6·61 | — | 37·54 | 11·62[d] = 100·52 |

[a] $Mn_2O_3$. [b] Incl. 0·29 $Cr_2O_3$. [c] Incl. 0·24 $Cr_2O_3$. [d] At 100°, 0·36.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|
| *Chrysotile.* | | | | | | | | | |
| 40. Reichenstein | | 43·50 | 0·40 | — | 2·08 | 40·00 | 13·80 | | = 99·78 |
| 41. Amelose | 2·604 | 42·54 | 3·78 | 4·75 | 5·57 | 30·48 | 13·13 | | = 100·25 |
| 42. Montville, N. J. | | 42·62 | 0·38 | — | 0·27 | 42·67 | 14·25 | | = 100·19 |
| 43. " " | | 42·42 | 0·63 | 0·62 | *und.* | 41·01 | 15·64 | NiO 0·23 | = 100·55 |
| 44. New Haven, Ct. | 2·49 | 44·05 | — | — | 2·53 | 39·24 | 13·49 | | = 99·31 |
| 45. Shipton, Quebec, *dk. grn.* | 2·14 | 41·84 | — | — | 2·23 | 41·99 | 14·28 | | = 100·34 |
| 46. " " *yellow* | 2·29 | 42·04 | — | — | 3·66 | 39·54 | 14·31 | | = 99·55 |
| 47. Canada | 2·56 | 37·10 | *tr.* | — | 5·73 | 39·94 | 16·85 | | = 99·62 |
| 48. Broughton | | 40·57 | 0·90 | — | 2·81 | 41·50 | 13·55 | | = 99·33 |
| 49. Templeton | | 40·52 | 2·10 | — | 1·97 | 42·05 | 13·46 | | = 100·10 |
| 50. "Italian" | | 40·30 | 2·27 | — | 0·87 | 43·37 | 13·72 | | = 100·53 |

Paijkull mentions a serpentine from Långban containing 7 8 p. c. MnO, G. För. Förh., **3**, 351, 1877; Koenig has described a serpentine-like mineral from Franklin Furnace, N. J., with 7·4 MnO, 3·9 ZnO, Proc. Acad. Philad., 350, 1886.

A chrysotile embedded in the blocks of a lime-breccia from Médoux near Bagnerres-de-Bigorre gave Goguel 12·3 p. c. CaO and 5 p. c. $Al_2O_3$, but perhaps from impurity. Bull. Soc. Min., **11**, 155, 1888.

**Pyr., etc.**—In the closed tube yields water. B.B. fuses on the edges with difficulty. F. = 6. Gives usually an iron reaction. Decomposed by hydrochloric and sulphuric acids. From chrysotile the silica is left in fine fibers.

**Obs.**—Serpentine, more or less pure, often constitutes mountain masses and in this form is widely distributed. It is a metamorphic rock, resulting from the alteration of other rocks, particularly of peridotyte. Crystals of serpentine, pseudomorphous after monticellite, occur in the Fassathal, Tyrol; near Miask at Lake Aushkul, Barsovka. Ekaterinburg, and elsewhere; in Norway, at Snarum; etc. Fine precious serpentines come from Falun and Gulsjö in Sweden, the Isle of Man, the neighborhood of Portsoy in Banffshire, the Lizard, Cornwall (anals. 4–8), Corsica, Siberia, Saxony, etc. At Zermatt (*schweizerite*). The names of many other localities are given above.

In N. America, in *Maine* at Deer Isle, precious serpentine of a light green color. In *Vermont,* at New Fane, Cavendish, Jay, Roxbury, Troy, Westfield. In *Mass.,* fine at Newburyport; Blandford with schiller spar, and the marmolite variety; also at Westfield, Middlefield, Lynnfield, Newburyport, and elsewhere. In *R. Island,* at Newport; the bowenite at Smithfield. In *Conn.,* near New Haven and Milford, at the verd-antique quarries. In *N. York,* at Phillipstown in the Highlands; at Port Henry, Essex Co.; at Antwerp, Jefferson Co., in crystals; at Syracuse, east of Major Burnet's, interesting varieties; in Gouverneur, St. Lawrence Co., in crystals, and also in Rossie, two miles north of Somerville; at Johnsburg in Warren Co.; Davenport's Neck, Westchester Co., affording fine cabinet specimens; in Cornwall, Monroe, and Warwick, Orange Co., sometimes in large crystals at Warwick; and from Richmond to New Brighton, Richmond Co. In *N. Jersey,* at Hoboken, with brucite, magnesite, etc., and the marmolite variety; also at Frankfort and Bryan; at Montville, Morris Co., silky fibrous (chrysotile) and retinalite, with common serpentine, produced by the alteration of pyroxene, Merrill, l. c. In *Penn.,* massive, fibrous, and foliated, of various colors, purple, brown, green, and gray, at Texas, Lancaster Co.; also at Nottingham and West Goshen, Chester Co.; at West Chester, Chester Co., the *williamsite;* at Mineral Hill, Newtown, Marple, and Middletown, Delaware Co.; a variety looking like meerschaum or lithomarge at Middletown; at Easton, pseudomorphous after pyroxene and amphibole. In *Maryland,* at Bare Hills; at Cooptown, Harford Co., with diallage; also in the north part of Cecil Co. In *California,* at various points in the Coast Range (cf. Becker, l. c.).

In *Canada,* abundant among the metamorphic rocks of the Eastern Townships and Gaspé peninsula, Quebec; at Thetford, Coleraine, Broughton, Orford, S. Ham, Bolton, Shipton, Melbourne, etc. The fibrous variety chrysotile (asbestus, bostonite) often forms seams, several inches in thickness in the massive mineral, and is now extensively mined for technical purposes. Massive Laurentian serpentine also occurs in Grenville, Argenteuil Co., Quebec, and North Burgess, Lanark Co., Ontario. In *N. Brunswick,* at Crow's Nest in Portland.

The names *Serpentine, Ophite, Lapis colubrinus,* allude to the green serpent-like cloudings of the serpentine marble. *Retinalite* is from ῥετινή, *resin; Picrolite,* from πικρός, *bitter,* in allusion to the magnesia (or Bittererde) present; *Thermophyllite* from θέρμη, *heat,* and φύλλον, *leaf,* on account of the exfoliation when heated; *Chrysotile,* from χρυσος, *golden,* and τίλος, *fibrous; Metaxite,* from μέταξα, *silk; Marmolite,* from μαρμαίρω, *to shine,* "in allusion to its pearly and somewhat metallic luster" (Nuttall).

**Artif.**—Formed by A. Gages in transparent amorphous mass, by placing a solution of gelatinous silicate of magnesium in a dilute solution of potash. It is deposited after some months' standing. (Rep. Brit. Assoc., 203, 1863.)

On the origin and occurrence of serpentine, see the following:

Rose, Pogg., **82**, 511, 1851. Tschermak, Ber. Ak. Wien **56** (1), 261, 283, 1867. Roth, Abh., Ak. Berlin, p. 339, 1869. Drasche, Min. Mitth., 1, 1871. Lemberg, Zs. G. Ges., **27**, 531, 1875. Weigand, Min. Mitth., 183, 1875. Bonney, Lizard, Q. J. G. Soc., **33** 884, 1877. Heddle, Trans. R. Soc. Ed., 28, 45, 1878. Cossa, Mem. Acc. Linc., 2, 933, 1878. Hare, Inaug. Diss. Breslau, 1879. Hussak, Min. Mitth., 5, 61, 1882. T. Sterry Hunt, Geol. Hist. Serpentine, 1883, Origin of Cryst. Rocks, 1884; Williams, Am. J. Sc., 34, 137, 1887. Merrill, Proc. U. S. Nat. Mus., 105, 1888. Becke, U. S. G. Surv., Mon. 13, 108, 1888. For a popular account, see the recent work by R. H. Jones (London, 1890): "Asbestos, its properties, occurrences and uses."

On the crystalline structure of serpentine, see the following:

Websky, Zs. G. Ges., 10, 277, 1856. Dx., Min., 1, 106 *et seq.*, 1862. Reusch, Pogg., **127**, 166, 1866. Wiik, Öfv. Finks. Vet. Soc., 17, 8, 1874–75. Hussak, Min. Mitth., 5, 61, 1883. Rosenbusch, Mikr. Phys., 557, 1886. Brauns, Jb. Min., Beil., 5, 275, 1887. Patton, Min. Mitth., 9, 85, 1887. Lévy-Lcx., Min. Roches, 278, 1888. Tschermak, Ber. Ak. Wien, **99** (1), 253, 1890, **100** (1), 32, 1891.

On the various forms of serpentine (derived from chondrodite) at the Tilly Foster Iron mine, Brewster, N. Y., see J. D. Dana, Am. J. Sc., 8, 375, 1874.

On the alteration-products derived directly or indirectly from the chrysolite rocks of Krems (Křemze), Bohemia, especially with reference to the origin and subsequent changes in the serpentine, see Schrauf, Zs. Kr., 6, 321, 1882 (see p. 666, also *Kelyphite*, p. 447). He shows that much serpentine is impregnated with opal-silica, and includes such occurrences under the general term *siliciophite*. This may be true of aphrodite, p. 675. *Enophite* is a chloritic serpentine-like alteration product; analysis:

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|
| G. = 2·64 | 38·40 | 3·71 | 3·11 | 4·51 | 30·46 | 3·21 | 17·06 = 100·46 |

On the alterations connected with the paleopikryte of Amelose near Biedekopf, cf. R. Brauns, Jb. Min., Beil.-Bd., 5, 275, 1887. *Webskyite* is an alteration-product of the serpentine. Amorphous. H. = 3. G. = 1·771. Color pitch-black with brownish green streak. Analysis.

⅔ $SiO_2$ 34·92 $Fe_2O_3$ $Al_2O_3$ 9·60 FeO 3·13 MgO 21·62 $H_2O$ 31·04 (below 110° 21 p. c.) = 100·31

Named after Prof. Martin Websky (1824–1886).

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The following are magnesian silicates allied to serpentine but of somewhat doubtful character:

TOTAIGITE *Heddle*, Trans. R. Soc. Ed., 28, 455, 497, 1878. A serpentinous mineral appearing as a pseudomorphous substance surrounding malacolite and itself often enveloped in serpentine. Color pale fawn, sometimes blue-black. Soft. Analysis of a fawn-colored variety:

$SiO_2$ 37·22 $Al_2O_3$ 0·76 FeO 1·05 MnO 0·23 MgO 44·97 CaO 5·24 $H_2O$ 10·64 = 100·11

Occurs in a granular limestone at Totaig, Ross-shire, Scotland.

ZÖBLITZITE *Frenzel*, Min. Lex. Sachsen, 351, 1874, Jb. Min., 680, 1875.

Massive. Slightly brittle. Pale gray or yellowish white. H. = 3–4. Anal.—Melling, Rg., Min. Ch., 503, 1875. 2, 3, Frenzel, Jb. Min., 680, 1875.

| | | $SiO_2$ | $Al_2O_3$ | FeO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. Zöblitz | | 47·13 | 2·57 | 2·92 | 36·13 | 11·50 | = 100·25 |
| 2. Hrubschitz | | 42·57 | 9·12 | 1·82 | 32 90 | 13·19 | = 99·60 |
| 3. Kändler | G. = 2·49 | 42·44 | 4·67 | 0·91 | 38·49 | 13·48 | = 99·99 |

Occurs in serpentine at Zöblitz, similarly at Kändler near Limbach; also as an incrustation on chromite in serpentine at Hrubschitz, also at Lettowitz, both in Moravia. Frenzel finally calls zöblitzite a somewhat impure white serpentine.

METAXOITE *Arppe*, Finsk. Min., Act. Sc. Fenn., 6, 580, 1861, Holmberg, Vh. Min. Ges., 145, 1862.

Massive, compact; also radiated or granular crystalline. G. = 2·58–2·61. Color white to greenish blue. Anal.—1, 2, Asp, and 3, Hällsten, Arppe, Finsk. Min., l. c.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. *Crystals* | 38·69 | 9·68 | 4·70 | *undet.* | 15·28 | *undet.* | 12·97 | |
| 2. " | 37·90 | 9·78 | 6·73 | 2·05 | 12·23 | 18·79 | 12·76 | = 100·24 |
| 2. *Amorphous* | 40·63 | 10·17 | 6·78 | *undet.* | 11·24 | 16·03 | 12·88 | |

Found near Lupikko in Finland, some versts south of Pitkäranta, with serpentine. Named from its nearness to *metaxite.*

HYDROPHITE. Hydrofit *Svanberg*, Ak. H. Stockh., 186, 1839. Jenkinsite *Shepard*, Am. J. Sc., 13, 392, 1852. Eisengymnit.

Massive; sometimes in fibrous crusts.

H. = 2·5–3·5. G. = 2·65, hydrophite; 2·4–2·6, jenkinsite. Luster feeble, subvitreous. Color mountain-green to blackish green. Streak paler. Translucent to opaque.

*Jenkinsite* is apparently an iron serpentine; hydrophite the same with one more molecule of water. Websky regards hydrophite as impure *metaxite*, Zs. G. Ges., **10**, 284, 1858.

Anal.—1, Svanberg, l. c. 2, 3, Smith & Brush, Am. J. Sc., **16**, 369, 1853.

| | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. Hydrophite | 36·19 | 2·90 | 22·73 | 1·17 | 21·08 | 16·08 $V_2O_5$ 0·11 = 100·26 |
| 2. Jenkinsite | 38·97 | 0·53 | 19·30 | 4·36 | 22·87 | 13·36 = 99·39 |
| 3. " | 37·42 | 0·98 | 20·60 | 4·05 | 22·75 | 13·48 = 99·28 |

In the closed tube gives off water. B.B. blackens and fuses at about 3 to a black magnetic globule. With the fluxes gives reactions for iron and manganese. Decomposed by hydrochloric acid.

*Hydrophite* occurs at Taberg in Småland, Sweden; *jenkinsite* at O'Neil's mine in Orange Co., N. Y., as a fibrous incrustation on magnetite. Named *Hydrophite* in allusion to the water present; and *Jenkinsite* after J. Jenkins of Monroe.

APHRODITE. Afrodit *Berlin*, Ak. H. Stockh., 167, 172, 1840.

A soft earthy mineral near sepiolite. G. = 2·21. Color milk-white. Opaque. Perhaps $H_6Mg_4Si_4O_{15}$ but of doubtful homogeneity, cf. Fischer, Zs. Kr., **4**, 368, 1880; Schrauf, ib., **6**, 353, 1882. Anal.—Berlin, l. c.:

| $SiO_2$ | MgO | MnO | FeO | $Al_2O_3$ | $H_2O$ |
|---|---|---|---|---|---|
| 51·55 | 33·72 | 1·62 | 0·59 | 0·20 | 12·32 = 100 |

From Långban, Sweden. Named from ἀφρός, *foam*.

Another magnesium silicate analyzed by Delesse gave: $SiO_2$ 53·5, MgO 28·6, $Al_2O_3$ 0·9 ($Fe_2O_3$ *tr.*), $H_2O$ 16·4 = 99·4, corresponding to $MgO.SiO_2.H_2O$.

Occurs in serpentine, of a white or yellowish color, with a waxy luster, and somewhat translucent. G. = 2·335.

*Hampshirite* is a name applied by Hermann to the steatite of certain steatitic pseudomorphs having mostly the form of quartz described and analyzed by Dewey (Am. J. Sc., **4**, 274, **5**, 249, **6**, 334, 1822, 1823), who obtained: $SiO_2$ 50·60, MgO 28·83, $Al_2O_3$ 0·15, FeO 2·59, MnO 1·10, $H_2O$ 15·00 = 98·27. Probably not homogeneous.

CEROLITE. Kerolith *Breithaupt*, Char., 145, 254, 1823. Cerolith *Glock.*, 1831. Kerolite.

Massive, reniform, compact or lamellar.

Fracture conchoidal. Feel greasy. H. = 2–2·5. G. = 2·3–2·4. Luster vitreous or resinous. Color greenish or yellowish white, yellow, reddish. Streak uncolored. Transparent to translucent.

Anal.—1, Kühn's scholars, Lieb. Ann., **59**, 368, 1846. 2, Kühn, l. c. 3, Hermann, J. pr. Ch., **95**, 134, 1865 4, Genth, Am. J. Sc., **33**, 203, 1862.

| | $SiO_2$ | FeO | MgO | $H_2O$ |
|---|---|---|---|---|
| 1. Frankenstein | 47·34 | — | 29·84 | 21·04 = 98·22 |
| 2. " | 46·96 | — | 31·26 | 21·22 = 99·44 |
| 3. L. Itkul, *green* G. = 2·27 | 47·06 | NiO 2·80 | 31·81 | 18·33 = 100 |
| 4. Harford Co., Md., *bl. wh.* | 51·09 | 0·23 | 28·28 | 20·91 = 100·51 |

B.B. blackens, but does not fuse. From Frankenstein in Silesia, associated with serpentine, and also, according to Kühn, brucite. Similar minerals occur at L. Itkul and with the serpentine of Harford Co., Maryland.

Named from κηρός, *wax*, and λίθος.

LIMBACHITE *Frenzel*, Jb. Min., 789, 1873; Min. Lex. Sachsen, 184, 1874. A mineral resembling cerolite occurring in the serpentine of Limbach, Saxony. Massive. G. = 2·395. Luster greasy. Color grayish to greenish white. Not hard nor brittle. Does not adhere to the tongue. Analyses, Frenzel:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MgO | $H_2O$ |
|---|---|---|---|---|
| 41·42 | 22·09 | — | 23·67 | 12·47 = 99·65 |
| 42·03 | 19·56 | 1·46 | 25·61 | 12·34 = 101·00 |

A yellowish apple-green, massive, earthy mineral from Webster, Jackson Co., N. C., gave Dunnington, Ch. News, **25**, 270, 1872:

G. = 2·30 $SiO_2$ 43·87 $Al_2O_3$ 22·21 FeO 16·14 $Na_2O$ 1·05 $H_2O$ 16·37 = 99·64

The relations of the above are uncertain.

**482. DEWEYLITE.** *Emmons*, Man. Min. and Geol., 1826. Gymnite *Thomson*, Phil. Mag., **22**, 191, 1843. Eisengymnit *Hatle* and *Tauss*, Vh. G. Reichs., 226, 1887.

Amorphous, and having some resemblance to gum arabic, or a brownish or yellow resin. Brittle, and often much cracked.

H. = 2–3·5. G. = 2·0–2·2. Luster greasy. Color whitish, yellowish, wine-yellow, greenish, reddish. Translucent.

**Comp.**—A magnesian silicate near serpentine but with more water. Formula perhaps $4MgO.3SiO_2.6H_2O$ = Silica 40·2, magnesia 35·7, water 24·1 = 100.

**Anal.**—1, Brush, Dana Min., 286, 1854. 2, Thomson, l. c. 3, Œllacher, Zs. G. Ges., **3**, 222, 1851. 4, Hatle and Tauss, l. c. Also Haushofer, Widtermann, 5th Ed., p. 470.

| | | $SiO_2$ | MgO | FeO | $H_2O$ | $Fe_2O_3$ |
|---|---|---|---|---|---|---|
| 1. Texas, Pa. | | 43·15 | 35·95 | — | 20·25 | — $Al_2O_3$ *tr.* = 99·35 |
| 2. Bare Hills, Md. | G. = 2·22 | 40·16 | 36·00 | — | 21·60 | 1·16 CaO 0·80, $Al_2O_3$ *tr.* = 99·72 |
| 3. Tyrol, Fleimsthal | G. = 2·05 | 40·40 | 35·85 | — | 22 60 | 0·38 apatite 0·78 = 100 |
| 4. Kraubath, *Eisengymnite* | | 42·32 | 30·81 | 4·89 | 20·47 | — = 98·49 |

Half the water in 4 is lost at 110°–120°, the remainder only at a red heat.

**Pyr., etc.**—In the closed tube gives off much water. B.B. becomes opaque, and fuses on the edges. Decomposed by hydrochloric acid.

**Obs.**—Occurs with serpentine in the Fleimsthal, Tyrol; at Passau in granular limestone; also at Texas, Penn., and the Bare Hills, Md.; at Middlefield, Mass. Named after Prof. Chester Dewey (1784–1867). The gymnite of Thomson, named from γυμνός, *naked*, in allusion to the locality at Bare Hills, Md., is the same species.

*Eisengymnite* occurs intermixed with serpentine and gymnite at Kraubath, Styria, of a bright red color. H. = 3. G. = 1·986 of material not entirely pure.

**483. GENTHITE.** Nickel-Gymnite *Genth*, Kell. & Tiedm. Monatsb., **3**, 487, 1851. Genthite *Dana*, Am. J. Sc., **44**, 256, 1867.

Amorphous, with a delicately hemispherical or stalactitic surface, incrusting.

H. = 3–4; sometimes (as at Michipicoten) so soft as to be polished under the nail, and fall to pieces in water. G. = 2·409. Luster resinous. Color pale apple-green, or yellowish. Streak greenish white. Opaque to translucent.

**Comp.**—A gymnite with part of the magnesium replaced by nickel $2NiO.2MgO.3SiO_2.6H_2O$ = Silica 34·8, nickel protoxide 28·8, magnesia 15·5, water 20·9 = 100.

**Anal.**—1, Genth, l. c. 2, Hunt, Rep. G. Canada, 507, 1863.

| | $SiO_2$ | NiO | FeO | MgO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. Texas, Pa. | 35·36 | 30·64 | 0·24 | 14·60 | 0·26 | 19·09 = 100·19 |
| 2. Michipicoten Id. | 33·60 | 30·40 | 2·25 | 3·55 | 4·09 | 17·10 $Al_2O_3$ 8·40 = 99·39 |

The so-called genthite from Webster, Jackson Co., N. C., gave Dunnington (Ch. News, **25**, 270, 1872): $SiO_2$ 49·89, MgO 22·35, NiO 16·60, FeO 0·06, $H_2O$ 12·36 = 101·26. Occurs as an apple-green incrustation. G. = 2·48. The same mineral has given Walker results leading to a sepiolite formula (see p. 681).

After drying at a temperature above 100° C., Hunt obtained: $SiO_2$ 35·80, NiO 32·20, $H_2O$ 12·20.

**Pyr., etc.**—In the closed tube blackens and gives off water. B.B. infusible. With borax in O.F. gives a violet bead, becoming gray in R.F. (nickel). Decomposed by hydrochloric acid without gelatinizing.

**Obs.**—From Texas, Lancaster Co., Pa., in thin crusts on chromite; on Michipicoten Id., Lake Superior, of a greenish yellow to apple-green color. Also reported from near Malaga, Spain, with chromite and talcose schist; and by Wiser, from the Saasthal in the Upper Valais.

*Röttisite* Breith., B. H. Ztg., **18**, 1, 1859, may be essentially the above. It occurs with phosphate of nickel at Röttis in Voigtland, in amorphous masses and reniform incrustations, apple-green or emerald-green, of little luster, translucent to subtranslucent, but opaque when earthy, with H. = 2–2·25, and G. = 2·358–2·370.

483A. GARNIERITE *W. B. Clarke*, 1874. *Garnier*, Bull. Soc. G., **24**, 438, 1867. A new mineral from Noumea, New Caledonia, *A. Liversidge*, J. Ch. Soc., **12**, 613, July, 1874; Noumeite, Noumeaite, *Id.*, Proc. Roy. Soc., N. S. W., Dec. 9, 1874; Sept. 1, 1880; Min. N. S. W., 275, 1888. Numeite.

Amorphous. Soft and friable. G. = 2·3–2·8. Luster dull. Color bright apple-green, pale green to nearly white. In part unctuous; sometimes adheres to the tongue.

An important ore of nickel, consisting essentially of a hydrated silicate of magnesium and nickel, perhaps $H_2(Ni,Mg)SiO_4$ + aq, but very variable in composition, particularly as regards the mutual replacement of nickel and magnesium, and not always a homogeneous mineral. Liversidge has attempted to distinguish two varieties, one of which is dark green and unctuous, *noumeite;* the other rarer, pale green and adhesive to the tongue, *garnierite* (anal. 7).

**Anal.**—1 Dann (?), Ber. nied. Ges., Jan. 7, 1878. 2, Garnier, C. R., **86**, 684, 1878. 3, Kiepenheuer, Ber. nied. Ges., July 14, 1879. 4, 5, Liversidge, l. c., 1880. 6, Id., l. c., 1874. 7, Id., Proc. R. Soc. N. S. W., Dec. 9, 1874. 8, Dmr., Bull. Soc. Min., **1**, 29, 1878. 9–11, Liversidge, l. c., 1880; also other anals., in part by Leibius. 12, Garnier, white veins in the green mineral; resembling sepiolite, l. c. 13, 14, Hood, Min. Res. U. S., **1**, 404, 1883. 15, F. W. Clarke, Am. J. Sc., **35**, 483, 1888.

| | | | $SiO_2$ | NiO | MgO | $H_2O$ | $Al_2O_3,Fe_2O_3$ | |
|---|---|---|---|---|---|---|---|---|
| 1. | N. Caledonia | | 35·45 | 45·15 | 2·47 | 15·55[a] | 0·50 | = 99·12 |
| 2. | " " | | 44·40 | 38·61 | 3·45 | 10 34 | 1·68 | FeO 0·43, CaO 1·07 |
| 3. | " " | | 37·78 | 33·91 | 10·66 | 15·83 | 1·57 | = 99·75 [= 99·98 |
| 4. | Nakety, *dark grn.* | | 38·35 | 32·52 | 10·61 | 17·97[a] | 0·55 | = 100 |
| 5. | Kanala, *grn.* | | 37·49[b] | 29·72 | 14·97 | 17·60[a] | 0·11 | = 99·89 |
| 6. | N. Caledonia | G. = 2·27 | 47·24 | 24·01 | 21·66 | 5·27[d] | 1·67 | CaO *tr.* = 99·85 |
| 7. | " " | G. = 2·58 | 47·90 | 24·00 | 12·51 | 12·73 | 3·00 | CaO *tr.* = 100·14 |
| 8. | " ' | G. = 2·87 | 42·61 | 21·91 | 18·27 | 15·40 | 0·89 | = 99·08 |
| 9. | Ouaïlon, *light grn.* | | 48·25 | 14·60 | 16·40 | 19·77 | 0·55 | = 99·57 |
| 10. | " *pale grn.* | | 50·15 | 10·20 | 17·43 | 21 65[a] | 0·57 | = 100 |
| 11. | Kanala, " " | | 51·94[c] | 2·32 | 21·35 | 23·17[a] | 1·36 | = 100·14 |
| 12. | N. Caledonia | | 41·80 | — | 37·38 | 20·39 | 1·26 | = 100·83 |
| 13. | Douglas Co., Oregon | | 48·21 | 23·88 | 19·90 | 6·63 | 1·38 | = 100 |
| 14. | " " " | | 40·55 | 29·66 | 21·70 | 7·00 | 1·33 | = 100·24 |
| 15. | " " " | | 44·73 | 27·57 | 10·56 | 15·86[e] | 1·18 | = 99·90 |

[a] At 100° in (1) 4·05; in (4) 6·44; in (5) 8·65; (9) 10·95 (105°); in (10) 11·28; in (11) 14·30.

[b] Soluble $SiO_2$ 0·70. [c] Do., in (11) 0·13. [d] First dried at 100°. [e] At 110°, 8·87.

Occurs in veins traversing a serpentine rock near Noumea, capital of New Caledonia; associated with chromic iron and steatite; also at numerous other points on the island. The three chief districts are the Kanala-Méré-Kuana, Thio-Port Bouquet, and Bourindi (cf. Min Res. U. S., 300, 1885)

The supply is very large, and the amount that can be mined in general greater than the market calls for; it is stated that for several years 1000 tons of the ore per annum have been marketed. Meissonier has reported the existence of similar deposits in the province of Malaga, Spain, C. R., 83, 229, 1876.

Deposits of a similar ore, perhaps of large extent, occur at Riddle in Douglas County, southern Oregon. Also at Webster, Jackson Co., N. C.; in both cases in connection with a peridotyte. Clarke (l. c.) shows that the former may owe their origin to a nickel-bearing chrysolite, and the North Carolina mineral probably had the same origin (Biddle, Min. Res., 170, 1886).

DE SAULESITE *Koenig*, Proc. Ac. Philad., 185, 1889

A hydrous silicate of nickel and zinc, associated with chloanthite and a nickel arsenate. It is amorphous, of a yellowish green, apple- or emerald-green color, and occurs as an incrustation or filling cavities in purple fluorite. Analysis gave.

| $SiO_2$ | NiO | ZnO | FeO | CaO | MgO | $H_2O$ | $As_2O_5$ |
|---|---|---|---|---|---|---|---|
| 31·62 | 38·22 | 4·00 | 2·03 | 0·70 | 0·42 | 16·58[a] | 4·77 = 98·34 |

[a] At 100° 9·44 p. c.; at 600° 7·14.

From the Trotter mine at Franklin Furnace, N. J.; named after the manager, Major A. B. de Saules.

The following are other nickel silicates, of doubtful character:

PIMELITE. Grüner Chrysopraserde (fr. Kosemütz) *Klapr.*, Schrift., Ges. N. Berlin, 8, 17, 1788, Beitr., 2, 134, 1797. Pimelit *Karst.*, Tab., 28, 72, 1800.

Massive or earthy. H. = 2·5. G. = 2·23–2·3; 2·71–2·76, Baer. Luster weak, greasy. Color apple-green. Streak greenish white. Translucent to sub-translucent. Feel greasy. Does not adhere to the tongue. Anal.—1, Klaproth, l.c., and Rg., Min. Ch., 871, 1860. 2, W. Baer, J. pr. Ch., **55**, 49, 1852.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | NiO | MgO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. *Chrysoprase earth* | 35·00 | 5·00 | 4·58 | 15·63 | 1·25 | 0·42 | 38·12 = 100 |
| 2. *Hard Pimelite* | 35·80 | 23·04 | 2·69 | 2·78 | 14·66 | — | 21·03 = 100 |

Pimelite gives water in the closed tube, is infusible B.B., and with the fluxes reacts for nickel. Decomposed by acids. From Silesia and elsewhere. Named from *πιμελή, fatness.*

ALIPITE. Pimelit *Schmidt*, Pogg., **61**, 388, 1844. Alipit *Glock.*, 1845. Massive; earthy. H. = 2·5. G. = 1·44–1·46, Schmidt. Color apple-green. Not unctuous. Adheres to the tongue. Analysis.—Schmidt.

$SiO_2$ 54·63 $Al_2O_3$ 0·30 NiO 32·66 FeO 1·13 MgO 5·89 CaO 0·16 $H_2O$ 5·23 = 100

From Silesia. Named from the Greek *ἀλιπής, not greasy.*

REFDANSKITE *Hermann*, J. pr. Ch., **102**, 405, 1867. An earthy mineral occurring in masses which fall to powder under slight pressure. Adheres to the tongue. Color dirty grayish green. G. = 2·77. From Revdinsk, Urals. Analysis:

$SiO_2$ 32·10 $Al_2O_3$ 3·25 FeO 12·15 NiO 18·33 MgO 11·50 $H_2O$ 9·50 Sand 13·00 = 99·83

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**484. TALC.** *Μαγνῆτις λίθος Theophr.* Magnetis *Germ.* Talck, Glimmer, *Agric.*, Foss., 254, Interpr., 466, 1546. Talk, Creta Brianzonia, C. Hispanica, C. Sartoria, Telgsten = Lapis Ollaris *Wall.*, Min, 133, 134, 1747. Talcum, Tälgsten, Speckstein, Steatites, *Cronst.*, Min., 89, 75, 1758. Talc, Soapstone, Steatite, Potstone. Craie de Briançon, etc., *Fr.* Pyrallolite pt. *Nordensk.*, Schw. J., **31**, 389, 1820. Rensselaerite *Emmons*, Rep. G. N. Y., 152, 1837. Agalite.

Orthorhombic or monoclinic. Rarely in tabular crystals, hexagonal or rhombic with prismatic angle of 60°. Usually foliated massive; sometimes in globular and stellated groups; also granular massive, coarse or fine; fibrous (pseudomorphous); also compact or cryptocrystalline.

Cleavage: basal perfect. Sectile. Flexible in thin laminæ, but not elastic. Percussion-figure a six-rayed star, orientated as with the micas. Feel greasy. H. = 1–1·5. G. = 2·7–2·8. Luster pearly on cleavage surface. Color apple-green to white, or silvery-white; also greenish gray and dark green; sometimes bright green perpendicular to cleavage surface, and brown and less translucent at right angles to this direction; brownish to blackish green and reddish when impure. Streak usually white; of dark green varieties lighter than the color. Subtransparent to translucent. Optically negative. Ax. pl. ∥ *a*. Bx ⊥ *c*. Axial angle:

| | | | |
|---|---|---|---|
| Rhode Island | $2E_r = 19° 1'$ | $2E_{bl} = 17° 56'$ | Dx.[1] |
| *Agalite* | $2E = 30°–40°$ | $\rho - v$, | Scheibe, Zs. G. Ges., **41**, 564, 1889. |

Steatite when rubbed with gun-cotton or Kienmayer's amalgam or fur becomes negatively electrified. Wied., Beibl., **22**, 707, 1889.

**Var.**—1. *Foliated. Talc.* Consists of folia, usually easily separated, having a greasy feel, and presenting ordinarily light green, greenish white, and white colors. G. = 2·55–2·78.

2. *Massive, Steatite* or *Soapstone* (Speckstein *Germ.*). *a.* Coarse granular, gray, grayish green, and brownish gray in colors; H. = 1–2·5. *Pot stone* or *Lapis ollaris* (Topfstein, Lavezstein, Giltstein *Germ.*) is ordinary soapstone, more or less impure. *b.* Fine granular or cryptocrystalline, and soft enough to be used as chalk; as the *French chalk* (*Craie de Briançon*), which is milk-white with a pearly luster. *c. Indurated talc.* An impure slaty talc, harder than ordinary talc. Talcose slate is a dark, slaty, argillaceous rock, having a somewhat greasy feel, which it owes to the presence of more or less talc.

Much of the steatite is pseudomorphous like the following.

3. *Pseudomorphous. a.* Fibrous, fine to coarse, altered from enstatite. *b. Rensselaerite,* cryptocrystalline, or wax-like in composition, but often having the form and cleavage of salite or pyroxene, and evidently pseudomorphous; colors whitish, yellowish, grayish, greenish white to very dark, and sometimes pearl-white; H. = 3–4; G. = 2·874 Beck; 2·757, fr. Grenville, 2·644, fr. Charleston Lake, in Canada, Hunt; usually translucent in pieces a fourth of an inch thick. Some agalmatolite is here included. Anal. 15 is of a variety of talc produced from chrysolite.

*Pyrallolite* is partly pseudomorphous steatite, after pyroxene, like rensselaerite. It varies exceedingly in composition, as shown by Arppe and others, and as recognized by A. E. Nordenskiöld in his Finland Mineralogy, the silica ranging from 49 to 76 p. c. It includes pyroxene, therefore, in various stages of steatitic alteration.

**Comp.**—An acid metasilicate of magnesium, $H_2Mg_3Si_4O_{12}$ or $H_2O.3MgO.4SiO_2$ = Silica 63·5, magnesia 31·7, water 4·8 = 100. The water goes off only at a red heat. Nickel is sometimes present in small amount.

Clarke and Schneider (Am. J. Sc., **40**, 306, 1890) have obtained the following water determinations (anal. 17):

| 105° | 250°–300° | red heat | white heat |
|---|---|---|---|
| 0·07 | 0·06 | 4·43 | 0·35 |

Also when treated with dry hydrochloric-acid gas for 15 hours at 383°–412° no appreciable change of weight resulted. Further, upon intense ignition over the blast-lamp and subsequent boiling with sodium carbonate solution 15·36 p. c. $SiO_2$ was given up according to the reaction:

$$H_4Mg_3Si_4O_{12} = 3MgSiO_3 + SiO_2 + H_2O.$$

The solution, however, had no effect upon the mineral before ignition. The stability with acids and liberation of silica as noted make it reasonably certain that the formula of an acid metasilicate, as written above, is correct.

**Anal.**—1–12, Scheerer, Pogg., **84**, 321 *et seq.*, 1851. 13, Ullik, Ber. Ak. Wien, **57** (1), 946, 1868. 14, Cohen, Jb. Min., **1**, 119, 1887. 15, Genth, Am. J. Sc., **33**, 200, 1862. 16, Adger, Ch. News, **25**, 270, 1870. 17, Clarke & Schneider, l. c. 18–20, Scheerer, l. c. 21, 22, Hunt, Rep. G. Canada, 470, 1863. 23, E. S. Sperry, priv. contr. 24, G. A. Graves, priv. contr. 25, Jannettaz, Bull. Soc. Min., **14**, 66, 1891.

| | | G. | $SiO_2$ | FeO | MgO | $H_2O$ | $Al_2O_3$ | NiO | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Tyrol, *green* | 2·69 | 62·12 | 1·58 | 31·15 | 4·73 | — | 0·24 | | = 99·82 |
| 2. | " *fol schistose* | 2·76 | 61·16 | 1·40 | 31·17 | 5·31 | 0·46 | 0·39 | | = 99·89 |
| 3. | St Gothard, *white, foliated* | | 60·85 | 0·09 | 32·08 | 4·95 | 1·71 | — | CaO *tr.* | = 99·68 |
| 4. | " " *radiated* | | 62·15 | 0·38 | 33·04 | 3·21 | 1·01 | — | CaO 0·07 | = 99·86 |
| 5. | " " *fibrous* | | 61·51 | 0·12 | 30·93 | 2·84 | 0·83 | — | CaO 3·70 | = 99·93 |
| 6. | Wallis | 2·79 | 62·34 | 0·61 | 31·96 | 4·82 | 0·35 | — | | = 100·08 |
| 7. | Mautern (?) | | 62·37 | 0·65 | 32·02 | 4·81 | 0·32 | — | | = 100·17 |
| 8. | Zöblitz, *green* | 2·80 | 60·31 | 2·11 | 29·94 | 5·87 | 1·24[a] | 0·30 | | = 99·77 |
| 9. | Yttre Sogn, *green, foliated* | 2·70 | 61·69 | 2·33 | 30·62 | 4·94 | — | 0·29 | | = 99·87 |
| 10. | Raubjerg, *dark green* | 2·79 | 61·63 | 1·20 | 31·37 | 5·13 | 0·16 | 0·39 | | = 99·88 |
| 11. | Röraas, *green* | 2·78 | 62·03 | 1·57 | 30·62 | 5·04 | 0·03 | 0·32 | | = 99·61 |
| 12. | Falun | | 57·10 | 1·07 | 30·11 | 6·07 | 5·50[b] | — | | = 99·85 |
| 13 | Greiner | | 61·51 | 1·38 | 30·27 | 4·88 | 1·08 | 1·06[e] | | = 100·18 |
| 14. | Griqualand, *Steatite* | 2·794 | 63·29 | 4·68 | 27·13 | 4·40 | 1·40[c] | — | CaO *tr.* | = 100·90 |
| 15. | Webster, N. C. | | 64·44 | 1·39 | 33·19 | 0·34 | 0·48 | 0·23 | | = 100·07 |
| 16. | Swayne Co., N. C. | 2·82 | 57·72 | 0·64 | 33·76 | 6·01 | 2·52 | — | | = 100·65 |
| 17. | Fairfax Co., Va. | | 62·27 | 0·85 | 30·95 | 4·91 | 1·10[d] | — | | = 100·08 |

[a] $Fe_2O_3$ 0·45. [b] $Fe_2O_3$ 0·81. [c] $Fe_2O_3$ 0·16. [d] $Fe_2O_3$ 0·95. [e] CaO 0·36, SrO 0·70

*Pseudomorphous Talc.*

| | | G. | $SiO_2$ | FeO | MgO | $H_2O$ | $Al_2O_3$ | | |
|---|---|---|---|---|---|---|---|---|---|
| 18. | Fenestrelles | 2·79 | 62·29 | 1·22 | 31·55 | 4·83 | 0·15 | | = 100·04 |
| 19. | Wunsiedel | | 62·35 | 1·34 | 31·32 | 4·78 | *tr.* | | = 99·79 |
| 20. | China | 2·78 | 62·30 | 1·62 | 31·32 | 4·89 | 0·06 | | = 100·19 |
| 21. | Canton, N. Y., *Renss.* | | 61·10 | 1·62 | 31·63 | 5·60 | — | | = 99·95 |
| 22. | Grenville " | | 61·60 | 1·53 | 31·06 | 5·60 | — | | = 99·79 |
| 23. | Edwards, *fibrous* | 2·908 | 60·59 | 0·21 | 34·72 | 3·77 | 0·13 | MnO 1·16 | = 100·58 |
| 24. | " " | | 59·92 | 0·76[a] | 31·37 | 6·25 | 0·50[b] | CaO 0·57, $Na_2O$ 0·48 | = 99·85 |
| 25 | Madagascar, " | | 62·3 | 2·6 | 29·4 | 5·1 | — | | = 99·4 |

[a] MnO. [b] Incl. $Fe_2O_3$.

Bachman has described (Am. Ch. J., **10**, 45, 1886) a mineral from Webster, Jackson Co., N. C., occurring in minute micaceous scales of a pale yellowish green color; readily crushed to an unctuous powder. Analysis gave:

| | $SiO_2$ | NiO | MgO | $H_2O$ | $Al_2O_3$ | FeO | |
|---|---|---|---|---|---|---|---|
| G. = 2·31 | 53·91 | 15·91 | 19·39 | 6·30[a] | 2·65 | 1·46 | = 99·62 |

[a] At 100° 0·80.

This corresponds to a highly nickeliferous hydrated talc.

The steatite from Göpfersgrün, in which Klaproth found but 59·5 per cent of silica, along with MgO 30·5, FeO 2·3, $H_2O$ 5·5 (Beitr., 2, 177, 1797), is what has been called *hydrosteatite.* The Fenestrelles (Piedmont) pseudomorph had the cleavage of amphibole; of those of Wunsiedel (from Göpfersgrün), 19 was a pseudomorph after dolomite.

**Pyr., etc.**—In the closed tube B.B., when intensely ignited, most varieties yield water. In the platinum forceps whitens, exfoliates, and fuses with difficulty on the thin edges to a white enamel. Moistened with cobalt solution, assumes on ignition a pale red color. Not decomposed by acids. Rensselaerite is decomposed by concentrated sulphuric acid.

**Obs.**—Talc or steatite is a very common mineral, and in the latter form constitutes extensive beds in some regions. It is often associated with serpentine, talcose or chloritic schist, and dolomite, and frequently contains crystals of dolomite, breunnerite, also asbestus, actinolite, tourmaline, magnetite.

Steatite is the material of many pseudomorphs, among which the most common are those after pyroxene, hornblende, mica, scapolite, and spinel. The magnesian minerals are those which commonly afford steatite by alteration; while those like scapolite and nephelite, which contain soda and no magnesia, most frequently yield pinite-like pseudomorphs. There are also steatitic pseudomorphs after quartz, dolomite, topaz, chiastolite, staurolite, cyanite, garnet, vesuvianite, chrysolite, gehlenite. Talc in the fibrous form is pseudomorph after enstatite. On pseudomorphs of talc after quartz, see Weinschenk, Zs. Kr., **14**, 305, 1888.

Apple-green talc occurs at Mt. Greiner in the Zillerthal, Tyrol; in the Valais and St. Gothard in Switzerland; also other places above mentioned; also in Cornwall, near Lizard Point, with serpentine; in Scotland, with serpentine, at Portsoy and elsewhere; on Unst, one of the Shetland islands; at Croky Head, Dunglow, Ireland, etc. A *fibrous* talc (pseudomorphous) with pearly luster, slightly greenish color, and greasy feel, has been described from Madagascar (anal. 25).

In N. America, foliated talc occurs in *Maine*, at Dexter. In *Vermont*, at Bridgewater, handsome green talc, with dolomite; at Athens or Grafton, Westfield, Marlboro, Newfane. In *New Hampshire*, at Francestown, Pelham, Orford, Keene, and Richmond. In *Mass.*, at Middlefield, Windsor, Blanford, Andover, and Chester. In *R. Island*, at Smithfield, delicate green and white in a crystalline limestone. In *N. York*, at Edwards, St. Lawrence Co., a fine fibrous talc (*agalite*) associated with pink tremolite; near Amity; on Staten Island, near the quarantine, common and indurated; four miles distant, in detached masses made up of folia, snow-white. In *N. Jersey*, at Lockwood, Newton, and Sparta. In *Penn.*, at Texas, Nottingham, Unionville; in South Mountain, ten miles south of Carlisle; at Chestnut Hill, on the Schuylkill, talc and also soapstone, the latter quarried extensively. In *Maryland*, at Cooptown, of green, blue, and rose colors. In *N. Car.*, at Webster, Jackson Co., a variety supposed by Genth to be altered chrysolite. In *Canada*, in the townships Bolton, Sutton, and Potton, Quebec, with steatite in beds of Cambrian age; in the township of Elzevir, Hastings Co., Ontario, an impure grayish var. in Archæan rocks.

The so-called *rensselaerite* occurs in northern New York, in the towns of Antwerp (with the form of pyroxene), Fowler, De Kalb, Edwards (at the iron mine, a white variety, from which ink-stands have been made), Russel, Gouverneur, Canton (in small crystals), Hermon (in large masses, crystalline massive); and in Canada, at Grenville, Charleston Lake, near Brockville, Rawdon, and Ramsay. It is often associated with crystalline limestone, and graduates at times imperceptibly into serpentine; its rock-masses are irregular, and are seldom continuous for more than three or four hundred yards.

A white steatite of a silvery-pearly luster was the *Magnetis* of Theophrastus—a stone, according to this author, of silvery luster, occurring in large masses, and easily cut or wrought. The word is the origin of the modern *magnesia*. Agricola, in his "Interpretatio Rerum Metallicarum" appended to his works (1546), gives as a German synonym of Magnetis, *Talck;* and he adds, as other synonyms, *Silberweiss* and *Katzensilber*, and also *Glimmer*, the German now for *mica*, evidently confounding the two minerals. He mentions its resistance to fire, and speaks of it as *lapis scissilis.*

Other later writers derive the word *talc* from the Arabic *talk;* and Aldrovandus (1648) states that it is of Moorish introduction, adding, "Hoc nomen apud Mauritanos *stellam* significare dicitur,"[1] *Stella Terræ*—Star of the Earth—being one old name of the mineral, given it because "like a star and with silvery luster it shines." Cæsius ("De Mineralibus," 1636) writes the word in Latin, *Talchus*, but most other writers of that century, *Talcum.*

The word *steatitis* occurs in Pliny as the name of a stone resembling fat; but no further description is given that can with certainty identify it.

Rensselaerite was named after Stephen Van Rensselaer, of Albany, N. Y.

**Ref.**—[1] Min., **1**, 97, 1862. N. R , 99 1867.

Talcoid *Naumann* is a snow-white, broadly-foliated talc of Pressnitz, described by Scheerer as *neutraler kieselsaurer Hydrotalc.* Analyses by Scheerer and Richter show 68 p. c. $SiO_2$. It may be only common talc with disseminated quartz.

**485. SEPIOLITE.** Meerschaum *Germ.*, Wern. Bergm., I., 377, 1788. L'Écume de mer *Fr.* Keffekill *Kirw.*, **1**, 144, 1794. Magnesite pt. *Brongn.*, Min., 1807, Magnesite *id.*, 1824. Sepiolith *Glock.*. Syn., 190, 1847.

Compact, with a smooth feel, and fine earthy texture, or clay-like; also rarely fibrous.

H. = 2–2·5. G. = 2. Impressible by the nail. In dry masses floats on water. Color grayish white, white, or with a faint yellowish or reddish tinge, bluish green. Opaque.

**Comp.**—$H_4Mg_2Si_3O_{10}$ or $2H_2O.2MgO.3SiO_2$ = Silica 60·8, magnesia 27·1, water 12·1 = 100. Some analyses show more water ($2H_2O$), which is probably to be regarded as hygroscopic. Copper and nickel may replace part of the magnesium.

**Anal.**—1–3, Scheerer, Pogg., **84**, 361, 362, 1851. 4, 5, Chester, Am. J. Sc., **13**, 296, 1877. 6, P. H. Walker, Am. Ch. J., **10**, 44, 1888. For other analyses, see 5th Ed , p. 456.

| | | $SiO_2$ | MgO | FeO | $H_2O$ | $Al_2O_3$ | $CO_2$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Turkey | | 61·17 | 28·43 | 0·06 | 9·83 | — | 0·67 | = 100·16 |
| 2. Greece | | 61·30 | 28·39 | 0·08 | 9·74 | — | 0·56 | = 100·07 |
| 3. | | 60·45 | 28·19 | 0·09 | 9·57 | 0·11 | 1·74 | = 100·15 |
| | | | | CuO | | | hygr. $H_2O$ | |
| 4. Utah, *white, fibrous* | | 52·97 | 22·50 | 0·87 | 9·90 | 4·70[a] | 8·80[c] | = 99·74 |
| 5. " *bluish green* | | 50·15 | 18·29 | 6·82 | 9·30 | 5·17[b] | 10·32[c] | = 100·05 |
| | | | | NiO | | | | |
| 6. Webster, N. C. | G. = 2·53 | 55·38 | 15·62 | 17·84 | 10·77[d] | 0·56[e] | — | = 100·17 |

[a] Incl. 0·70 $Fe_2O_3$, 3·14 $Mn_2O_3$. [b] Incl. 1·02 $Fe_2O_3$, 2·09 $Mn_2O_3$. [c] Below 110°. [d] At 100°, 5·18 p. c. [e] $Fe_2O_3$.

19 to 20 per cent of water were found by Berthier in meerschaum from Madrid and Coulommiers, and 19·6 p. c. by Kobell in that of Greece, J. pr. Ch., **28**, 482, 1843. Döbereiner and Eisenach (J. pr. Ch., **17**, 157, 1839) also found two molecules of water (instead of 1) in the meerschaum of Asia Minor. Chester found that of 18 to 20 p. c. $H_2O$ about half went off below 110°, the remainder only from 200° to a red heat.

**Pyr., etc.**—In the closed tube yields first hygroscopic moisture, and at a higher temperature gives much water and a burnt smell. B.B. some varieties blacken, then burn white, and fuse with difficulty on the thin edges. With cobalt solution a pink color on ignition. Decomposed by hydrochloric acid with gelatinization.

**Obs.**—Occurs in Asia Minor, in masses in stratified earthy or alluvial deposits at the plains of Eskihi-sher, where, according to Dr. J. Lawrence Smith, it has proceeded from the decomposition of magnesium carbonate, which is embedded in serpentine in the surrounding mountains. He observes that more or less magnesium carbonate is often found in the meerschaum, Am. J. Sc., **7**, 268, 1849; also found in Greece; at Hrubschitz in Moravia; in Morocco; at Vallecas in Spain, in extensive beds, affording a light but valuable building stone. The mineral from Morocco, called in French *Pierre de savon de Maroc*, is used in place of soap at the Moorish baths in different places in Algeria.

A fibrous mineral, having the composition of sepiolite, occurs in a seam two inches wide in "a silver mine in Utah;" anals. 4, 5; one variety is colored green with copper which is regarded as replacing the magnesium. The mineral of anal. 6 occurs in thin (1–3 mm.) layers in serpentine at Webster, Jackson Co., N. C.

The word *meerschaum* is German for *sea-froth*, and alludes to its lightness and color. *Sepiolite* Glocker is from *σήπια, cuttle-fish*, the bone of which is light and porous; and being also a production of the sea, "deinde *spumam marinam* significabat," says Glocker.

Brongniart, in the first edition of his Mineralogy (1807), included under *Magnesite* (1) the carbonate, which he calls *Mitchell's magnesite* (see under MAGNESITE); (2) the hydrous silicate or meerschaum; and (3) the siliceous carbonate from Baudissero in Piedmont; he putting "Mitchell's magnesite," the carbonate, *first*. Karsten, in his "Tabellen," published the next year, separated from meerschaum the carbonate, and adopted for it the name *magnesite*, and in this he has been followed by all German and most other mineralogists. The application of the name *magnesite* to the hydrous silicate, done in the later writings of Brongniart and by subsequent French mineralogists, is hence in violation of the law of priority.

**486. CONNARITE.** Konarit *Breith.*, B. H. Ztg., **18**, 2, 1859. Conarite, Comarite *wrong orthog.*

Hexagonal? In small fragile grains and crystals, with perfect clinodiagonal cleavage, and supposed (Breith.) to be like vivianite in crystallization.

H. = 2·5–3. G. = 2·459–2·619. Color yellowish, pistachio- and siskin-green, olive-green. Streak siskin-green. In thin lamellæ translucent. Optically uniaxial, negative with strong double refraction[1].

**Comp.**—A hydrous nickel silicate, perhaps $H_4Ni_2Si_3O_{10} = 2H_2O.2NiO_2.3SiO_2$ = Silica 49·3, nickel protoxide 40·8, water 9·9 = 100.

**Anal.**—Winkler, B. H. Ztg., **24**, 335, 1865.

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | NiO | CoO | $H_2O$ | $P_2O_5$ | $As_2O_5$ | $SO_3$ | |
|---|---|---|---|---|---|---|---|---|---|
| 43·6 | 4·6 | 0·8 | 35·8 | 0·6 | 11·1 | 2·7 | 0·8 | *tr.* | = 100 |

**Obs.**—Occurs at the Hanns Georg mine, at Röttis, in Saxon Voigtland, with röttisite (p. 676) which, it is suggested, may be an amorphous form of connarite.

Named from *κόνναρος, an evergreen tree;* hence connarite is the proper form and not conarite, from *κοναρός, well fed*, nor comarite, from *κόμαρος, the strawberry-tree* (as suggested by Dx., Min., **2**, XLVI, 1874).

**Ref.**—[1] Btd., Bull. Soc. Min., **5**, 75, 1882.

**487. SPADAITE.** *Fr. v. Kobell*, Gel. Anz. München, **17**, 945, 1843, J. pr. Ch., **30**, 467, 1843.

Massive, amorphous.

Fracture imperfect conchoidal and splintery. H.=2·5. Luster a little pearly or greasy. Translucent. Color reddish, approaching flesh-red.

**Comp.**—Perhaps $5MgO.6SiO_2.4H_2O$ or $H_2Mg_5Si_6O_{18} + 3H_2O$ = Silica 57·0, magnesia 31·6, water 11·4 = 100 (Rg).

**Anal.**—Kobell:

$SiO_2$ 56·00 $Al_2O_3$ 0·66 FeO 0·66 MgO 30·67 $H_2O$ 11·34 = 99·33

**Pyr., etc.**—In the closed tube yields much water and becomes gray. B.B. melts to a glassy enamel. Dissolves in concentrated hydrochloric acid, the silica easily gelatinizing.

**Obs.**—From Capo di Bove, near Rome, filling the spaces among crystals of wollastonite, in leucitic lava. Named after Sign. Medici Spada.

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**488. SAPONITE.** Terra porcellanea particulis impalpabilibus mollis, pt., Brianzoner Krita pt., Smectis, *Engelsk* Walklera. α hwit (Landsend i Cornwall), *Cronst.*, 75, 1758. Seifenstein (fr. Cornwall) *Klapr.*, Schrift nat. Ges. Berlin, **7**, 163, 1787. Beitr., **2**, 180, **5**, 22. Steatite of Cornwall *Kirw.*, Min., **1**, 152, 1794. Soapstone pt. Mountain Soap pt. Pierre à Savon *H.* Saponit *Svanberg*, Ak. H. Stockh., 153, 1840. Piotin *Svanberg*, Pogg., **54**, 267, 1841. Saponite, rosite, Pogg., **57**, 165, 1842. Thalite *Owen*, J. Ac. Philad., **2**, 179, 1852. Bowlingite *J. B. Hannay*, Min. Mag., **1**, 154, 1877. Cathkinite *J. J. Dobbie*, Trans. G. Soc. Glasgow, **7**, 166, 1883–5.

Massive. In nodules, or filling cavities.

Soft, like butter or cheese, but brittle on drying. G. = 2·24–2·30. Luster greasy. Color white, yellowish, grayish green, bluish, reddish. Does not adhere to the tongue.

**Comp.**—A hydrous silicate of magnesium and aluminium; but the material is amorphous and probably always impure, and hence analyses give no uniform results.

**Anal.**—1, Haughton, Phil. Mag., **10**, 253, 1855. 2, Svanberg, l. c. 3, 4, Smith & Brush, Am. J. Sc., **16**, 368, 1853. 5, Harrington, Can. Nat., **7**, 179, 1875. 6–17, Heddle, also Trans. R. Soc. Ed., **29**, 91 *et seq.*, 1879. 18, J. J. Dobbie, l. c., and Min. Mag., **5**, 131, 1883. Also other analyses, 5th Ed., p. 472.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Kynance | | 42·47 | 6·65 | — | — | 28·83 | — | — | — | 19·37 | = 97·32 |
| 2. *Piotine* | | 50·89 | 9·40 | 2·06 | — | 26·52 | 0·78 | — | — | 11·06 | = 100·71 |
| 3. *Thalite* | | 45·60 | 4·87 | 2·09 | — | 24·10 | 1·07 | 0·45 | | 20·66 | = 98·84 |
| 4. " | | 48·89 | 7·23 | 2·46 | — | 24·17 | — | 0·81 | | 15·66 | = 99·22 |
| 5. George's Is. | 2·25 | 43·91 | 6·47 | 1·23 | — | 27·18 | 0·59 | — | — | 19·64 | = 99·02 |
| 6. Gapol | 2·18 | 42·13 | 7·25 | 6·57 | 0·32[a] | 19·33 | 0·80 | 2·09 | 0·58 | 21·07[b] | MnO 0·13<br>[= 100·14 |
| 7. Kinneff, *green* | | 42·10 | 5·95 | 4·96 | 0·27[a] | 20·98 | 2·15 | 0·46 | 0·28 | 22·93[b] | = 100·08 |
| 8. " *red* | 2·28 | 42·50 | 5·88 | 4·91 | 0·24[a] | 20·74 | 2·13 | 0·46 | 0·19 | 22·75[b] | = 99·80 |
| 9. Glen Farg | 2·235 | 36·54 | 9·40 | 2·85 | 5·40[a] | 21·61 | 2·50 | — | — | 21·68[b] | = 99·98 |
| 10. Tay Bridge | | 42·84 | 4·83 | 6·50 | 2·56[a] | 21·81 | 2·16 | — | *tr.* | 20·70[b] | = 101·40 |
| 11. Tayport | 2·283 | 40·11 | 6·49 | 5·61 | 2·37[a] | 21·67 | 2·01 | 0·21 | 0·32 | 21·60[b] | = 100·39 |
| 12. Cathkin Hills | 2·279 | 41·34 | 10·53 | 1·86 | 3·92[a] | 21·07 | 1·21 | 0·37 | 0·05 | 19·48[b] | = 99·84 |
| 13. " " | 2·288 | 42·22 | 8·51 | 2·99 | 4·95[a] | 21·23 | 0·92 | — | — | 19·48[b] | = 100·30 |
| 14. Bowling, *Bowlingite* | 2·308 | 38·08 | 6·26 | 4·36 | 5·20[a] | 21·46 | 2·97 | 0·11 | 0·95 | 20·48[b] | = 99·87 |
| 15. Storr | 2·296 | 41·41 | 9·08 | 2·05 | 0·11[a] | 22·80 | 1·86 | — | — | 23·43[b] | = 100·74 |
| 16. Quiraing | | 42·50 | 5·05 | 0·85 | 0·22[a] | 23·95 | 3·27 | 0·45 | 0·17 | 23·68[b] | = 100·14 |
| 17. " | | 40·33 | 8·72 | 1·97 | 0·13[a] | 21·71 | 2·80 | — | — | 24·34[b] | = 100 |
| 18. *Cathkinite* | 2·214 | 40·07 | 6·61 | 4·16 | 8·69 | 19·24 | 2·67 | *tr.* | | 17·16[b] | $CO_2$ 0·38<br>[= 98·98 |

[a] Incl. MnO, in 6, 0·13; in 7, 0·09; in 8, 0·12; in 9, 0 15; in 10, 0·20; in 12, 0·09; in 13, 0·07; in 14, 0·23; in 15, 0·11; in 16, 0·22; in 17, 0·13.

[b] Loss at 100°, in 6, 15·75; in 7, 14·09; in 8, 14·52; in 9, 12·96; in 10, 13·87; in 11, 13·96; in 12, 15·61; in 13, 14·76; in 14, 12·32; in 15, 13·65; in 16, 15·54; in 17, 15·13; in 18, 13·02.

**Pyr., etc.**—B.B. gives out water very readily and blackens; thin splinters fuse with difficulty on the edge. Decomposed by sulphuric acid.

**Obs.**—Occurs at Lizard Point, Cornwall, in veins in serpentine; at various localities in

Scotland, cf. Heddle, l. c., and anals. 6–17; at Svärdsjö in Dalarne (*piotine* and *saponite*); in the geodes of datolite at Roaring Brook, near New Haven, Ct.; in the trap of the north shore of Lake Superior, between Pigeon Point and Fond du Lac, in amygdaloid (*thalite* of Owen); George's Is., on north coast of Prince Edward Is.

*Bowlingite* is from Bowling near Dumbarton on the Clyde; it is shown to be saponite by Heddle; earlier analyses gave very discordant results, cf. App. III, p. 17, and Lcx., Bull. Soc. Min., 8, 97, 1885. *Cathkinite* is from the Cathkin Hills.

*Prasilite* of Thomson (p. 663) probably belongs here according to Heddle.

Saponite is from *sapo, soap;* and piotine from *πιότης, fat.*

**489. CELADONITE.** Terre verte de Verone *de Lisle*, Crist., 2, 502, 1783. Grünerde *Hoffm.*, Bergm. J., 519, 1788. Green Earth pt.; Green Earth of Verona. Seladonit *Glock.*, Syn., 193, 1847. Celadonite *Fr.*

Earthy or in minute scales. Very soft. Color deep olive-green, celandine-green, apple-green. Feel more or less greasy.

**Comp.**—A silicate of iron, magnesium, and potassium, formula doubtful.

**Anal.**—1–4, Heddle, Trans. R. Soc. Edinburgh, **29**, 102, 1879.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Scuir Mohr | 2·574 | 57·72 | 0·33 | 17·05 | 3·73 | 0·08 | 3·84 | 0·60 | 5·55 | 0·42 | 10·78 | =100·10 |
| 2. Tayport | 2·590 | 52·69 | 5·79 | 9·75 | 5·37 | 0·31 | 8·54 | 1·16 | 6·21 | 0·39 | 10·48 | =100·69 |
| 3. Tay Bridge | 2·598 | 52·54 | 5·82 | 9·71 | 5·40 | 0·31 | 8·31 | 1·29 | 6·50 | 0·64 | 10·41 | =100·93 |
| 4. Giant's Causeway | 2·63 | 56·41 | 2·14 | 14·07 | 5·10 | 0·23 | 5·91 | 0·60 | 8·83 | — | 6·80 | =100·09 |

An early analysis by Klaproth (Beitr., **4**, 239, 1807) gave:

Mte. Baldo $SiO_2$ 53 $Fe_2O_3$ 28 MgO 2 $K_2O$ 10 $H_2O$ 6 = 99

According to Klaproth, and also later, von Kobell, *not* acted on by hydrochloric acid.

**Obs.**—From cavities in amygdaloid at Mte. Baldo near Verona. Also a similar mineral from Scotland (anal. 1–4).

Named in allusion to the ordinary color of the mineral, *celadon-green*, equivalent in French to sea-green (written *Seladon* in German), for which term the English substituted *celandine-green.** Celadon is the name of one of the characters in a French romance by d'Urfé, entitled Astrée, published in 1610. He was a weak verdant lover of insipid tenderness, and thence the application to the above variety of green. D'Urfé borrowed the name from Ovid; it comes originally from *κελάδων, burning.*

**490. GLAUCONITE.** Glaukonit *Keferstein*, Deutsch. geol. dargest., 5, 510, 1828, *Glocker*, Handb., 832, 1831. Grünerde pt. *Germ.* Green Earth pt. Terre verte pt. *Fr.* Chlorophänerit *Jenzsch*, Jahrb. Min., 798, 1855.

Amorphous, and resembling earthy chlorite. Either in cavities in rocks, or loosely granular massive.

H. = 2. G. = 2·2–2·4. Luster dull, or glistening. Color olive-green, blackish green, yellowish green, grayish green. Opaque.

**Comp., Var.**—Essentially a hydrous silicate of iron and potassium; but the material is mostly, if not always, a mixture, and consequently varies much in composition.

In most of the early analyses the state of oxidation of the iron was not determined, but according to Haushofer it is chiefly ferric iron.

The kinds of glauconite are:

1. Green earth of cavities in eruptive rocks; to which the *chlorophanerite* of G. Jenzsch may perhaps be added.

2. Green grains of sand beds or rocks, as of the green sand of the Chalk formation, rarely found in limestones; called *glauconite* (in allusion to the grayish green color). H. = 2; G. = 2·29–2·35; color olive-green to yellowish green.

**Anal.**—1–3, A. Kupffer, JB. Ch., 1307, 1870; also other anals. of Russian glauconites. 4, Haushofer, J. pr. Ch., **102**, 38, 1866, also ibid., **97**, 353, 1866; many other anals. (in 5th Ed., p. 463). 5, Dewalque, Ann. Soc. G. Belg., **2**, 3, 1877. 6, Bamberger, Min. Mitth., 271, 1877. 7, Heddle, Trans. R. Soc. Edinb., **29**, 79, 1879. 8, Gümbel, Ber. Ak. München, Dec. 4, 1886. 9, Knerr & Schoenfeld, Am. Ch. J., **6**, 412, 1884. 10, 11, T. S. Hunt, Rep. G. Canada, 486–488, 1863. Earlier analyses are given in 5th Ed., pp. 462, 463; also a summary by Gümbel, l. c.

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* Jameson has *seladon-green* (from Werner) in his Treatise on the External Characters of Minerals, 1805; and *celandine-green* in his System of Mineralogy, **1**, 466. 1816.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Svir R., Russia | | 49·42 | 10·23 | 16·01 | 3·00 | 3·78 | 0·31 | 7·91 | 0·26 | 8·08 | insol. 0·80 = 99·80 |
| 2. Ontika, " | | 51·24 | 12·22 | 13·44 | 3·06 | 3·93 | 0·10 | 7·50 | 0;31 | 8·20 | =100 |
| 3. Grodno Valley, " | | 49·76 | 8·18 | 16·00 | 3·77 | 3·97 | 0·41 | 7·57 | 0·52 | 9·82 | =100 |
| 4. Havre | | 50·62 | 3·80 | 21·03 | 6·02 | 0·57[a] | 0·54[a] | 7·14 | — | 9·14 | = 99·86 |
| 5. Anvers, Belg. | | 50·42 | 4·79 | 19·90 | 5·96 | 2·28 | 3·21 | 7·87 | 0·21 | 5·28 | $P_2O_5$ *tr.* = 99·92 |
| 6. Gozzo Is. | 3·314 | 46·91 | 7·04 | 23·06 | 2·64 | 4·40 | 2·95 | 7·31 | 0·91 | 4·71 | = 99·93 |
| 7. Ashgrove | 2·296 | 49·09 | 15·21 | 10·56 | 3·06 | 2·65 | 0·55 | 6·05 | 1·21 | 11·64 | =100·02 |
| 8. Agulhas Bank | | 46·90 | 4·06 | 27·09 | 3·60 | 0·70 | 0·20 | 6·16 | 1·28 | 9·25 | = 99·24 |
| 9. French Creek, Pa. | 2·2 | 52·86 | 7·08 | 7·20 | 19·48 | 2·90 | *tr.* | 2·23 | *tr.* | 8·43 | =100·18 |
| 10. New Jersey | | 50·70 | 8·03 | 22·50 | | 2·16 | 1·11 | 5·80 | 0·75 | 8·95 | =100 |
| 11. Red Bird, Miss. | | 46·58 | 11·45 | — | 20·61 | 1·27 | 2·49 | 6·96 | 0·98 | 9·66 | =100 |

[a] Carbonates.

**Pyr., etc.**—Yields water. Fuses easily to a dark magnetic glass. Some varieties are entirely decomposed by hydrochloric acid, while others are not appreciably attacked.

The glauconite grains are most abundant in the "green sand," of the Chalk formation, sometimes constituting 75 to 90 p. c. of the whole. They are often casts of the shells of Rhizopods. The material has also been found in Silurian rocks, and beds of other geological periods, and even in the shells of recent Rhizopods, and in fragments of coral obtained in deep-sea soundings (Am. J. Sc., **22**, 281, 1856). The glauconite of the Silurian, analyzed by Hunt, contains less iron and more alumina than that of the Chalk formation.

For a general discussion of the nature and method of formation of glauconite, see Gümbel, Ber. Ak. München, 417–449, Dec. 4, 1886.

A green calcite from Central India contains a skeleton of glauconite—separable by acids—constituting about 14 p. c. of the whole. Haughton names the rock, which is a mixture of calcite and glauconite, *Hislopite* (Phil. Mag., **17**, 16, 1859).

**491. PHOLIDOLITE.** Folidolit *G. Nordenskiöld*, G. För. Förh., **12**, 348. 1890.

In minute crystalline scales distinctly bounded on two sides inclined to each other 60°, parallel to which there are two systems of fine cracks each making 30° with the medial line, which is the trace of the twinning plane.

Cleavage: basal, perfect. G. = 2·408. Luster resinous to pearly. Color grayish yellow by reflected light; nearly colorless under the microscope. Optically biaxial, negative. Ax. pl. ∥ edges of scales. Ax. angle = 20° approx.

**Comp.**—Corresponds approximately to $5H_2O.K_2O.12(Fe,Mg)O.Al_2O_3.13SiO_2$

**Anal.**—

| $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|
| 49·78 | 6·31 | 4·08 | 0·12 | 27·94 | 5·93 | 5·49 = 99·65. |

The material analyzed had been dried at 100° and the remaining water goes off only at a red heat; the air-dried mineral gives off 4·77 p. c. $H_2O$ over calcium chloride and 0·80 at 100°, or 5·57 in all, corresponding to another $5H_2O$.

Occurs at Taberg in Wermland, Sweden, with garnet, diopside, etc. Named φολίδος—φόλις, *scale*, εἶδος, *form*—in allusion to its micaceous structure.

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## IV. Kaolin Division.

| | | |
|---|---|---|
| **492. Kaolinite** | $H_4Al_2Si_2O_9$ | Monoclinic |
| **493. Halloysite** | $H_4Al_2Si_2O_9 + aq$ | Amorphous |
| **494. Newtonite** | $H_8Al_2Si_2O_{11} + aq$ | Rhombohedral |

$\grave{a} : b : \acute{c} = 0{\cdot}5748 : 1 : 1{\cdot}5997 \quad \beta = 83^\circ\ 11'$ (Kaolinite)

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| | | |
|---|---|---|
| **495. Cimolite** | $H_6Al_4(SiO_3)_9 + 3aq$ ? | Amorphous |
| **496. Montmorillonite** | $H_2Al_2(SiO_3)_4 + n\,aq$ | " |

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| | | |
|---|---|---|
| **497. Pyrophyllite** | $H_2Al_2(SiO_3)_4$ | Monoclinic |

| | | |
|---|---|---|
| **498. Allophane** | $Al_2SiO_5.5H_2O$ | Amorphous |
| **499. Collyrite** | $Al_4SiO_8.9H_2O$ | " |
| **500. Schrötterite** | $Al_{16}Si_3O_{30}.30H_2O$ | " |

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**492. KAOLINITE.** Talkerde von schuppigen Theilen (fr. Sonne Adit, Halsbrücke, near Freiberg) *Wern.*, Ueb., 218, 1780. Erdiger Talk *Hofmann*, Bergm. J., 160, 1789; *Karst.*, Tab., 32, 1800. ? Talc granuleux *H.*, Tr., **3**, 1801. Nacrite pt. *Brongn.*, Min., **1**, 505, 1807. Schuppiger Thon *Karst.*, Tab., 91. 1808. Nakrit *Breith.*, Char., 94, 318, 1832. Kaolinite *S. W. Johnson*, Am. J. Sc., **43**, 351, 1867. Caolino *Ital.* Caolina Sp.

Medulla Saxi, *Germ.* Steinmarck, pt., *Agric.*, Interpr., 466, 1546 = Lithomarge pt. Karnat *Breith.*, Handb., **2**, 359, 1841 = Steinmark von Rochlitz *Klapr.*, **6**, 285, 1815. Terra Samia, Collyrium, Aster, *Plin.*, **35**, 53. Marga porcellana, Leucargilla, pt., *Wall.*, 22, 1747. Terra Porcellanea *Cronst.*, 73, 1758. Porcelain Clay. Kaolin. Porzellanerde, Porzellanthon, *Germ.* Argiles à porcelaine *Fr.* Terre à foulon pt. Fr. = Fuller's Earth. Arcilla *Sp.*

Pholerite *Guillemin*, Ann. Mines, **11**, 489, 1825. Pholerite, Pelitische Felsittuffe von Chemnitz, *A. Knop*, Jb. Min., 540, 1859. Ancudit *O. Koch*, Inaug. Diss. Jena, 1884.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 0{\cdot}5748 : 1 : 1{\cdot}5997$; $\beta = 83° 11'$ Miers[1].
$100 \wedge 110 = 29° 43'$, $001 \wedge \bar{1}01 = 76° 22\frac{1}{2}'$, $001 \wedge 011 = 57° 48\frac{1}{3}'$.

**Forms:** *b* (010, *i-ì*), *c* (001, *O*), *m* (110, *I*), *n* ($\bar{1}11$, 1).

Angles: *mm'''* = 59° 26', *bm* = *60° 17', *nn'* = 58° 23', *bn* = 60° 48½' (meas. 60° 44'), *cm* = *84° 5', *cn* = *78° 8'.

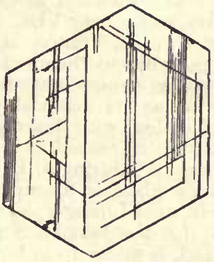
Also several doubtful pyramids.

If *m* be made 221 (= *M*, biotite) the forms noted for kaolinite approximate to those of biotite (p. 627); thus the measured angles for kaolinite as compared with the angles calculated for biotite are:

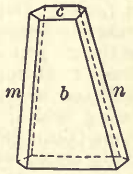
| | $001 \wedge 221$ | $001 \wedge \bar{1}11$ | $221 \wedge 2\bar{2}1$ | $\bar{1}11 \wedge \bar{1}\bar{1}1$ |
|---|---|---|---|---|
| Kaolinite | 84° 5' | 78° 8' | 59° 26' | 58° 23' |
| Biotite | 85° 38' | 81° 19' | 59° 48½' | 59° 14½' |

Usually in thin rhombic, rhomboidal, or hexagonal scales or plates with angles of 60° and 120° (f. 1), and sometimes twins, according to the mica law, made up of six sectors analogous to clinochlore. The scales rarely show distinct pyramidal planes and undetermined clinodomes; they are often grouped in fan-shaped forms. Also in crystals with pyramidal faces largely developed (f. 2), frequently twins (penninite law) with tw. plane and comp.-face *c* (001). Usually constituting a clay-like mass, either compact, friable, or mealy.

1.



2.



1, Johnson and Blake. 2, Anglesea, Dick.

Cleavage: basal, perfect. Flexible, inelastic. H. = 2–2·5. G. = 2·6–2·63. Luster of plates, pearly; of mass, pearly to dull earthy. Color white, grayish white, yellowish, sometimes brownish, bluish, or reddish. Scales transparent to translucent; usually unctuous and plastic.

Optically biaxial, negative. $Bx_o \perp b$. $Bx_a$ and ax. pl. inclined behind some 20° to normal to *c* (001) Dick. Axial angle large, approx. 90°. Dispersion weak.

**Var.**—1. *Kaolinite.* In crystalline scales, pure white and with a satin luster in the mass.

2. *Ordinary.* Common kaolin, in part in crystalline scales but more or less impure and either (*a*) *Argilliform*—soft, clay-like; (*b*) *Fariniform*—mealy, hardly coherent; or (*c*) *Indurated; Lithomarge* (*Steinmark* Germ.)—firm and compact; H. = 2–2·5. When pulverized, often shows a scaly texture. G. = 2·6, from Cainsdorf, solid var. *Tuesite* of Thomson is a lithomarge from Scotland, used sometimes for slate pencils; H. = 2·5; G. = 2·43–2·56; color milk-white.

3. *Ferruginous; Carnat* Breith. A firm lithomarge of a reddish white or flesh-red or brownish red color; the color owing to the presence of some iron oxide; H. = 2–3; G. = 2·543. Streak colorless; smooth to the touch

Myelin *Breith.*, Talksteinmark *Freiesleben* is simply kaolin according to Frenzel, J. pr. Ch., 5, 401, 1872. *Ancudite* (Koch) is an impure kaolin from Ancud (S. Carlos) on the island Chiloë, anal. 7.

Schlössing (l. c.) finds in certain French clays besides the crystallized kaolinite with the composition given below an *argile colloidale* which he makes lower in alumina and higher in silica, magnesia, and potash.

**Comp.**—$2H_2O.Al_2O_3.2SiO_2$ = Silica 46·5, alumina 39·5, water 14·0 = 100. The water goes off at a high temperature, above 330° Hillebrand (also, Dick).

Pholerite has been separated on the basis of Guillemin's analyses who gave 15 p. c. water, but there can be little doubt of its identity with kaolinite, cf. de Koninck, l. c.

**Anal.**—1, Tookey and Dick, Percy's Metallurgy, Fuel, 1875, and Min. Mag., **8**, 15, 1888. 2, Hillebrand, U. S. G. Surv., Bull. **20**, 97, 1885. 3, Hiortdahl, Jb. Min., **2**, 70, 1887. 4–6, L. L. de Koninck, Bull. Ac. Belg., **44**, 733, 1877.

| | | $SiO_2$ | $Al_2O_3$ | $H_2O$ | $Fe_2O_3$ |
|---|---|---|---|---|---|
| 1. Anglesea | G. = 2·62 | 46·53 | 38·93 | 13·87 | — = 99·33 |
| 2. Red Mt., Col. | G. = 2·611 | 46·35 | 39·59 | 13·93 | 0·11 F 0·15 = 100·13 |
| 3. " " " | | 45·57 | 41·52 | 13·58 | — = 100·67 |
| 4. Quenast | | 45·58 | 36·80 | 14·49 | 3·68 = 100·55 |
| 5. St. Gilles | | 45·97 | 40·12 | 13·91 | *tr.* = 100 |
| 6. La Chartreuse | | 46·72 | 38·32 | 13·85 | 0·77 CaO 0·60 = 100·26 |
| 7. *Ancudite* | | 44·56 | 36·92 | 15·64 | 1·22 CaO 0·31, MgO 0·41, $CO_2$ 0·36 = 99·42 |

For analyses of kaolins from France (Allier, Bretagne, Bayonne) and China, see Schlössing, C. R., **79**, 473, 1874. On the kaolins of the Bunt-Sandstein of Thuringia see Herold, Inaug. Diss. Jena, 1875 (E. E. Schmid, Zs G. Ges., **28**, 87, 1876).

For analyses of samples of "China clay" see Macadam, Min. Mag., **7**, 76, 1886; also Collins, ib., 205, who makes most of his purified clays agree with the formula $3H_2O.2Al_2O_3.4SiO_2$ = Silica 48·0, alumina 41·2, water 10·8 = 100. The correctness of the formula given above for pure kaolinite is sufficiently established by analyses 1–6.

**Pyr., etc.**—Yields water. B.B. infusible. Gives a blue color with cobalt solution. Insoluble in acids.

**Obs.**—Ordinary kaolin is a result of the decomposition of aluminous minerals, especially the feldspar of granitic and gneissoid rocks and porphyries. In some regions where these rocks have decomposed on a large scale, the resulting clay remains in vast beds of *kaolin*, usually more or less mixed with free quartz, and sometimes with oxide of iron from some of the other minerals present. Pure kaolinite in scales often occurs in connection with iron ores of the Coal formation. It sometimes forms extensive beds in the Tertiary formation, as near Richmond, Va. Also met with accompanying diaspore and emery or corundum.

Occurs in the coal formation at Cache-Aprés in Belgium; at St. Gilles and La Chartreuse near Lüttich and Bagatelle near Visé; Schlan in Bohemia, and at Röhe; in argillaceous schist at Lodève, Dept. of Hérault, France; at the Einigkeit mine at Brand, near Freiberg, and elsewhere in Saxony: as kaolin at Diendorf (Bodenmais) in Bavaria; at Zeisigwald near Chemnitz; as the gangue of topaz at Schneckenstein; with emery and margarite at Naxos; as the gangue of diaspore at Schemnitz; as the material of pseudomorphs after prosopite at Altenberg, showing well the hexagonal scales; with fluor at Zinnwald, a white powdery substance consisting of hexag. scales; at Rochlitz (*carnat*) in a porphyritic rock; as a cementing material in the sandstone (Bunt-Sandstein) of Thuringia; in seams in an argillaceous rock on the Tweed (*tuesite*), the Latin name of which place is *Tuesis*. In crystalline plates near Almwch on the island of Anglesey. At Yrieix, near Limoges, is the best locality of kaolin in Europe (a discovery of 1765); it affords material for the famous Sèvres porcelain manufactory. The dark colored clay of Stourbridge, England, is made up in large part of transparent laminæ. Large quantities of clay (kaolin) are found in Cornwall and West Devon, England, as described by Collins (l. c.) who gives the name carclazyte to a china-clay rock as at Carclaze, Cornwall, and petuntzyte to a less altered rock containing still fresh feldspar.

In the U. States, kaolin occurs at Newcastle and Wilmington, Del.; at various localities in the limonite region of Vermont (at Brandon, etc.), Massachusetts, Pennsylvania; Jacksonville, Ala.; Edgefield, S. C.; near Augusta, Ga.; and Johnson and Blake observed transparent hexagonal scales abundantly in a blue fire-clay from Mt. Savage, Md.; in the white clay of Brandon, Vt., Beekman, N. Y., Perth Amboy, N. J., Reading, and a locality in Chester Co., Pa., Long Island, and in white and colored clays of various other places. Near Richmond, Va., the mealy var. constitutes a bed of considerable extent in the Tertiary formation; at Tamaqua and Summit Hill in Carbon Co., Pa., it occurs in the Coal formation; in a sandstone of the L. Silurian, just below the Chaudière Falls, filling seams or fissures, often ½ in. thick, having an unctuous feel, and consisting of minute soft scales. At the National Bell mine, Red Mountain, Silverton, Colorado, in very pure form in cavities of a quartz vein material enclosed in a large eruptive mass; also at Bedwell Basin, Gunnison Co., Col. (anal. by Eakins, see U. S. G. Surv., Bull. **60**, 136, 1890).

The kaolin of the Thuringian Bunt-Sandstein is crystalline but contains various foreign substances as the *microschörlite* and *microvermiculite* of Schmid.

The name *Kaolin* is a corruption of the Chinese *Kauling*, meaning *high-ridge*, the name of a hill near Jauchau Fu, where the material is obtained; and the petuntze (peh-tun-tsz) of the Chinese, with which the kaolin is mixed in China for the manufacture of porcelain, is a quartzose feldspathic rock, consisting largely of quartz (S. W. Williams). The word *porcelain* was first given to the china-ware by the Portuguese, from its resemblance to the nacre of the sea-shells *Porcellana* (Cypræas), they supposing it to be made from egg-shells, fish-glue, and fish scales (S. W. Williams).

G. Vogt has investigated the yeou-ko of the Chinese and finds that it is made up of: Quartz 52·9 p. c., muscovite 31·3, sodium feldspar 13·4, calcium carbonate 2·0, hydrated silica 1·0 = 100·6. C. R, **110**, 43, 1890.

**Ref.**—[1] Min. Mag., **8**, 15, 1888, with corrected fundamental angles as later noted by the author, ibid., **9**, 4, 1890. Cf. also Johnson and Blake, Am. J. Sc., **43**, 35, 1867; R. C. Hills, Am. J. Sc., **27**, 472, 1884.

Reusch (Jb. Min., **2**, 70, 1887) makes the extinction in the scales oblique (12°) to an hexagonal edge, perhaps because the scales are often fan-shaped aggregates; the triclinic character does not seem to be confirmed by Dick and Miers.

MEERSCHALUMINITE *Ross.* Simlaite *Schrauf*, Vh. G. Reichs., 43, 1870. A kind of pholerite from near Simla, India. An analysis by Maskelyne and Flight (Ch. News, **22**, 260, 1870) gave:

$SiO_2$ 43·15 $Al_2O_3$ 41·07 $H_2O$ 15·78 = 100.

RECTORITE *R. N. Brackett* and *J. F. Williams*, Am. J. Sc., **42**, 16, 1891.

Monoclinic? In leaves or plates resembling mountain leather. Very soft, hardness less than that of talc. Feel soapy. Folia flexible, inelastic, and separating with easy cleavage.

Luster pearly. Color pure white, sometimes stained red with iron oxide. Optically biaxial, Bx ⊥ cleavage. 2E = 5° to 15° or 20°. Refractive index low.

Composition for the mineral dried at 110°, $HAlSiO_4$ or $Al_2O_3.2SiO_2.H_2O$ = Silica 50·0, alumina 42·5, water 7·5. Taking the water expelled at 110° as water of crystallization the formula is $2HAlSiO_4 + aq$, or empirically like kaolinite, from which it differs, however, since the latter mineral contains only water of constitution.

Analysis, on material dried at 110°:

| | $SiO_2$ | $Al_2O_3$ | $H_2O$ | $Fe_2O_3$ | CaO | MgO | $Na_2O$ | $K_2O$ |
|---|---|---|---|---|---|---|---|---|
| 1. | 52·72 | 36·60 | 7·76 | 0·25 | 0·45 | 0·51 | 2·83 | 0·26 = 101·38 |
| 2. | 52·88 | 35·51 | 7·72 | | | | | |

$H_2O$ at 110° in 1, 8·78 p. c.; in 2, 8·33.

B.B. infusible, but loses water and becomes brittle.

Found in seams in L. Silurian sandstone in the Blue Mountain mining district, Marble township, Garland Co., Arkansas, about 24 miles north of Hot Springs.

Named after Hon. E. W. Rector of Hot Springs.

LEVERRIERITE *P. Termier*, C. R., **108**, 1071, 1889; Ann. Mines, **17**, 372, 1890; Bull. Soc. Min., **13**, 325, 1890.

In vermiculate aggregates resembling helminth. Crystals hexagonal prisms, perhaps orthorhombic, with *c* (001), *b* (010), *m* (110), and $mm''' = 52°$ approx. Form and twinning like the micas.

Cleavage: basal, perfect. Soft. H. = 1·5. G. = 2·3–2·4. Luster vitreous to pearly. Colorless to brown. Optically −. Ax. pl. ∥ *b* (010). Bx ⊥ *c*. Ax. angle 45°–52°. $\beta = 1·6$. $\gamma - \alpha = 0·0075–0·0082$.

Comp.—A hydrated silicate of aluminium, but formula doubtful, as the material is more or less mixed with clay and analyses fail to agree. The author gives $2Al_2O_3.5SiO_2.5H_2O$ = Silica 50·5, alumina 34·3, water 15·2 = 100.

Anal.—1, A. Carnot, l. c.; C. R., **108**. 2, 3, quoted by Termier, l. c., Ann. Mines. 2, by Meunier.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MnO | CaO | MgO | $K_2O$ | ign. |
|---|---|---|---|---|---|---|---|---|
| 1. | 49·30 | 22·60 | 0·34 | 0·40 | 6·80 | 0·66 | 1·36 | 17·90 = 99·36 |
| 2. | 46·4 | 38·4 | *tr.* | — | 1·2 | — | — | 15·0 $P_2O_5$ 0·5 = 101·5 |
| 3. | 46·79 | 34·47 | — | — | 4·53 | — | — | 13·21 = 99· |

Common in the black carbonaceous shales of the Departments de la Loire, France; thus at Beaubrun, Rive-de-Gier, Quartier-Gaillard near St. Etienne and other points; also in eruptive rocks (porphyry) of St. Etienne, at La Gagnérette, etc., Dept. du Gard.

Named after the mining engineer Le Verrier.

**493. HALLOYSITE.** Halloysite *Berthier*, Ann. Ch. Phys., **32**, 332, 1826. Galapektit, Gummit, *Breith.*, Char., 99, 1832. Glagerit *Breith.*, Handb., 357, 1841. Smectite *Salvetat*, Ann. Ch. Phys., **31**, 102, 1851. Steinmark or Lithomarge pt., Pseudo-Steatite pt., Glossecollite, *Shep.*, Min., 1857, App. to Suppl., p. iii.

? Lenzinit *John.*, Chem. Schrift., **5**, 193, 1816. ? Severite *Beud.*, Tr., 1824, in Index, and **2**, 36, 1832. ? Nertschinskite *Razumovski.* Bole pt. Milanit *Tietze*, Jb. G. Reichs., 588, 1870. Indianaite *Cox*, Rep. Geol. Indiana, 15, 1874, 154, 1878.

Massive. Clay-like or earthy.

Fracture conchoidal. Hardly plastic. H. = 1–2. G. = 2·0–2·20. Luster somewhat pearly, or waxy, to dull. Color white, grayish, greenish, yellowish, bluish, reddish. Translucent to opaque, sometimes becoming translucent or even transparent in water, with an increase of one-fifth in weight.

**Var.**—1. *Ordinary.* Earthy or waxy in luster, and opaque massive. *Galapectite* is halloysite of Anglar. *Pseudosteatite* of Thomson & Binney is an impure variety, dark green in color, with H. = 2·25, G. = 2·469. *Glagerite*, from Bergnersreuth in Bavaria, is proved to be halloysite by Fikenscher; it is white to yellowish white; G. = 2·35–2·38; H. = 2–2·5.

*Indianaite* is a white porcelain clay from Lawrence Co., Indiana, where it occurs with allophane in beds four to ten feet thick. H. = 2–2·5. G. = 2·31–2·53.

2. *Smectite* of Salvetat is greenish, and in certain states of humidity appears transparent and almost gelatinous; it is from Condé, near Houdan, France. Breithaupt's *Gummite* (Char., 99, 1832; is a "gum-like halloysite," not adhering to the tongue, from Anglar, though in his Handbuch, where the same locality is mentioned, he quotes Berthier's analysis of *collyrite* from the Pyrenees. *Glossecollite* is milk-white and earthy, but becomes translucent on the edges and a little opaline in water. It forms a seam 1 in. thick in a siliceous Silurian rock in Rising Fawn, Dade Co., Georgia. A yellow gum-like clay from near Budapest is referred to halloysite by Fr. Koch, Zs. Kr., **19**, 198, 1891.

3. *Lenzinite* is earthy, compact, white, translucent, and somewhat opaline, from Kall in the Eifel; and brownish, from rifts in pegmatyte, at La Vilate, near Chanteloube, in France. Leonhard considered it (Handb., 1826) a decomposed semiopal. It is described as not gelatinizing in acids. Named after the German mineralogist Lenz. *Nerchinskite* of Razumovski, a whitish or bluish earth from Nerchinsk, has been referred to lenzinite. *Severite*, or lenzinite of St. Sever, was first noticed in 1818, and analyzed in that year by Pelletier (J. Phys., **86**, 251, 1818). It has sometimes the semitransparency of opal, a soft feel, adheres strongly to the tongue, and makes no paste with water; it is from the upper arenaceous stratum in the gypsiferous Tertiary at St. Sever in France. It is not clear whether it belongs here or to kaolinite.

4. *Bole*, in part, may belong here; that is, those colored, unctuous clays containing more or less iron oxide, which also have about 24 p. c. of water; the iron gives it a brownish, yellowish, or reddish color; but more investigation is needed before it is known that they are not mere mixtures. *Oropion* of Glocker (Syn., 188, 1847) is a dark brown to black bole; it is the *Bergseife* (= mountain soap) of Werner (Ueb. Cronst., 189, 1780), having a greasy feel and streak, and H. = 1–2; the color is attributed to bituminous matters present. It is from Olkutsch in Poland. Where it belongs is doubtful. A similar kind from Thuringia has been analyzed by Bucholz (5th Ed., p. 477); but its identity with Werner's Polish *Bergseife* is not certain.

*Milanite* is from Maidanpek, Servia.

**Comp.**—A silicate of aluminium ($Al_2O_3.2SiO_2$) like kaolinite, but amorphous and containing more water; the amount is somewhat uncertain but, as shown by Le Chatelier, the formula is probably to be taken as $H_4Al_2Si_2O_9$ + aq, or $2H_2O.Al_2O_3.2SiO_2$ + aq = Silica 43·5, alumina 36·9, water 19·6 = 100.

Analyses by Le Chatelier on material heated to 250° gave the following results corresponding to the kaolinite formula $2H_2O.Al_2O_3.2SiO_2$; he finds further that the remaining water goes off only above 400°, the earlier amount at 150°. Bull. Soc. Min., **10**, 210, 1887.

| | $SiO_2$ | $Al_2O_3$ | $H_2O$ | | | $H_2O$ below 250° |
|---|---|---|---|---|---|---|
| Angleur | 46·3 | 39·5 | 14·3 | = | 100·1 | 8·5 |
| Huelgoat | 47·9 | 38·0 | 14·3 | = | 100·2 | 5·4 |
| Miglos | 46·3 | 38·7 | 14·0 | = | 99·0 | 6·5 |
| Breteuil | 48·3 | 35·6 | 14·3 | = | 98·2 | 12·5 |
| Laumède | 48·7 | 36·5 | 13·6 | = | 98·8 | 4·0 |
| Eifel | 46·6 | 39·3 | 13·0 | = | 98·9 | 3·5 |
| Russia | 47·4 | 38·8 | 14·0 | = | 100·2 | 7·0 |

The following are analyses of *indianaite* by Pemberton on air-dried material:

| $SiO_2$ | $Al_2O_3$ | $H_2O$ | $H_2O$ at 100° C. | CaO,MgO | alkalies | | |
|---|---|---|---|---|---|---|---|
| 39·00 | 36·00 | 14·00 | 9·50 | 0·63 | 0·54 | = | 99·67 |
| 39·35 | 36·35 | 22·90 | | 0·40 | — | = | 99·00 |
| 38·90 | 37·40 | 23·60 | | *undet.* | — | = | 99·90 |

Helmhacker shows that some halloysites contain 4½ aq. and others 3 aq. when dried over sulphuric acid. He gives analyses 1–3. by Hofmann, Min. Mitth., **2**, 231, 1879. G. = 1·961–1·962, after exposure to dry air 1·985.

| | $SiO_2$ | $Al_2O_3$ | $H_2O$ above 100° | $H_2O$ at 100° | |
|---|---|---|---|---|---|
| 1. | 40·19 | 34·84[a] | 15·27 | 8·08 | CaO 2·55, MgO *tr.* = 100·93 |
| 2. | 36·34 | 32·34[b] | 18·29 | 10·59 | CaO 2·31 = 99·87 |
| 3. | 35·73 | 33·83[a] | 17·65 | 10·96 | CaO 2·58, CuO 0·10 = 100·85 |

[a] $Fe_2O_3,P_2O_5$ *tr.* [b] $Fe_2O_3$ 0·27 p. c.

Other analyses 5th Ed., pp. 476, 477.

Compact *glagerite* forming seams in clay at Gusevsk, Ural (Zs. Kr., **17**, 628, 1890), gave:

$SiO_2$ 45·85 $Al_2O_3$ 36·97 $Fe_2O_3$ *tr.* CaO 0·64 MgO 0·25 $H_2O$ 16·14 = 99·85

**Pyr., etc.**—Yields water. B.B. infusible. A fine blue with cobalt solution. Decomposed by acids.

**Obs.**—Occurs often in veins or beds of ore, as a secondary product; also in granite and other rocks, being derived from the decomposition of some aluminous minerals (localities mentioned above). The *Halloysite* of Housscha is derived from graphic granite.

The name *halloysite* is from Omalius d'Halloy (1707–1789), who first observed it.

**494. NEWTONITE.** *R. N. Brackett* and *J. F. Williams*, Am. J. Sc., **42**, 11, 1891.

Rhombohedral. In soft compact masses, resembling kaolin, the powder resolved under the microscope (× 400 to 500 diam.) into minute rhombs, nearly squares, but giving angles of 88° to 89°.

Soft. G. = 2·37. Color white. Extinction parallel to the diagonals of the rhombs.

**Comp.**—$H_8Al_2Si_2O_{11}$ + aq or $Al_2O_3.2SiO_2.5H_2O$ = Silica 38·5, alumina 32·7 water 28·8 = 100.

**Anal.**—1, 2, Brackett & Williams, l. c.

| | $SiO_2$ | $Al_2O_3$ | $H_2O$[a] | $Fe_2O_3$ | CaO | MgO | $Na_2O$ | $K_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 38·86 | 35·20 | 23·69 | 0·21 | 0·31 | *tr.* | [1·73] | | = 100 |
| 2. | 40·22 | 35·27 | 22·89 | 0·21 | 0·54 | *tr.* | 0·99 | 0·73 | = 100·85 |

[a] Ignition; at 110°–115°, 5·53 p. c. $H_2O$ in 1; 5·44 in 2.

**Pyr., etc.**—B.B. infusible; gives the alumina reaction with cobalt solution. Only slightly attacked by boiling hydrochloric acid, but almost completely decomposed by boiling concentrated sulphuric acid with separation of silica.

**Obs.**—Found on Sneed's Creek in the northern part of Newton Co., Arkansas. Occurs in lumps varying from a few ounces to forty pounds, embedded in a dark gray clay.

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**495. CIMOLITE.** Κιμωλία *Theophr.* Cimolia *Plin.*, **35**, 57. Cimolit *Klapr.*, Beitr., **1**, 291, 1795. Pelikanit *Ouchakoff*, Bull. Ac. St. Pet., **16**, 129, J. pr. Ch., **74**, 254, 1858. Hunterite *Haughton*, Phil. Mag., **17**, 18, 1859, **23**, 50, 1862.

Terra Lemnia *Dioscor*, *Plin.*, etc. Sphragid *Karst.*, Tab., 28, 88, 1808. Ehrenbergit *Nöggerath*, Vh. Ver. Rheinl., **9**, 378, 1852. Anauxite *Breith.*, J. pr. Ch., **15**, 325, 1838.

Amorphous, clay-like, or chalky.

Very soft. G. = 2·18–2·30. Luster of streak greasy. Color white, grayish white, reddish. Opaque. Harsh. Adheres to the tongue.

**Comp.**—A hydrous silicate of aluminium, $2Al_2O_3.9SiO_2.6H_2O$ = Silica 63·4, alumina 23·9, water 12·7 = 100. Perhaps a basic salt.

**Anal.**—1, Klaproth, l. c. 2, Ilimov [Ann. J. M. Russ., 336, 1841] Rg., Min. Ch., 584, 1860. 3, v. Hauer, Jb. G. Reichs., **5**, 83, 1854. 4, Haughton, l. c. 5, Riggs, Am. J. Sc., **32**, 355, 1886. Also F. W. Clarke, Am. J. Sc., **28**, 23, 1884; Scharizer, Jb. G. Reichs., **32**, 488, 491, 1882.

| | G. | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. Argentiera | | | 63·00 | 23·00 | 1·25 | 12·00 = 99·25 |
| 2. Ekaterinovska | | | 63·52 | 23·55 | — | 12·00 = 99·07 |
| 3. Near Bilin, *Anauxite* | 2·376 | $\frac{2}{2}$ | 62·30 | 24·23 | — | 12·34 CaO 0·83 = 99·70 |
| 4. *Hunterite* | 2·319 | | 65 93 | 20·97 | — | 11·61 MgO 0·45, CaO 0·30 = 99·26 |
| 5. Norway, Me. | | | 66·86 | 22·23 | 0·47 | 8·26 X[a] 1·00, alk. 0·93, F 0·06 = 99·81 |

[a] X = FeO,MnO,CaO,MgO.

The hunterite, according to the analysis, contains a little excess of silica, probably due to free quartz, as the material was gritty under the pestle.

**Pyr., etc.**—Yields water. B.B. becomes gray and finally burns white; infusible. With cobalt solution a blue color.

**Obs.**—From the island of Argentiera (Kimolos of the Greeks); Berg Hradischt, near Bilin, Bohemia (pseud. after augite, cf. Scharizer, l. c.); also from Ekaterinovska, district of Alexandrovsk, Russia; Government of Kiev, Russia; Nagpur, Central India, with orthoclase in granite. A related mineral (anal. 6) from Norway, Me., associated with tourmaline.

A light porous clay-like mineral of a dull white color, resembling meerschaum, has been investigated by Liversidge, Min N. S. W., 194, 1888. H. = 2–2·5. Specific gravity after immersion 1·168. Fracture conchoidal. Analysis:

$SiO_2$ 51·46[a] $Al_2O_3$ 37·72 $Fe_2O_3$ 0·46 CaO 0·34 MgO 1·25 $H_2O$ 7·62[b] $CO_2$ 1·54 = 100·39

[a] Soluble 0·11 p. c. [b] At 100°, 3·28 p. c.

From Richmond River, New South Wales.

**496. MONTMORILLONITE.** *Salvetat*, Ann. Ch. Phys., **21**, 376, 1847. Confolensite *Dufr.*, Min., 3. 583, 1856. Delanovit *Kenng.*, Jb. G. Reichs., **4**, 633, 1853. Delanouite *Dufr.*, Min., 3, 583, 1856. Stolpenit (= Bole of Stolpen) *Kenng.*, Min., 41, 1853. Saponite *Nicklès*, Ann. Ch. Phys., **56**, 46, 1859 = Pierre a savon (*Germ.* Bergseife) de Plombières. Steargillite *Meillet*, Dx., Min., **1**, 205, 1862. Erinite *Thomson*, Min., **1**, 341, 1836.

Massive, clay-like.

Very soft and tender. Luster feeble. Color white or grayish to rose-red, and bluish; also pistachio-green. Softens in water, and for the most part does not adhere to the tongue. Unctuous.

**Var.**—1. *Montmorillonite* is rose-red; from Montmorillon, France. *Confolensite* is paler rose-red; fr. Confolens, Dept. of Charente, at St. Jean-de-Côle, near Thiviers. *Delanouite* is similar in color, and is from Millac, near Nontron, France; stated by Kenngott to adhere to the tongue.

2. *Stolpenite* is a clay from the basalt of Stolpen. *Steargillite* is white, yellow, and pistachio-green, subtranslucent, insoluble in acids; and is easily cut into cakes looking like soap or wax; fr. near Virolet on the Rochelle railroad, and at the tunnel of Poitiers. *Saponite* of Nicklès is a white, plastic, soap-like clay from the granite from which issues one of the hot springs of Plombières, France, called *Soap Spring;* it was named *smegmatite* by Naumann. Nicklès obtained: $SiO_2$ 42·3, $Al_2O_3$ 19·2, $H_2O$ 38·5 = 100.

*Erinite* is a yellowish red clayey mineral from the Giant's Causeway; G. = 2·04; opaque; a little resinous in luster; unctuous; B.B. infusible, but whitens. Named from Erin (Ireland).

**Comp.**—Probably $H_2Al_2Si_4O_{12} + n$ aq. Chatelier, but analyses vary rather widely.

**Anal.**—1, 2, Salvetat & Damour, l. c. 3, Berthier [Tr. Ess. v. sèche **1**, 58], 5th Ed., p. 459. 4, Hauer, Jb. G. Reichs., **4**, 633, 1853. 5, Salvetat, l. c. 6, Rg., Pogg., **47**, 180, 1839. 7, Meillet, l. c. 8, Thomson, l. c. 9, Le Chatelier, Bull. Soc. Min., **10**, 209, 1887. 10, Helmhacker, Min. Mitth., **2**, 251, 1879. 11, H. L. Wells, Am. J. Sc., **20**, 283, 1880. 12, Collins, Min. Mag., **2**, 92, 1878.

| | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MgO | CaO | $(Na,K)_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 1. Montmorillon, *Mont.* | $\frac{4}{4}$ | 49·40 | 19·70 | 0·80 | 0·27 | 1·50 | 1·50 | 25·67 = 98·84 |
| 2. " " | $\frac{3}{3}$ | 50·04 | 20·16 | 0·68 | 0·23 | 1·46 | 1·27 | 26·00 = 99·84 |
| 3. Confolens, *Conf.* | | 49·5 | 18·0 | — | 2·1 | 2·1 | — | 28·0 = 99·7 |
| 4. Millac, *Delan.* | | 50·55 | 19·15 | — | 4·40[a] | 0·63 | — | 24·05 = 98·78 |
| 5. St. J. de Côle, *Conf.* | | 45·55 | 22·60 | 1·05 | 0·30 | 1·66 | 0·10 | 26·20 $SiO_2$ gel. 0·96, qtz. [1·04 = 99·46 |
| 6. *Stolpenite* | | 45·92 | 22·15 | — | — | 3·90 | — | 25·86 = 97·83 |
| 7. *Steargillite* | | 45·30 | 23·30 | 1·21[b] | 1·48[a] | — | 1·70 | 27·00 = 99·99 |
| 8. *Erinite* G. = 2·04 | | 47·04 | 18·46 | 6·36[b] | — | 1·00 | — | 25·28 NaCl 0·9 = 99·04 |
| 9. St. Jean de Côle | | 49·0 | 23·1 | 2·4 | — | 0·5 | — | 23·7[c] = 98·7 |
| 10. Podurusj, *rose-red* | | 58·77 | 24·03 | 0·52 | 4·73 | 2·32 | 0·67 | 10·28[d] = 101·32 |
| 11. Branchville, Ct., *rose-red* | $\frac{2}{2}$ | 51·20 | 22·14 | — | 3·72 | 3·53 | 0·56 | 17·08 MnO 0·18, $P_2O_5$ 1·42 [= 99·83 |
| 12. Cornwall | | 47·9 | 27·1 | 1·2 | — | — | [0·8] | 23·0 = 100 |

[a] MnO. [b] FeO. [c] At 250°, 16·7 p. c. [d] At 100°, 2·97 p. c.

The material of anal. 11 contained 2·28 p. c. apatite; that of anal. 10 had G. = 2·172 with 10·54 hygr. $H_2O$, and G. = 2·520 when dried over sulphuric acid.

Salvetat observes that sodium carbonate separates a little gelatinous silica, and sulphuric acid some quartz-silica—a fact of great interest in connection with the earthy hydrous aluminous silicates generally.

**Pyr., etc.**—B.B. infusible, excepting the stolpenite, which affords a yellowish enamel, probably owing to the 4 p. c. of lime in the state of silicate present as impurity. Montmorillonite loses 6 p. c. of water at 100° C., and delanouite 14 p. c.

*Severite*, according to the analysis of Pelletier (p. 688), would be identical nearly with the mineral from Confolens.

**Obs.**—Occurs as an alteration-product at the localities mentioned above.

Also in the U. S., at Branchville, Conn., in a soft pink form in a vein of albitic granite, probably due to the alteration of spodumene.

RAZOUMOVSKYN. Razoumoffskin *John*. A greenish white clay-like mineral from Kosemütz, in Silesia, near montmorillonite, except in the less amount of water. Zellner obtained, Schwgg. J., **18**, 340, 1816:

$SiO_2$ 54·50 $Al_2O_3$ 27·25 FeO 0·25 MgO 0·37 CaO 2·00 $H_2O$ 14·25 = 98·62

A similar bluish or greenish clay from the old copper mines at Lading, west of Wolfsberg, in Carinthia, has been investigated by Helmhacker, Min. Mitth., **2**, 256, 1879. H. = 3. Fracture subconchoidal. G. = 2·022 air-dried, = 2·285 after losing 10·12 p. c. hygroscop. water, = 2·138 corrected for impurities.

Analyses.—1, Helmhacker, l. c. 2, Hofmann, ibid.

| | $SiO_2$ | $Al_2O_3$ | CuO | CaO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|
| | | | | | at 100° | above 100° | |
| 1. | 43·06 | 25·26 | 3·25 | 0·83 | 8·44 | 20·10 | = 100·94 |
| 2. | 41·94 | 25·55 | 5·77 | 1·80 | 9·35 | 15·16 | = 99·57 |

The material analyzed contained some calcite and azurite. The formula for 1 is $Al_2O_3.3SiO_2 + 6H_2O$, or dried at 100°, $+ 4H_2O$.

## 497. PYROPHYLLITE.

Pyrophyllit *Herm.*, Pogg., **15**, 592, 1829. Pyrauxit *Breith.*, Handb., 397, 1841. Agalmatolite or Pagodite pt.

Monoclinic? Not observed in distinct crystals. Foliated, radiated lamellar or somewhat fibrous; also granular to compact or cryptocrystalline; the latter sometimes slaty.

Cleavage: basal, eminent. Laminæ flexible, not elastic. Feel greasy. H. = 1–2. G. = 2·8–2·9. Luster of folia pearly; of massive kinds dull and glistening. Color white, apple-green, grayish and brownish green, yellowish to ochre-yellow, grayish white. Subtransparent to opaque. Optically −. Bx ⊥ cleavage. Ax. angle large, to 108°, Dx.

**Var.**—(1) Foliated, and often radiated, closely resembling talc in color, feel, luster, and structure; G. = 2·785 Berlin. (2) Compact massive, white, grayish, and greenish, somewhat resembling compact steatite, or French chalk; G. = 2·81–2·92 Brush; H. = 1·5–3. This compact variety, as Brush has shown, includes part of what has gone under the name of agalmatolite, from China; it is used for slate pencils, and is sometimes called *pencil-stone*.

**Comp.**—$H_2Al_2Si_4O_{12}$ or $H_2O.Al_2O_3.4SiO_2$ = Silica 66·7, alumina 28·3, water 5·0 = 100.

**Anal.**—1, Rg., Pogg., **68**, 513, 1846. 2, Sjögren, Öfv. Ak. Stockh., **5**, 110, 1848. 3, Walmstedt, ib., p., 111. 4, Brush, Am. J. Sc., **26**, 68, 1858. 5, Church, Ch. News, **22**, 220, 1870. 6, Tyson, Am. J. Sc., **34**, 219, 1862. 7, Allen, ib. 8, F. A. Genth, ib., **18**, 410, 1854 (also a second anal.). 9, Id., Am. Phil. Soc., **18**, 259. 1879. 10, Gümbel, Ber. Ak. München, 498, 1868. 11, Gorceix, Bull. Soc. Min., **6**, 27, 1883. Also Igelström, Öfv. Ak. Stockh., **25**, 38, 1868; Dewalque, Bull. Soc. G. Belg., **6**, 150, 151, 1879; Koninck, Bull. Ac. Belg., **26**, 469, 1868; and 5th Ed., p. 455.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Spa, Belg. | | 66·14 | 25·87 | — | 1·49 | 0·39 | 5·59 | = 99·48 |
| 2. Westanå, Sw. | | 65·61 | 26·09 | 0·70 | 0·09 | 0·69 | 7·08 | MnO 0·09 = 100·35 |
| 3. China, *Pagodite* | | 66·38 | 27·95 | 0·06 | 0·06 | 0·18 | 5·20 | = 99·83 |
| 4. " " | 2·81 | 65·95 | 28·97 | | — | 0·22 | 5·48 | alk. 0·25 = 100·87 |
| 5. *Pagodite* | 2·8 | 62·25 | 31·06 | 0·82 | 0·60 | — | 4·66 | = 99·39 |
| 6. Deep R., N. C., *mass.* | 2·92 | 65·93 | 29·54 | | — | — | 5·40 | = 100·87 |

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 7. Carbonton | 2·82 | 66·25 | 27·91 | 1·08 | — | — | 5·25 | = 100·49 |
| 8. Chesterfield Dist., S. C., *fol.* | | 66·01 | 28 52 | 0·87 | 0·18 | 0·23 | 5·22 | = 101·03 |
| 9. Mahanoy City, Penn. | 2·804 | 66·61 | 27·63 | 0·16 | 0·10 | — | 5·43 | = 99·93 |
| 10. Fichtelgebirge | | 58·87 | 34·87 | — | — | — | 5·77 | = 99·51 |
| 11. Ouro Preto | 2·76 | 65·3 | 28 0 | 1·7[a] | — | 0·4 | 5·5 | = 100·5 |

[a] FeO.

**Pyr., etc.**—Yields water, but only at a high temperature. B.B. whitens, and fuses with difficulty on the edges. The radiated varieties exfoliate in fan-like forms, swelling up to many times the original volume of the assay. Heated and moistened with cobalt solution gives a deep blue color (alumina). Partially decomposed by sulphuric acid, and completely on fusion with alkaline carbonates.

**Obs.**—Compact pyrophyllite is the material or base of some schistose rocks. The foliated variety is often the gangue of cyanite.

Pyrophyllite occurs in the Ural, between Pyschminsk and Berezov; at Westanå, Sweden; the Horrsjöberg in Elfdalen, with cyanite; near Ottrez in Luxembourg; Ouro Preto, Brazil, in foliated masses of considerable extent.

Also in white stellate aggregations in Cottonstone Mtn., Mecklenburg Co., N. C.; in Chesterfield Dist., S. C., with lazulite and cyanite; in Lincoln Co., Ga., on Graves Mtn.; in Arkansas, at the Kellogg lead mine, near Little Rock. The compact kind, resembling a slaty soapstone in aspect and feel, is found in large beds in Deep River, N. C., greenish to yellowish white in color; similar at Carbonton, Moore Co., N. C. In thin seams and as petrifying material in coal slates of Mahanoy City, Penn.

The compact pyrophyllite of Deep River, N. C., is extensively used for making slate pencils and resembles the so-called agalmatolite or pagodite of China, often used for ornamental carvings. The term agalmatolite, however, has been loosely used for a variety of minerals; it properly belongs to a kind of pinite (p. 622).

GÜMBELITE *F. von Kobell*, Ber. Ak. München, 1, 294, 1870.

In thin, short fibrous layers in clay slate. Color light greenish white. Translucent. Luster pearly. Soft and flexible. Analyses.—1, Kobell, l. c. 2, Gümbel, Min. Mitth., 2, 189, 1879.

| | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MgO | $K_2O$ | $Na_2O$ | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Nordhalben | | 50·52 | 31·04 | 3·00 | 1·88 | 3·18 | — | 7·00 | X[a] 1·46 | = 98·08 |
| 2. Tarentaise | G. = 2·8 | 49·71 | 28·62 | 2·69 | 1·60 | 6·80 | 2·21 | 7·38[b] | $TiO_2$ 1·04 | = 100·05 |

[a] Undecomposed mineral. [b] Incl. C.

In the closed tube yields water. B.B. exfoliates somewhat like pyrophyllite. Fuses at 4. Not acted upon by acid.

Found at Nordhalben near Steben, in Oberfranken. Also (anal. 2) as a petrifying material of coal plants in the Tarentaise.

A mineral similarly associated in Pennsylvania was found by Genth to be pyrophyllite (anal. 9, above). Gümbelite may be an impure pyrophyllite.

NEUROLITE *Thomson*, Min., 1, 354, 1836. According to T. S. Hunt (Rep. G. Can., 485, 1863) a quartzose variety of wood-like agalmatolite. Thomson gave: $SiO_2$ 73·00, $Al_2O_3$ 17·35, $Fe_2O_3$ 0·40, CaO 3·25, MgO 1·50, $H_2O$ 4·30 = 99·80. Hunt's analysis afforded:

$SiO_2$ 50·30 $Al_2O_3$ 32·60 FeO *tr.* MgO 1·20 $Na_2O, K_2O$ *undet.* $H_2O$ 6·50

It occurs at Stanstead, Province of Quebec, forming a belt 150 feet wide; in some places granular and nearly pure, in others schistose and containing quartz. A thin layer has a banded structure, ligneous in appearance, with a shiny satin luster. It is translucent, of a wax- or amber-yellow color; feel unctuous. Named from νεῦρον, a *string* or *tendon* in allusion to the fibrous structure.

BIHARITE *K. F. Peters*, Ber. Ak. Wien, 44 (1), 132, 1861.

Massive; fine granular or microcrystalline.

H. = 2·5. G. = 2·737, yellow var. Luster greasy, inclined to pearly. Color yellowish to green, brownish. Translucent to hardly subtranslucent. Feel a little greasy. Optically doubly refracting.

Analysis.—Soltész (l. c.), after removing 4·68 $CaCO_3$:

$SiO_2$ 41·74 $Al_2O_3$ 13·47 MgO 28·92 CaO 4·27 $K_2O$ 4·86 $H_2O$ 4·46 $Fe_2O_3, Na_2O$ *tr.* = 97·72

B.B. infusible or nearly so.

Occurs embedded in a fine granular limestone in the Biharberg, near Rezbánya in Hungary.

**498. ALLOPHANE.** Allophan *Stromeyer*, Gel. Anz. Gött., 1251, 1816. Riemannit *Breith.*, Hoffm. Min., **4** b, 182, 1817. Elhuyarit *Sack*, Schw. J., **65**, 110, 1832 (announced, not named), Jahrb. Min., 28, 1834 (mentioned, not described).

Amorphous. In incrustations, usually thin, with a mammillary surface, and hyalite-like; sometimes stalactitic. Occasionally almost pulverulent.

Fracture imperfectly conchoidal and shining, to earthy. Very brittle. H. = 3. G. = 1·85–1·89. Luster vitreous to subresinous; bright and waxy internally. Color pale sky-blue, sometimes greenish to deep green, brown, yellow, or colorless. Streak uncolored. Translucent.

**Comp.**—Hydrous aluminium silicate, $Al_2SiO_5 + 5H_2O$ = Silica 23·8, alumina 40·5, water 35·7 = 100. Some analyses give 6 equivalents of water = Silica 22·2, alumina 37·8, water 40·0 = 100.

Impurities are often present. The coloring matter of the blue variety is due to traces of chrysocolla, and substances intermediate between allophane and chrysocolla (mixtures) are not uncommon, see chrysocolla. The green variety is colored by malachite, and the yellowish and brown by iron. Allophane occurs at Richmond, Mass., mixed intimately with part of the gibbsite of that locality (Silliman).

**Anal.**—1, Rath, Pogg., **144**, 393, 1871. 2, E. F. Smith, Am. Ch. J., **5**, 272, 1883. See also Gamper, Vh. G. Reichs., 354, 1876; and for earlier analyses 5th Ed., p. 419.

| | | $SiO_2$ | $Al_2O_3$ | CuO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. Dehrn | G. = 2·079 | 23·53 | 37·73 | — | 1·92 | 36·86 = 100·04 |
| 2. Allentown, Penn. | | 21·39 | 35·20 | — | 1·96[a] | 40·86 = 99·41 |

[a] $(Ca,Mg)CO_3$.

**Pyr., etc.**—Yields much water in the closed tube. B.B. crumbles, but is infusible. Gives a blue color with cobalt solution. Gelatinizes with hydrochloric acid.

**Obs.**—Allophane is regarded as a result of the decomposition of some aluminous silicate (feldspar, etc.); and it often occurs incrusting fissures or cavities in mines, especially those of copper and limonite, and even in beds of coal. It lines cavities in a kind of marl at Gräfenthal, near Saalfeld in Thuringia, where it was first observed, in 1809, by Riemann, and hence has been called *riemannite.* Found also at Schneeberg in Saxony; at Gersbach in the Schwarzwald; Petrow in Moravia, in a bed of limonite; Chotina in Bohemia, at a copper mine in alum slate; at Friesdorf, near Bonn, in lignite (the *elhuyarite*, of a brownish or honey-yellow color, with G. = 1·6); Visé in Belgium, in the Carboniferous limestone; at the Chessy copper mine, near Lyons, France; in the chalk of Beauvais, France, presenting a honey-yellow color; at New Charlton, near Woolwich, in Kent, England, in old chalk-pits, of amber-yellow, ruby-red, and nearly opaque white colors.

In the United States it occurs in a mine of limonite, with gibbsite, at Richmond, Mass., forming a hyaline crust, scaly or compact in structure, and brittle; at the Bristol Copper Mine, Ct.; at Morgantown, Berks Co., Pa.; at the Friedensville zinc mines, Pa.; in the copper mine of Polk Co., Tenn.

Named from *ἄλλος, other*, and *φαίνεσθαι, to appear*, in allusion to its change of appearance under the blowpipe.

A yellowish white earthy mineral from Kornwestheim, between Stuttgart and Ludwigsburg, with G. = 1·794 and 2·098, consists of allophane and aluminite, and has been called *Kieselaluminite* (*Siliceous aluminite*) by Groningen and Oppel. In one of their analyses they obtained (JB.Ch., 892, 1852, from Württemb. Nat. Jahreshefte, 189, 1851): $SiO_2$ 13·06, $SO_3$ 5·04, $Al_2O_3$ 42·59, ign. 39·32 = 100·01. The *sulfatallophan* of Muck (Zs. Berg.-Sal. Wesen, **28**, 192, 1880) is similar; it occurs as an earthy, white or pale wine-yellow to greenish yellow substance in the clay of the Schwelm mine.

*Plumballophane* is a variety of allophane in stalactitic forms containing a little lead; from Monte Vecchio, Sardinia, Bombicci [Att. Soc. Ital. Sc. Nat., **11**], Jb. Min., 750, 1868.

CAROLATHINE *F. L. Sonnenschein*, Zs. G. Ges., **5**, 223, 1853 and J. pr. Ch., **60**, 268, 1853. Amorphous, with a mammillary surface, and approaching allophane in the ratio of Si to Al, but contains less water. H. = 2·5; G. = 1·515; color honey- to wine-yellow; subtranslucent.

Analysis by Sonnenschein gave: $SiO_2$ 29·62, $Al_2O_3$ 47·25, $H_2O$ 15·10, C 1·33, H 0·74, O 5·96 = 100.

B.B. ignites without flame, owing to the organic ingredients present. From the coal-bed of the Königin-Louise Mine, at Zabrze, in Upper Silesia. Named for Prince von Carolath.

SAMOITE *Dana*, Min., 288, 1850; and Geol. Rep. Expl. Exp., 324, 1849.

Stalactitic, with a lamellar structure. H. = 4–4·5. G. = 1·7–1·9. Luster resinous in the fracture. Color white, grayish, or yellowish. Translucent to subtranslucent, not adhering to the tongue nor plastic, being too hard.

Comp.—Perhaps $2Al_2O_3.3SiO_2.10H_2O$ = Silica 31·9, alumina 36·2, water 31·9 = 100.

Analyses.—1, 2, B. Silliman, l. c. 3, Janovsky, quoted by Zepharovich, Ber. Ak. Wien, **69** (1), 32, 1874.

| | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $H_2O$ | $CaCO_3$ | |
|---|---|---|---|---|---|---|---|
| 1. *Samoite* | G. = 1·69–1·813 | 31·25 | 37·21 | — | 30·45 | 0·01 | MgO 0·06, $Na_2O$ 0·06 = 99·04 |
| 2. " | G. = 1·894 | 35·14 | 31·95 | — | 30·80 | 1·21 | MgO 1·05 = 100·15 |
| 3 *Pseud.* | G. = 1·87 | 29·12 | 31·46 | 8·86 | 30·56 | — | = 100 |

Gelatinizes in acids, leaving a portion of silica.

Forms stalactites and stalagmites; the former low conical; the latter flattened hemispherical in shape, with a width of 3 inches or so, smooth at surface. They consist within of a series of thin plates closely adhering. When fresh they were soft enough to be cut with a knife, but hardened on exposure. They occur in a lava cavern on the south side of the extinct volcanic island of Upolu, of the Navigator or Samoa group; the cavern was a passage some hundreds of yards long, entered about a mile and a half from the sea by a perpendicular descent of 25 feet, and extending toward and beneath the sea, and also up the mountain to an unascertained distance. Its sides and bottom were in places covered with the samoite, which had been formed from the percolating waters. The overlying rock was about 15 feet thick.

*Samoite* of Silliman, Jr. (Dana's Expl. Exp. Geol. Rep., 732), is a kind of feldspar incorrectly analyzed; probably labradorite.

The material of analysis 3 is an alteration-product of gehlenite from Orawitza, cf. Zepharovich, l.c. and this Min., p. 476.

**499. COLLYRITE.** Das man dort Salpeter nannte (fr. Schemnitz) *Freiesleben*, Lempe's Mag., **10**, 99, 1793. Natürliche Alaunerde (fr. Schemnitz) *v. Fichtel*, Min., 170, 1794; *Klapr.*, Beitr., **1**, 257, 1795. Kollyrit *Karst.*, Tab., 30, 73, 1800.

A clay-like mineral, white, with a glimmering luster, greasy feel, and adhering to the tongue. G. = 2–2·15. H = 1–2.

**Comp.**—$2Al_2O_3.SiO_2.9H_2O$; or 1 of allophane $6H_2O$ + 1 of gibbsite = Silica 14·1, alumina 47·8, water 38·0.

Analysis.—J. H. and G. Gladstone, Phil. Mag., **23**, 461, 1862.

Hove $SiO_2$ 14·49 $Al_2O_3$ 47·44 $H_2O$ [36·39] CaO 0·89 $CO_2$ 0·79 = 100

In other specimens Gladstone obtained from 8 to 3 p. c. of silica, indicating a varying proportion of aluminium hydrate. Early anals., see 5th Ed., p. 420.

**Pyr., etc.**—Yields water. B.B. infusible. Gives a blue color when heated with cobalt solution. Gelatinizes with nitric acid. Does not fall to pieces in water, or increase in weight.

**Obs.**—From Ezquerra in the Pyrenees; near Schemnitz, Hungary; near Weissenfels, Saxony; at Hove, near Brighton, England, in fissures in the upper chalk, of a pure white color and very soft.

The name *collyrium* (κολλύριον) was applied by the Greeks to the "Samian earth;" Kursten adopted it because the description of this earth by Dioscorides answers well for the above mineral.

DILLNITE *Haidinger, Hutzelmann*, Pogg., **78**, 577, 1849. A related substance; the gangue of the diaspore of Schemnitz, at a place called Dilln. It is probably a mixture of diaspore and kaolinite. See further 5th Ed., p. 421.

**500. SCHRÖTTERITE.** Opalin-Allophan *Schrötter*, Baumg. Ztg., **4**, 145, 1837. Schröttcrit *Glocker*, Grundr., 536, 1839. Opal Allophane.

Resembles allophane; sometimes like gum in appearance.

H. = 3–3·5. G. = 1·95–2·05. Color pale emerald- to leek-green, greenish white, yellowish, or at times spotted with brown. Translucent to nearly transparent.

**Comp.**—$8Al_2O_3.3SiO_2.30H_2O$ = Silica 11·7, alumina 53·1, water 35·2 = 100.

**Anal.**—1, Schrötter, J. pr. Ch., **11**, 380, 1837. 2, J. W. Mallet, Am. J. Sc., **26**, 79, 1858.

| | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $H_2O$ | CaO | CuO | |
|---|---|---|---|---|---|---|---|---|
| 1. Styria | | 11·95 | 46·30 | 2·95 | 36·20 | 1·30 | 0·25 | $SO_3$ 0·78 = 99·73 |
| 2. Alabama | ⅔ | 10·53 | 46·48 | — | 41·09 | — | — | ZnO 0·77, FeO,MgO *tr.*, $SO_3$ 0·80=99·67 |

**Obs.**—From Dollinger mountain, near Freienstein, in Styria, in nests between clay-slate and granular limestone; in Cornwall; at the Falls of Little River, on the Sand Mtn., Cherokee Co., Alabama, as an incrustation over half an inch thick and partly stalactitic, resembling gum arabic when broken, having H. = 3·5, and G. = 1·974.

SCARBROITE *Vernon*, Phil. Mag., **5**, 178, 1829. A white clayey substance, allied to schrötterite in composition ($H_2O$ = 46·75 Vernon). It is dull, adhesive to moist surfaces and may be polished by the nail. It fills the veinings of a sandstone, which is much marked with oxide of iron, or of its septaria, on the coast of Scarborough, Yorkshire, England.

## APPENDIX TO CLAYS.

The following are other earthy hydrous aluminous silicates, all of doubtful character:

SINOPITE *Hausm.*, Handb., 1847; *Σινωπìς? Theophr.;* Rubrica *Vitruv.;* Sinopis *Pliny*, Sinopische Erde *Klapr.*, Beitr., **4**, 345, 1807; Bol de Sinopis *Beud.* A clayey earth of brick-red color dotted with white, adhering to the tongue. The material analyzed by Klaproth was from Anatolia, Asia Minor. The sinopic earth of the ancients was brought from Cappadocia, and used as a red paint, and may have been a red ocher. Theophrastus speaks of two other kinds of sinopic earth, one whitish, the other between the red and white in color, and called the pure kind because it was used without mixing; besides also an artificial kind made by burning a clay —the clay becoming red owing to the hydrated iron oxide present, which was freed from its water by the heat. Anal. 1, below.

MELINITE *Glocker*, Syn., 186, 1847; Gelb-Erde pt. *Wern.*, Hoffm. Min., **2**, b, 210; Argile ocreuse jaune pt. *H.*; Yellow ocher pt. A yellow clayey material, looking like yellow ocher, more or less lamellar in structure, shining in streak, adhering to the tongue, and soiling the fingers; G. = 2·24. The kind analyzed, and to which the name especially belongs, is that from Amberg in Bavaria. Other reported localities are Münden and Schoningen in Hanover; Wehrau, Prussia; Robschütz, Saxony; Vierzon (whence sometimes called *Vierzonite*), Dept. of Cher, and Pourrain, Dept. of Yonne, France. Anal. 2, below.

OCHRAN *Breith.*, Char., 100, 1832. A kind of "bole" of a yellow color from Orawitza, a little greasy in feel, with H. = 1–2, and G. = 2·4–2·5; streak pale yellow to colorless.

PLINTHITE. Plynthite *Thom.*, Min., **1**, 323, 1836. A brick-red clay from Antrim, Ireland, having G. = 2·342, and H. = 2·75, and not adhering to the tongue. Also from Quiraing in Skye, Heddle, Min. Mag., **5**, 26, 117.

Analyses.—1, Klaproth, l. c. 2, Kühn, Schw. J., **51**, 466, 1827. 3, Kersten, Schw. J., **66**, 31, 1832. 4, Thomson, l. c. 5, Heddle, l. c.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | NaCl | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. *Sinopite* | 32·0 | 26·5 | 21·0 | — | 1·5 | 17·0 = 98·0 |
| 2. *Melinite* | 33·23 | 14·21 | 37·76 | — | — | 13·24 MgO 1·38 = 99·82 |
| 3. *Ochran* | 31·8 | 43·0 | 1·2 | — | — | 21·0 = 97 |
| 4. *Plinthite* | 30·88 | 20·76 | 26·16 | 2·60 | — | 19·60 = 100 |
| 5. " Skye | 29·55 | 19·03 | 28·01 | 2·23 | — | 17·39 FeO 3·25, MnO 0·84 = 100·30 |

These ocherous clays are probably only mixtures.

SMECTITE. Fuller's Earth pt.; Terra *or* Creta Fullonum pt.; Walkthon, Walkerde pt. *Germ.*; Terre à Foulon pt. *Fr.* Walker's Clay. Walkerite. Smectit *Breith.*, Handb., 344, 1841. Malthacit *Breith.*, J. pr. Ch., **10**, 510, 1837.

Massive. Clay-like. Very soft. G. = 1·9–2·1. Luster dull; of streak shining. Color white, gray, and various shades of green to mountain-green and olive-green, or brownish. Streak colorless. Unctuous. Does not adhere to the tongue. Softens in water.

*Fuller's Earth* includes many kinds of unctuous clays, gray to dark-green in color, and is only in part Breithaupt's smectite. Much of it is kaolinite. *Malthacite* is described as occurring in thin laminæ or scales and sometimes massive, with the color white or slightly yellowish, and thin plates translucent; the original is from basalt, at Steindörfel, in Lausitz; and Beraun in Bohemia is given as another locality. *Smectite* is a mountain-green, oil-green, and grayish green clay, from Cilly in Lower Styria.

The chemical species characteristic of these minerals is probably the same—a silicate of aluminium related to cimolite, but containing three or four times as much water.

Analyses.—1, Jordan, Pogg., **77**, 591, 1849. 2, Klaproth, Beitr., **4**, 338, 1807. 3, O. Meissner, l. c.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MgO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. Cilly, *Smectite* | 51·21 | 12·25 | 2·07 | 4·89 | 2·13 | 27·89 = 100·44 |
| 2. Reigate, *Fuller's E.* | 53·00 | 10·00 | 9·75 | 1·25 | 0·50 | 24·00 $K_2O$ *tr.*, NaCl 0·10 = 98·60 |
| 3. Steindörfel, *Malth.* | 50·17 | 10·66 | 3·15 | — | 0·25 | 35·83 = 100·06 |

B.B. malthacite is infusible; but smectite and the Reigate fuller's earth, owing to the impurities present, fuse rather easily. Decomposed by hydrochloric acid.

RHODALITE *Thomson*, Min., **1**, 354, 1836, is a soft, earthy rose-red mineral; feel soapy. An impure hydrous silicate of iron and aluminium. From nodules in amygdaloid, in Antrim, northern Ireland.

SPHRAGIDITE. *Λημνία γῆ Dioscor. Σφραγὶς λήμνια.* Terra lemnia *Plin.*, **36**. Sphragid *Karst.*, Tab., 28, 88, 1808. Related in composition to cimolite (p. 689), but contains some alkali. Color yellowish gray, brownish, or yellowish white. Sometimes mottled with rust-like spots; harsh to the touch, adheres feebly to the tongue, and forms a paste with water.

Klaproth obtained for its composition, Beitr., **4**, 333, 1807: $SiO_2$ 66·00, $Al_2O_3$ 14·50, $Fe_2O_3$ 6·00, MgO 0·25, CaO 0·25, $Na_2O$ 3·50, $H_2O$ 8·50 = 99.

From Stalimene, the ancient *Lemnos*. It was also called *Terra sigillata*. It was dug for medicinal purposes once a year, cut into spindle-shaped pieces, and *stamped with a seal*, and hence the name *sigillata* in Latin, and *sphragis* in Greek. There was also a *Rubrica Lemnia*, or *Lemnian Reddle*, used by painters, which is confounded by Pliny with the true terra lemnia.

**Ehrenbergit** *Nöggerath*, Vh. Ver. Rheinl., **9**, 378, 1857. Near the preceding in composition, and, like that, containing alkali. It is almost gelatinous in the fresh state, and becomes fragile, pulverulent, and opaque on drying; color rose-red. Anal.—1, Schnabel, l. c. 2, G. Bischof, l. c.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MnO | MgO | CaO | $Na_2O,K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 1. | 56·77 | 15·77 | 1·65 | 0·86 | 1·30 | 2·76 | [3·78] | 17·11 = 100 |
| 2. | 64·54 | 6·04 | 4·56 | 4·61 | 0·41 | 3·96 | [8·11] | 7·77 = 100 |

*Ehrenbergite* occurs in clefts in trachyte at the quarries of Steinchen and Wolkenburg, Siebengebirge.

**Portite** *Meneghini & Bechi*, Am. J. Sc., **14**, 63, 1852. Orthorhombic. In radiated masses; cleavage very distinct parallel to a rhombic prism of 60° and 120°. H. = 5. G. = 2·4. Luster vitreous Color white. Opaque. Analysis by Bechi, l. c.: $SiO_2$ 58·12, $Al_2O_3$ 27·50, MgO 4·87, CaO 1·76, $Na_2O$ 0·16, $K_2O$ 0·10, $H_2O$ 7·92 = 100·43. B.B. intumesces much and affords a milk-white enamel. Dissolves in acids, even in the cold, and gelatinizes. From the gabbro rosso in Tuscany. Named after Mr. Porte of Tuscany.

**Teratolite** *Glocker*, Grundr., 544, 1839; Terra miraculosa Saxoniæ *C. Richter*, 1732; Saxonische Wundererde *of old Germ. authors;* Eisensteinmark *Breith.*, Char., 147, 1823, 301, 1832. A. Knop holds (Jb. Min., 546, 1859) that the teratolite is an impure lithomarge-like pholerite. It is described as having H. = 2–2·5, and G. = 2·49–2·5; color varied with lavender and other shades of blue, and spots of red, and rarely pearl-gray. It is from an amygdaloidal rock overlaid by coal strata at Planitz near Zwickau in Saxony. It contains much oxide of iron; but, according to Knop, probably is a mixture of pholerite with some free quartz, pulverized feldspar, hydrate of iron, carbonate of lime, and magnesia.

**Catlinite** *C. T. Jackson*, Am. J. Sc., **35**, 388, 1839; G. Catlin, ib., **38**, 138, 1840. The red clay forming beds of considerable extent in Pipestone county in the southwestern part of Minnesota. It was much used by the Indians for pipes, etc. It is not a definite mineral species. Anal.—1, 2, Peckham, 6th Ann. Rep. Minn., 101, 1877; cf. also ibid., p. 98, and 11th Rep., p. 7, 1883.

| | | | | | |
|---|---|---|---|---|---|
| 1. *Red* | $SiO_2$ 57·43 | $Al_2O_3$ 25·94 | $Fe_2O_3$ 8·70 | $H_2O$ 7·44 | MgO,CaO *tr.* = 99·51 |
| 2. *Light colored* | 58 25 | 35·90 | *tr.* | 6·48 | = 100·63 |

Named after the writer on the North American Indians, George Catlin (1796–1872).

**Keffekilite** Keffekilith *Fischer*, Mem. Soc. Nat. Moscou, **1**, 60, 1811. A pearl-gray to grayish white lithomarge, from the Crimea, having a greasy feel, and somewhat adhering to the tongue, with G. = 2·40. John. Becomes hard enough to scratch glass by calcination. It is evidently merely a clayey mixture.

*Keffekil Tartarorum* was, according to Cronstedt (Min., 79, 1758), a yellowish white lithomarge from Tartary, used there as a substitute for soap. It has been referred to sepiolite.

**Oravitzite** *Breith.*, Handb., 366, 1841. Massive and in nodules, and resembling halloysite, but heavier. H. = 2–2·5; G. = 2·701; luster waxy; color greenish white; unctuous. It is supposed to be a hydrous aluminous silica containing zinc oxide. In the glass tube yields much water. B.B. yields, according to Plattner, with soda and borax on charcoal, a slag which is yellow while hot and white on cooling. The zinc oxide is probably present as a mixture in the clay. From Orawitza, Hungary, with calamine.

**Hverlera** *Forchhammer*. Berz. JB., **23**, 265, 1844. A white or reddish clay resulting from the action of sulphuric and carbonic acids on the ferriferous clays of Krisuvig, Iceland. Analysis: $SiO_2$ 50·99, $Al_2O_3$ 7·39, $Fe_2O_3$ 21·21, MgO 19·96, $TiO_2$ 0·46 = 100·01.

**Wolchonskoite** *Kämmerer*, Jb. Min., **2**, 420, 1831. Volchonskoite.

Amorphous. Dull to shining. Color bluish green, passing into grass-green. Streak bluish green and shining. Feel resinous. Polished by the nail. Fracture subconchoidal. Adheres slightly to the tongue. Very fragile. H. = 2–2·5. G. = 2·2–2·3.

A chrome-bearing clay. Anal.—1, Kersten, Pogg., **47**, 489, 1839. 2, Ivanov, quoted by Kk., Min. Russl., **1**, 145.

| | $Si_2O$ | $Al_2O_3$ | $Cr_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Okhansk | 37·01 | 6·47 | 17·93 | 10·43 | 1·66 | 1·91 | 21·84 | PbO 1·01, $K_2O$ *tr.* = 98·26 |
| 2. " | 36·84 | 3·50 | 18·85 | 17·85 | *tr.* | — | 22·46 | CaO 1·39 = 100·89 |

In the closed tube yields water. B.B. blackens, but is infusible. With the fluxes gives reactions for chromium and iron. Gelatinizes with hot concentrated hydrochloric acid, in which half the chromium is dissolved, the rest remaining in union with silica.

From Okhansk in Siberia.
Named after the Russian Volchonsky.

Miloschite. Miloschin *Herder*, Pogg., **47**, 485, 1839. Serbian *Breith.*, J. pr. Ch., **15**, 327, 1838.

Compact. H. = 1·5–2. G. = 2·131, Breith. Color indigo-blue to celandine-green. Approaches a *chromiferous allophane* with half the water of allophane. Analyses.—1, Kersten, Pogg., **47**, 485, 1839. 2, Bechi, Am. J. Sc., **14**, 62, 1852.

| | $SiO_2$ | $Al_2O_3$ | $Cr_2O_3$ | CaO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. Rudniak | 27·50 | 45·01 | 3·61 | 0·30 | 0·20 | 23·30 | = 99·92 |
| 2. Tuscany | 28·36 | 41·33 | 8·11 | — | — | 22·75 | = 100·55 |

In a matrass yields water. B.B. infusible. Partly dissolved in hydrochloric acid.

From Rudniak in Servia, associated with quartz and brown iron ore; Volterra, Tuscany. Named after Prince Miloschi.

Selwynite *Ulrich* [Laboratory, **1**, 237, 1867] Contrib. Min. Victoria, 61. Massive. H.=3·5. G. = 2·53. Emerald-green. Subtranslucent. Fracture uneven and splintery. Somewhat brittle.

Composition, according to an analysis by Cosmo Newbery:

$SiO_2$ 47·15 $Al_2O_3$ 33·23 $Cr_2O_3$ 7·61 MgO 4·56 $H_2O$ 6·23 = 98·78

B.B. becomes white and fuses on the edges to a grayish white blebby glass. Only partially soluble in strong acids

Found near Heathcote, Victoria (Australia), in the Upper Silurian. Named after A. C. Selwyn, director of the geological survey of Victoria.

*Chrome Ocher.* A clayey material, containing some chromium oxide. Occurs earthy of a bright green shade of color.

Anal.—1, Drappiez. 2, Duflos, Schw. J., **64**, 251, 1832. 3, Zellner, Isis, 637, 1834.

| | $SiO_2$ | $Al_2O_3$ | $Cr_2O_3$ | $Fe_2O_3$ | $H_2O$ | |
|---|---|---|---|---|---|---|
| 1. Creuzat, Fr. | 64·0 | 23·0 | 10·5 | — | — | CaO and MgO 2·5 = 100 |
| 2. Halle | 57·0 | 22·5 | 5·5 | 3·5 | 11·0 | = 99·5 |
| 3. Silesia | 58·5 | 30·0 | 2·0 | 3·0 | 6·25 | = 99·75 |

Chrome ocher occurs at the localities above mentioned; also on Unst, one of the Shetlands, Mortenberg in Sweden, and elsewhere.

The *chrome ocher* of Halle, analyzed by Wolff (J. pr. Ch., **34**, 202, 1845), approaches selwynite in composition, but contains much more water. It afforded: $SiO_2$ 46·11, $Al_2O_3$ 30·53, $Cr_2O_3$ 4·28, $Fe_2O_3$ 3·15, $H_2O$ 12·53, $Na_2O$ 0·46, $K_2O$ 3·44 = 100·50; G. = 2·7, giving rather closely the formula of kaolin, and may be an impure kaolinite.

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## V. Concluding Division.

| | | |
|---|---|---|
| **501. Cenosite** | $H_4Ca_2(Y,Er)_2CSi_4O_{17}$ | Orthorhombic (?) |
| **502. Thaumasite** | $CaSiO_3.CaCO_3.CaSO_4.15H_2O$ | |
| **503. Uranophane** | $CaU_2Si_2O_{11}.6H_2O$ | Orthorhombic |
| **504. Chrysocolla** | $CuSiO_3 + 2H_2O$ | |
| **505. Chloropal** | $Fe_2(SiO_3)_3.5H_2O$<br>$(Fe,Al)_2(SiO_3)_3.5H_2O$ | Amorphous. |
| **506. Hisingerite**<br>Gillingite, Jollyte.<br>Melanosiderite. | Hydrated iron silicate. | Amorphous. |
| **507. Bementite** | $2MnSiO_3.H_2O$ | |
| **508. Caryopilite** | $Mn_4Si_3O_{10}.3H_2O$ | |
| **509. Neotocite,**<br>Stratopeite | | |

**501. CENOSITE.** Kainosit *A. E. Nordenskiöld*, G. För. Förh., 8, 143, 1886.

Orthorhombic or monoclinic; pseudo-hexagonal. Known only as a fragment of a six-sided prismatic crystal.

Cleavage: in one direction distinct; in two others, at 90° or nearly 90°, indistinct. Fracture uneven. H. = 5·5. G. = 3·413. Luster somewhat greasy. Color yellowish brown. Semi-transparent. Optically biaxial.

**Comp.**—$H_4Ca_2(Y,Er)_2CSi_4O_{17}$, which may be written $Ca(Y,Er)_2(SiO_3)_4.CaCO_3.2H_2O$ = Silica 34·7, carbon dioxide 6·4, yttrium oxides 37·6 (molec. wght. = 260·3), lime 16·1, water 5·2 = 100.

The true constitution is doubtful; Nordenskiöld calls attention to a possible relation to cancrinite, p. 427.

**Anal.**—Nordenskiöld, l. c.:

| | $SiO_2$ | $Y_2O_3$* | $Ce_2(La,Di)_2O_3$ | CaO | MgO | FeO | $Na_2O$ | $CO_2$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| | 34·63 | 37·67 | *tr.* | 15·95 | 0·03 | 0·26 | 0·40 | 5·90 | 5·26 = 100·10 |

* Incl. $Y_2O_3, Er_2O_3$, etc., molec. weight 260·3.

**Pyr.**—Gives off water at a low red heat and $CO_2$ on strong heating. B.B. fuses with difficulty to a white enamel. Dissolves slowly in cold acids, readily if heated, with the evolution of carbon dioxide.

**Obs.**—From Igeltjern on the island Hitterö, Norway; known only in a single specimen, the fragment of a large crystal resembling beryl.

Named from καινός, *unusual*, in allusion to the composition.

**502. THAUMASITE.** *A. E. Nordenskiöld*, C. R., 87, 313, 1878. *G. Lindström*, Öfv., Ak. Stockh., 35, No. 9, p. 43, 1878.

Tetragonal or hexagonal. Massive, compact, crystalline.

Cleavage in traces. Fracture subconchoidal. Brittle. H. = 3·5. G. = 1·877. Luster greasy, dull. Color white. Translucent. Optically uniaxial, negative. Refractive indices: $\omega = 1·503$, $\epsilon = 1·467$ Btd.[1]; $\omega = 1·507$, $\epsilon = 1·468$ Lévy-Lcx.[1]

**Comp.**—$CaSiO_3.CaCO_3.CaSO_4.15H_2O$ = Silica 9·6, carbon dioxide 7·1, sulphur trioxide 12·9, lime 27·0, water 43·4 = 100.

**Anal.**—1-3, Lindström, l. c. 4, Hedström, quoted by Widman, G. För. Förh., **12**, 20, 1890. 5, Widman, l. c.

| | G. | $SiO_2$ | $CO_2$ | $SO_3$ | CaO | $H_2O$ | $Al_2O_3$ | $Na_2O$ | $K_2O$ | Cl |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Bjelke M. | | 9·62 | 6·90 | 13·12 | 27·43 | 42·16 | 0·17 | 0·18 | 0·07 | 0·13 = 99·78 |
| 2. " | 1·877 | 9·70 | 6·81 | 12·59 | 27·17 | 41·80 | 0·17 | 0·07 | 0·07 | 0·14 = 98·52 |
| 3. " | | 9·78 | 6·88 | 13·34 | 27·24 | 42·63 | 0·13 | 0·07 | 0·10 | 0·10 = 100·27 |
| 4. Kjölland | 1·83 | 9·54 | 6·84 | 13·23 | 27·38 | 43·32 | — | — | — | — = 100·31 |
| 5. " | | 9·54 | 7·19 | 13·48 | 27·12 | 43·05 | — | — | — | — = 100·38 |

On the question of the nature of this remarkable mineral, cf. Törnebohm (quoted by Lindström); Btd., Bull. Soc. Min., **3**, 159, 1880, **4**, 8, 1881; Nd., G. För. Förh., **5**, 270, 1880, ib., **8**, 146, 1886; Cohen, Jb. Min., **2**, 22 ref., 1881; Lcx., G. För. Förh., **9**, 35, 1887, Btd., ib., p. 131. Thaumasite is shown to be essentially a homogeneous substance consisting for the most part of a negative uniaxial mineral with some amorphous matter, and small quantities of two minerals optically biaxial (Lcx., Btd.).

**Pyr.**—B.B. swells up, colors the flame red, but infusible. In salt of phosphorus a skeleton of silica. In the closed tube decrepitates and gives off much water.

**Obs.**—Occurs filling cavities and crevices at the Bjelke mine, near Åreskuta, Jemtland, Sweden; at first soft, but hardens on exposure to the air. Part of the specimens described by Nordenskiöld and Lindström were collected by A. Polheimer in 1802–05 (anal. 2), others in 1859 (anal. 1), and 1878 (anal. 3); that analyzed by Widman (5) is stated to have been collected in 1838 by Burman at Kjölland in the Kall parish, Jemtland, some 13 miles from the Bjelke mine. The identity of these several specimens is strong proof that the substance is a homogeneous mineral. Named from θαυμαζειν, *to be surprised*, in allusion to the remarkable composition, which is without parallel among minerals.

A fine fibrous chalk-white mineral occurs with the thaumasite, and is regarded as a decomposition product: H. = 1·5–2·5; analysis, Lindström: $SiO_2$ 11·85, $CO_2$ 6·86, $SO_2$ 13·31, CaO 25·74, $Al_2C_3(Fe_2O_3)$ 2·58.

**Ref.**—[1] Cf. references above, also Lévy-Lcx., Min. Roches, 286, 1888.

**503. URANOPHANE.** *Websky*, Zs. G. Ges., **5**, 427, 1853, **11**, 384, 1859. Uranotil *E. Boricky*, Ber. Böhm. Ges., 36, 1870.

Orthorhombic. In minute acicular prisms, in radiated or stellate aggregations. Also massive with fine fibrous structure.

H. = 2–3. G. = 3·81–3·90. Luster vitreous, of *b* pearly. Color honey-yellow, lemon- or straw-yellow.

**Comp.**—A hydrous silicate of uranium and calcium, $CaO.2UO_3.2SiO_2 + 6H_2O$ (Genth) = Silica 13·9, uranium trioxide 67·0, lime 6·5, water 12·6 = 100.

**Anal.**—1, Grundmann, Zs. G. Ges., **11**, 390, 1859; recalculated by Websky after deducting impurities (7 p. c.), ib., **22**, 92, 1870. 2, Boricky, l. c. 3, 4, Winkler, Jb. Min., **2**, 111, 1880. 5, Genth, Am. Ch. J., **1**, 88, 1879. 6, 7, H. von Foullon, Vh. G. Reichs., 21, 1883.

| | G. | $SiO_2$ | $UO_3$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Kupferberg | | 17·08 | 53·33 | 6·10 | — | 5·07 | 15·11 | MgO 1·46, $K_2O$ 1·85=100 |
| 2. Wölsendorf | 3·96 | 13·78 | 66·75 | 0·51 | | 5·27 | 12·67 | $P_2O_5$ 0·45 =99·43 |
| 3. Neustädtel | | 13·02 | 63·93 | *tr.* | 3·03 | 5·13 | 14·55 | = 99·66 |
| 4. " | 3·856 | 14·48 | 62·84 | *tr.* | 2·88 | 5·49 | 13·79 | = 99·48 |
| 5. Mitchell Co., N. C. | 3·834 | $\frac{2}{2}$ 13·72 | 66·67 | *tr.* | *tr.* | 6·67 | 12·02 | PbO 0·60, BaO 0·28, SrO [0·13, $P_2O_5$ 0·29 = 100·38 |
| 6. " " " | | $\frac{2}{2}$ 13·24 | 65·87 | — | 0·14 | 7·05 | 13·11 | = 99·41 |
| 7. " " " | | 13·47 | 64·36 | — | 0·47 | 7·49 | 13·32 | = 99·11 |

A related mineral from the Garta feldspar quarry near Arendal, Norway, gave Nordenskiöld (approx.): $SiO_2$ 13·0, $ThO_2$ 3·5 (with Ce and Y), $UO_3$ 48·8, CaO 14·7, PbO 1·7, ign. 18·6=100·3. It is an alteration-product of cleveite, G. För. Förh., **7**, 121, 1884.

**Pyr., etc.**—B.B. turns dark and yields water. Soluble in warm hydrochloric acid with separation of flocculent silica.

**Obs.**—*Uranophane* (anal. 1) is from the granite of Kupferberg, Silesia; a prism of 34° and macrodome of 90° are mentioned. *Uranotil* (anal. 2–4) occurs at Wölsendorf, Bavaria, in cavities in quartz on fluorite with uraninite (a prism of 16° is mentioned). Also from the Weisser Hirsch mine at Neustädtel near Schneeberg, Saxony.

As an alteration-product of gummite (from uraninite) at the mica mines of Mitchell Co., N. C. (anal. 5–7); it forms an incrustation upon and penetrating the gummite.

**504. CHRYSOCOLLA.** Chrysocolla pt. *Theophr.*, *Diosc.*, *Plin.* Chrysocolla pt., Cæruleum pt. *Germ.* Berggrün, *Agric.*, Foss., 1546. Cæruleum montanum pt. *Wall.*, Min., 280, 1747; C. montanum, Viride montanum pt., *Cronst.*, Min., 172, 1758. Mountain Blue and Mountain Green pt. Bleu de Montagne, Vert de Montagne, Bleu de Cuivre, Vert de Cuivre, *Fr.* Kupfergrün *Wern.*, Bergm. J., 382, 1789; *Karst.*, Tab., 46, 1800, 62, 1808. Cuivre carbonaté vert. pulverulent, *H.*, Tr., 1801; Tabl., 1809. Kieselkupfer *Klapr.*, Beitr., **4**, 36, 1807. Vert de Cuivre, Chrysocolle, *Brochant*, Min., **2**, 203, 1808. Kieselmalachit *Hausm.*, Handb., 1813. Kieselkupfer *Leonh.*, Handb., 1821. C. hydrosiliceux *H.* Cuivre hydraté silicifère, Hydrophane cuivreux, *Fr.* Somervillite (fr. N. J.) *Dufr.*, Min., **3**, 147, 1847. Dillenburgite. Kupferpecherz pt. Hoffm. Min., **3**, b, 103, 1816; Hepatinerz *Breith.*, Char., 224, 1832; Pechkupfer *Hausm.*, Handb., 372, 1847. Llanca *Chilian Miners.* Demidovit *N. Nd.*, Bull. Soc. Moscou, **29** (1), 128, 1856. Demidoffite. Asperolite *Herm.*, ib., **39**, 68, 1866. Pilarite *Kramberger*, Zs. Kr., **5**, 260, 1880. Cyanochalcite *Hermann*, J. pr. Ch., **106**, 65, 1869.

Cryptocrystalline; often opal-like or enamel-like in texture; earthy. Incrusting or filling seams. Sometimes botryoidal.

Fracture conchoidal. Rather sectile; translucent varieties brittle. H. = 2–4. G. = 2–2·238. Luster vitreous, shining, earthy. Color mountain-green, bluish green, passing into sky-blue and turquois-blue; brown to black when impure. Streak, when pure, white. Translucent to opaque.

**Comp.**—True chrysocolla appears to correspond to $CuSiO_3 + 2H_2O$ = Silica 34·3, copper oxide 45·2, water 20·5 = 100, the water being double that of dioptase.

Composition varies much through impurities, as with other amorphous substances, resulting from alteration. As the silica has been derived from the decomposition of other silicates, it is natural that an excess should appear in many analyses. Impure chrysocolla may contain, besides free silica, alumina, black oxide of copper, oxide of iron (or limonite), and oxide of manganese; and consequently vary in color from bluish green to brown and black, the last especially when manganese or copper is present. Other kinds are impure with carbonate or sulphate of copper; and others with lead, antimony, arsenic, etc.

A kind from Dillenburg containing carbonate of copper has been called *dillenburgite;* another containing limonite is the *copper pitch-blende*, Kupferpecherz or Hepatinerz *Germ.* These are only mixtures.

An aluminous chrysocolla from Chili (anal. 7) has been called *pilarite* after Professor Pilar of Agram. Color greenish blue. G. = 2·62. A similar mineral from Utah has been examined by Santos, anal. 9.

*Demidovite* occurs at Tagilsk, Ural, in mammillated crusts of a sky-blue color. N. Nordenskiöld found in it 8·6 p. c. $P_2O_5$ (anal. 5). *Cyanochalcite* of Hermann from Nizhni Tagilsk is similar, containing 6·9 $P_2O_5$ Hermann (anal. 6). Massive, compact. H. = 4. G. = 2·79. Color azure-blue.

*Asperolite* of Hermann, with 27·25 p. c. $H_2O$, is made $CuSiO_3 + 3H_2O$; from Tagilsk, Russia; named in allusion to its brittleness. *Somervillite* is made by Berthier $CuSiO_3 + 4H_2O$, but on insufficient grounds; from Somerville, N. J. See Ann. Ch. Phys., **51**, 395, 1832, and 5th Ed., p. 403.

**Anal.**—1, Kobell, Pogg., **18**, 254, 1830. 2, Freda [Gazz. Ch. Ital., **14**, 339, 1884], Zs. Kr., **11**, 408. 3, Berthier, l. c. 4, Bowen, Am. J. Sc., **8**, 118, 1824. 5, N. Nordenskiöld, l. c. 6, Hermann, l. c. 7, Kramberger, l. c. 8, Eustis, Ch. News, **48**, 109, 1883. 9, Santos, Ch. News, **36**, 167, 1877. 10, Jannettaz, Bull. Soc. Min., **9**, 211, 1886. 11, Liversidge, Min. N. S. W., 57, 1888. 12, 13, Hutchings, Ch. News, **36**, 18, 1877. 14, J. L. Smith, Gillis's Exped., **2**, 92, 1854. 15–17, Pellegrini, Zs. Kr., **4**, 408, 1880. 18, Robertson, Ch. News, **50**, 209, 1884. Also 5th Ed., pp. 403, 404.

| | G. | $SiO_2$ | CuO | $H_2O$ | $Fe_2O_3$ | $Al_2O_3$ | |
|---|---|---|---|---|---|---|---|
| 1. Bogoslovsk | | 36·54 | 40 00 | 20·20 | 1·00 | — | gangue 2·10 = 99·84 |
| 2. Etna | | 35·41 | 44·43 | 18·72 | *tr.* | *tr.* | = 98·56 |
| 3. *Somervillite* | | 35·4 | 35·1 | 28·5 | — | — | gangue 1·0 = 100 |
| 4. " | | 37·25 | 45·17 | 17·00 | — | — | = 99·42 |
| 5. *Demidovite* | | 31·55 | 33·14 | 23·03 | — | 0·53 | MgO 3·15, $P_2O_5$ 8·60 = 100 |
| 6. *Cyanochalcite* | 2·79 | 26·90 | 49·63 | 16·52 | — | — | $P_2O_5$ 6·95 = 100 |
| 7. *Pilarite* | 2·62 | $\frac{2}{2}$ 38·6 | 19·0 | 21·7 | — | 16·9 | CaO 2·5 = 98·7 |
| 8. Ivanhoe M., Arizona | | 34·08 | 33·22 | 31·65 | — | — | = 98·95 |
| 9. Utah | | 37·19 | 26·03 | 25·76 | — | 10·78 | = 99·76 |
| 10. California | | 49·1 | 30·4 | 18·0 | 1·2 | — | CaO 0·5, $CuCl_2$ 0·9 = 100·1 |
| 11. N. S. Wales | | 43·11 | 35·28 | 21·32$^a$ | *tr.* | — | = 99·71 |
| 12. L. California | | 67·07 | 24·95 | 5·82 | 0·27 | 0·55 | $X^b$ 1·53 = 100·19 |
| 13 " | | 46·45 | 39·15 | 7·99 | 0·48 | 3·65 | $X^c$ 2·13 = 99·85 |
| 14. Chili | | 31·35 | 42·51 | 21·62 | 1·97 | 2·83 | = 100·28 |
| 15. Cerro Blanco | | 16·62 | 65·30 | 7·30 | | 4·96 | CaO 3·08 = 97·26 |
| 16. " " | | 26·69 | 39 89 | 24·00 | 1·50 | 0·42 | FeO 1·82, CaO 2·31 = 96·63 |
| 17. " " | | 25·94 | 31·91 | 26·15 | | 9·23 | CaO 3·99 = 97·22 |
| 18. Gila Co., Arizona | 2·04 | 31·58 | 30·28 | 28·71 | 0·84 | 6·27 | $Mn_2O_3$ 2·22 = 99·90 |

[a] At 120°, 11·92. [b] X = PbO 0·26, ZnO 0 09, CaO 0·81, MgO 0·37.
[c] X = PbO 0·41, ZnO 0·10, CaO 0·80, MgO 0·82.

**Pyr., etc.**—In the closed tube blackens and yields water. B.B. decrepitates, colors the flame emerald-green, but is infusible. With the fluxes gives the reactions for copper. With soda and charcoal a globule of metallic copper. Decomposed by acids without gelatinization.

**Obs.**—Accompanies other copper ores, occurring especially in the upper part of veins.

Found in most copper mines in Cornwall; at Libethen in Hungary; at Falkenstein and Schwatz in the Tyrol; in Siberia; the Banat; Thuringia; Schneeberg, Saxony; Kupferberg, Bavaria; South Australia; Chili, etc. In bluish green spherical forms in the lava at Monti Rossi, Etna.

In Somerville and Schuyler's mines, New Jersey, at Morgantown, Pa., and at Wolcottville, Conn., chrysocolla occurs associated with red copper ore, native copper, and green malachite; in Pennsylvania, near Morgantown, Berks Co.; at Perkiomen; at Cornwall, Lebanon Co.; also with similar associated minerals, and with brown iron ore, in Nova Scotia, at the Basin of Mines; also in Wisconsin and Michigan, mixed with carbonate of copper. In fine specimens, sometimes glassy green, at the Clifton mines, Graham Co., Arizona; also at the Old Globe mine, Gila Co., and at many other points. Emma mine, Utah

*Chrysocolla* is from χρυσός, *gold*, and κόλλα, *glue*, and was the name of a material used in soldering gold. The name is often applied now to borax, which is so employed. But much of the ancient *chrysocolla* was a green stone containing copper as the coloring ingredient, and the best, as Dioscorides says, was that which was κατακόρως πρασίζουσα, or of a fine leek-green or prase color; and the island of Cyprus, which was named from its copper mines, was a prominent locality. Pliny says the mineral was named after the real *chrysocolla*, because it looked like it. It may have included carbonate of copper, as was true to some extent of the *chrysocolla* and *mountain-green* of the 16th, 17th, and 18th centuries. The *cæruleum montanum* of Wallerius included both chrysocolla and an earthy variety of the carbonate.

KUPFERBLAU *G. Rose*, Reis. Ural, 1, 414, 1837. Bogoslovskite *Heddle*, Enc. Brit., **16**, 411, 1883. An impure copper silicate from the Bogovslosk, Ural. It yielded Rose $CO_2$ when treated with acid.

**505. CHLOROPAL.** *Bernhardi & Brandes*, Schw. J., **35**, 29, 1822. Unghwarit *Glocker*, Grundr., 537, 1839. Nontronite *Berthier*, Ann. Ch. Phys., **36**, 22, 1827. Pinguite *Breith.*, Schw J., **55**, 303, 1829. Fettbol *Freiesleben*, Mag. Orykt. Sachsen, **5**, 136. Gramenite *Krantz*, Ber. nied. Ges., Bonn, March, 1857; C. Bergemann, Jb. Min., 395, 1857. Graminite.

Compact massive, with an opal-like appearance; earthy.

H. = 2·5–4·5. G. = 1·727, 1·870, earthy varieties, the second a conchoidal specimen; 2·105, Ceylon, Thomson. Color greenish yellow and pistachio-green. Opaque to subtranslucent. Fragile. Fracture conchoidal and splintery to earthy. Feebly adhering to the tongue, and meagre to the touch.

**Var.**—*Chloropal* has the above-mentioned characters, and was named from the Hungarian mineral occurring at Unghwar, whence Glocker's name Unghwarite. It is described as breaking into parallelopipeds, having opposite magnetic polarity at opposite angles.

*Nontronite* is pale straw-yellow or canary-yellow, and greenish, with an unctuous feel; flattens and grows lumpy under the pestle, and is polished by friction; from Nontron, Dept. of Dordogne, France.

*Pinguite* is siskin and oil-green, extremely soft, like new-made soap, with a slightly resinous luster, not adhering to the tongue; the original from Wolkenstein in Saxony.

*Fettbol* has a liver-brown color, a slightly greasy luster, shining streak, conchoidal fracture, and G. = 2·249, Breith., and is from Halsbrücke near Freiberg.

*Graminite* has a grass-green color (whence the name), and occurs at Menzenberg, in the Siebengebirge, in thin fibrous seams, or as a feather of delicate lamellæ; H. = 1; G. = 1·87, after drying at 212° F.; luster and feel somewhat greasy, as in pinguite.

**Comp.**—A hydrated iron silicate, perhaps with the general formula $H_6Fe_2Si_3O_{12} + 2H_2O$ or $Fe_2O_3.3SiO_2.5H_2O$ = Silica 41·9, iron sesquioxide 37·2, water 20·9 = 100. Alumina is present in some varieties.

The water and silica both vary much. The Hungarian chloropal occurs mixed with opal, and graduates into it, and this accounts for the high silica of some of its analyses.

On the composition of this and related minerals, cf. Collins, Min. Mag., **1**, 70, 1876.

**Anal.**—1, Bernhardi & Brandes, l. c. 2, Berthier, Ann. Ch. Phys., **36**, 22, 1827. 3, Dufrenoy, Ann. Mines, 3, 393, 1833. 4, 5, Mehner, J. pr. Ch., **49**, 382, 1850. 6, Karsten, Schw. J., **66**, 9, 1832. 7, Bergemann, l. c. 8, Schrauf, Jb. Min., 255, 1877. 9, Weibull, G. För. Förh., **5**, 627, 1881. 10, Thorpe, J. Ch. Soc., **23**, 29, 1870. 11, Collins. Min. Mag., **1**, 67, 1876. 12, Liversidge, Proc. Roy. Soc. N. S. W., Nov. 3, 1880. 13–18, E. F. Smith, Am. Ch. J., **5**, 277, 1883. 19, L. N. Chappell, Ch. News, **50**, 220, 1884. Also other analyses 5th Ed., p. 461.

| | G. | $SiO_2$ | $Fe_2O_3$ | $Al_2O_3$ | FeO | MgO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 1. Unghwar, *earthy* | | 45·0 | 32·0 | 0·75 | — | 2·0 | — | 20·0 = 99·75 |
| 2. Nontron, *Nontronite* | | 44·0 | 29·0 | 3·6 | — | 2·1 | — | 18·7 clay 1·2 = [98·6 |
| 3. Villefrance, " | 2·08 | 40·68 | 30·19 | 3·96 | — | 2·37 | — | 23·0 = 100·20 |
| 4. Andreasberg, *greenish* | | 40·50 | 33·70 | 1·09 | 2·26 | — | 1·11 | 21·82 = 100·48 |
| 5. " *black* | | 46·21 | 36·32 | — | — | *tr.* | — | 20·38 = 102·91 |
| 6. Wolfenstein, *Pinguite* | 2·315 | 36·90 | 29·50 | 1·80 | 6·10 | 0·45 | — | 25·10 $Mn_2O_3$ 0·15 [= 100 |
| 7. *Graminite* | | 38·39 | 25·46 | 6·87 | 2·80 | 0·75 | 0·56 | 23·36 MnO 0·67, [$K_2O$ 1·14 = 100 |
| 8. Mugrau | | 42·93 | 28·91 | 3·19 | — | 2·84 | 3·35 | 18·32 = 99·54 |
| 9. Starbo, Sweden | 2·19 | 48·59 | 32·54 | 9·09 | 0·55 | *tr.* | 2·09 | 7·05 = 99·91 |
| 10. Heppenheim | | 40·30 | 36·44 | — | — | *tr.* | 2·68 | 20·98 = 100·40 |
| 11. Smallacombe, Devon | 1·89 | 39·70 | 21·94 | 10·92 | — | — | 0·14 | 25·41[a] alk. [1·89] [= 100 |
| 12. Mudgee, N. S. W. | 1·94 | 49·66 | 29·11 | — | — | 0·51 | 2·61 | 17·53[b] $Na_2O$ 0·60, [$K_2O$ 0·17 = 100·19 |
| 13. Lehigh Mt., Penn., *drk. yw.* | | 40·81 | 39·30 | — | — | — | — | 19·79 = 99·90 |
| 14. " " *lt. yw.* | 2·033 | 42·79 | 39·19 | — | — | — | — | 19·09 = 101·07 |
| 15. " " *yw. grn.* | | 41·16 | 30·79 | 2·05 | 0·21 | — | — | 20·79 $K_2O$ 4·54 [= 99·54 |
| 16. " " " | | 41·41 | 35·35 | 3·04 | — | — | — | 20·45 = 100·25 |
| 17 " " *brn.* | | 43·54 | 39·52 | — | — | — | — | 17·71 = 100·77 |
| 18. " " *white* | | 44·52 | 11·04 | 25·95 | — | *tr.* | — | 17·65 $K_2O$ 0·94 [= 100·10 |
| 19. Albemarle Co., Va. | 2·06 | 38·64 | 22·18 | 20·05 | 0·04 | 0·44 | 1·09 | 15·71 = 98·15 |

[a] Over $H_2SO_4$ 11·58, at 250° 7·22. [b] Combined 5·22.

**Pyr., etc.**—Yields water. B B. infusible, but turns black and becomes magnetic. With the fluxes gives reactions for iron. Chloropal is partially decomposed by hydrochloric acid;

pinguite is completely decomposed, with separation of pulverulent silica, while nontronite gelatinizes with hydrochloric acid.

**Obs.**—Localities are mentioned above. The locality of *chloropal* at Meenser Steinberg is near Göttingen; *pinguite* occurs also at Sternberg in Moravia.

The Lehigh Mt , Pa., locality is south of Allentown, near Mountainville, where it occurs in connection with iron deposits.

Named from χλωρός, *green*, and *opal*.

Chloropal also occurs (Church, Ch. News, **2**, 71, 1866) in a feldspar quarry, near the old tin mine known as Carclase, not far from St. Austell, in Cornwall, associated with fluorite; it is the variety which has been named *graminite*.

GLASURITE. PROTONONTRONITE *A. Knop* [Vers. Oberrh. G. Ver. Stuttgart, 13, 1888], Zs. Kr., **18**, 668, 1891. Imperfectly characterized silicates occurring in amygdaloidal cavities in the limburgyte of Sasbach in the Kaiserstuhl. *Glasurite* is a brownish yellow substance mixed with calcium carbonate, etc., appearing in layers as a glazed coating of the cavities. After partial purification the results of analysis 1 were obtained.

*Protonontronite* is a dark leek-green substance which, mixed with calcium carbonate, forms a greenish white fatty mass filling the cavities entirely. Composition of material freed from the carbonate in analysis 2:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 51·20 | 8·29 | 19·62 | — | 0·25 | 4·04 | — | 16·80 | = 100·20 |
| 48·52 | 5·94 | — | 6 00 | 0·59 | 24·72 | 2·79 | 10·70 | = 99·26 |

ANTHOSIDERITE *Hausm.*, Gel. Anz. Gött., 281, 1841.

In tufts of a fibrous structure, and sometimes collected into feathery flowers. Resembles cacoxene. H. = 6·5. G. = 3. Luster silky, a little chatoyant on a fresh fracture. Color ocher-yellow and yellowish brown, somewhat grayish, rarely white. Powder brown to colorless. Opaque or slightly subtranslucent. Gives sparks with a steel. Tough.

Composition, $2Fe_2O_3.9SiO_2.2H_2O$ = Silica 60·3, iron sesquioxide 35·7, water 4·0 = 100. Analysis by Schnedermann (l. c., and Pogg., **52**, 292, 1841) of the yellow variety:

$\frac{2}{2}$ $SiO_2$ 60·08 $Fe_2O_3$ 34·99 $H_2O$ 3·59 = 98·66

B.B. becomes reddish brown, then black, and fuses with difficulty to a black magnetic slag. Decomposed by hydrochloric acid.

From Antonio Pereira, in the province Minas Geraes, Brazil, where it is intimately associated with magnetic iron. Named from ανθος, *flower*, and σίδηρος, *iron*.

**506. HISINGERITE.** Hisingerit (fr. Riddarhyttan) *Berz.*, Pogg., **13**, 505, 1828. Degeröit *Holmberg*, Bidr. Finl. Nat., 1, 4, Min. Ges. St. Pet., 1850, 1851, N. Nordenskiöld, Verz. Finl. Min., 1852. Skotiolit *Arppe*, Finsk. Min., 13, 1857. Manganhisingerite *Weibull*, Öfv. Ak. Stockh., **41**, No. 9, 21, 1884.

Amorphous, compact, without cleavage.

Fracture conchoidal. H. = 3. G. = 2·5–3·0. Luster greasy, inclining to vitreous. Color black to brownish black. Streak yellowish brown.

**Comp.**—A hydrated ferric silicate, but of uncertain composition, the material analyzed being in most cases of questionable homogeneity.

**Var.**—(1) *Hisingerite*, (2) *Degeröite*, G. = 2·54, Holmberg; H. = 2·5; color blackish green to black. (3) *Scotiolite;* G. = 3·09; H. = 3; color dark green to black (and named from σκότιος, *dark*); contains much magnesia, and less water than hisingerite.

*Manganhisingerite* from Vestra Silfberg, Sweden, anal. 14, is an alteration-product of knebelite, probably not homogeneous. G. = 2·469.

**Anal.**—1–10, Cleve, Öberg, Lindström, Nordenskiöld, Thoreld, Öfv. Ak. Stockh., **23**, 169, 1866. 11, Rg., Pogg., **75**, 398, 1848. 12, Thoreld, Öfv. Ak. Stockh., 169, 1866. 13, Arppe, l. c. 14, Weibull, l. c. 15, Rand, Proc. Ac. Philad., 304, 1872. 16, F. W. Clarke, Am. J. Sc., **34**, 133, 1887. 17, Church, J. Ch. Soc., **23**, 3, 1870.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $H_2O^c$ | $H_2O(100°)$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Riddarhyttan | 35·02 | 1·20 | 39·46 | 2·20 | — | 0 80 | *tr.* | 10·50 | 11·20 | insol.<br>[0·95=101·33 |
| 2. " | 35·08 | 1·38 | 40·28 | 2·23 | — | 0·35 | 0·36 | 20·78 | | =100·46 |
| 3. Solberg, Norway | 35·33 | — | 32·14 | 7·08 | — | 3·60 | — | 10·38 | 11·66 | =100·19 |
| 4. " " | 37·55 | 1·17 | 30·57 | 7·00 | — | 2·91 | 1·41 | 7·21 | 13·11 | =100·93 |
| 5. Jordåsen | 34·90 | — | 36·00 | 9·20 | — | 2·67 | — | 9·13 | 9·33 | =101·23 |
| 6 Långban | 35·71 | — | 27·70 | 7·52 | 3·02 | 1·68 | 1·48 | 10·64 | 12·19 | = 99·94 |
| 7. Waldemarsvik | 33·66 | — | 39·90 | 2·30 | — | 2·95 | — | 11·72 | 9·37 | = 99·90 |
| 8. Orijärvi | 36·92 | — | 31·87 | 8 92 | — | 2·06 | — | 7·59 | 13·56 | =100·92 |
| 9. Tunaberg | 37·14 | 1·39 | 30·24 | 3·02 | 0·17 | 6·06 | — | 10·95 | 10·61 | = 99·58 |

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$[c] | $H_2O(100°)$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 10. Långban, *Scotiolite* | 36·73 | — | 34·97 | 3·09 | *tr.* | 8·75 | — | 9·20 | 6·30 | = 99·04 |
| 11. Riddarhyttan, *His.* | 33·07 | — | 34·78 | 17·59 | — | 0·46 | 2·56 | 11·54 | — | = 100 |
| 12. Degerö, *Degeröite* | 34·15 | 0·75 | 38·63 | 1·08 | — | 2·33 | 2·70 | 7·94 | 11·60 | insol. 1·64 = 100·82 |
| 13. Orijärvi, *Scotiolite* | 40·97 | 0·60 | 13·04 | 11·70 | — | 15·63 | 0·38 | 8·79 | 7·63 | = 98·74 |
| 14. Vestra Silfberg | 37·09 | 1·39 | 34·34 | — | 15·50[a] | 2·62 | 1·92 | 7·81 | — | = 100·67 |
| 15. Gap Mine, Pa. | 35·40 | — | 27·46 | 12·53 | — | — | — | 9·89 | 14·30 | = 99·58 |
| 16. Alex. Co., N. C. | 31·16 | 8·06 | 35·86[b] | — | — | 5·43 | — | 20·50 | — | = 101·01 |
| 17. Lostwithiel | 36·14 | — | 52·94 | — | — | *tr.* | — | 10·49 | — | = 99·57[d] |

[a] $Mn_2O_3$. [b] Chiefly but not wholly FeO. [c] Above 100°. [d] Also $P_2O_5$ 0·82.

A mineral from Ducktown, Tenn., pseudomorph after calcite, gave Genth: $SiO_2$ 24·42, $Fe_2O_3$ 49·02, ZnO 1·17, MgO 0·41, CaO 1·83, $H_2O$ 23·70 = 100·55 Am. Phil. Soc., **24**, 21, 1887.

**Pyr., etc.**—Yields much water. B.B. fuses with difficulty to a black magnetic slag. With the fluxes gives reactions for iron. In hydrochloric acid easily decomposed without gelatinizing.

**Obs.**—Found at the various localities mentioned above. At Riddarhyttan it occurs in reniform masses associated with pyrite in a copper mine, and is a result of alteration; at Degerö, near Helsingfors, Finland, in a silver mine.

Named after the Swedish chemist, W. Hisinger (1766-1852).

GILLINGITE. Svart Stenart (fr. Gillinge) *Hisinger*, Afh., **3**, 304, 1810. Gillingit *Hisinger*, Min. Geogr. Schwed. (Wöhler's), 102, 1826. Thraulit (fr. Bodenmais) *Kbl.*, Pogg., **14**, 67, 1828. Traulit.

Amorphous to compact. H. = 3. G. = 3·045, Gillinge, Hisinger. Luster shining to dull; surface of fracture earthy. Color black or blackish.

Anal.—1, Hisinger, Afh., **3**, 304. 2, Rg., Pogg., **75**, 400, 1848; also Hoglund and Tamm, Öfv. Ak. Stockh., **23**, 169, 1866. 3, Hermann, J. pr. Ch., **46**, 238, 1849. 4, Hisinger, Pogg., **13**, 505, 1828. 5, Kobell, l. c.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Gillinge | 27·50 | 5·50 | 52·27[a] | — | — | — | 11·75 | = 97·02 |
| 2. " | 32·18 | — | 30·10 | 8·63 | 4·22 | 5·50 | 19·37 | = 100 |
| 3. Orijärvi | 29·51 | — | 10·74 | 37·49 | 7·78 | — | 13·00 | = 98·52 |
| 4. Bodenmais, *Thraulite* | 31·77 | — | 49·87 | | — | — | 20·00 | = 101·64 |
| 5. " " | 31·28 | — | 43·42 | 5·70 | — | — | 19·12 | = 99·52 |

[a] Incl. 0·77 $Mn_2O_3$.

Yields much water. B.B. fuses at 5 to a black, slaggy, opaque, magnetic globule. Decomposed by hydrochloric acid.

From Gillinge mine, in Södermanland, Sweden, whence the name. *Thraulite* (named from θραυλός, *fragile*) occurs at Bodenmais, three leagues from Zwiesel, in Bavaria, with vivianite, etc.

JOLLYTE *Fr. v. Kobell*, Ber. Ak. München, 168, 1865.

Compact, amorphous. H. = 3. G. = 2·61. Luster weak, greasy. Color dark brown, with greenish powder. Analysis.—Kobell.

$SiO_2$ 35·55 $Al_2O_3$ 27·77 FeO 16·67 MgO 6·66 $H_2O$ 13·18 = 99·83

Occurs at Bodenmais in Bavaria, with pyrite, vivianite, iolite, etc. Resembles a hisingerite in which the iron is replaced by alumina. Named after the physicist, G. Jolly.

MELANOSIDERITE *J. P. Cooke*, Am. Ac. Sc., **10**, 451, 1875.

Amorphous; compact. H. = 4·5. G. = 3·391. Luster vitreous, inclining to resinous. Color black, with a tinge of red. Streak brownish to brick red. Subtranslucent.

If homogeneous, a basic hydrated iron silicate, having the formula $Fe_8SiO_{14}.6H_2O$ or $4Fe_2O_3.SiO_2.6H_2O$ = $SiO_2$ 7·4, $Fe_2O_3$ 79·2, $H_2O$ 13·4 = 100. Analysis.—W. H. Melville, ibid.:

⅔ $SiO_2$ 7·42 $Fe_2O_3$ 75·13 $Al_2O_3$ 4·34 $H_2O$ (above 100°) 7·68, 100° 6·17 = 100·74

In the closed tube decrepitates and gives off water. B.B. fuses at 4½ to a magnetic mass. Gelatinizes with hydrochloric acid.

Locality, Mineral Hill, Delaware Co., Penn. Named from μέλας and σίδηρος, in allusion to the black color.

Genth (2d Rep. Min. Pennsylvania, p. 216, 1876) suggests that melanosiderite is only a variety of an iron hydrate, probably a limonite. If the silica is an impurity the composition is exactly that of limonite, as Cooke remarks; he, however, regards it as a basic silicate on the ground of its vitreous luster, fusibility, definite composition, and the fact that it gelatinizes with acids.

Avasite *J. Krenner* [Földt. Értesitö, 2, 105, 1881], Zs. Kr., 8, 537, 1883. Occurs at the limonite deposits of the Avasthal, Comitat Szathmár, Hungary, and locally known as *Eisenpecherz.* Massive, black, but in thin splinters translucent, giving a red color. Fracture conchoidal, brittle. Luster vitreous. H. = 3·5. G. = 3·33.

Composition, according to Loczka, stated to be $5Fe_2O_3.2SiO_2.9H_2O$. Acetic acid dissolves the iron and leaves the silica in transparent colorless and glassy particles. Probably only a siliceous limonite.

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**507. BEMENTITE.** *G. A. König*, Proc. Acad. Philad., 310, 1887.

In radiated stellate masses with small foliated structure; resembles some pyrophyllite.

Cleavage: perfect, and structure micaceous. Soft. G. = 2·981. Luster pearly. Color pale grayish yellow.

**Comp.**—Approximately $2MnSiO_3.H_2O$ = Silica 42·9, manganese protoxide 50·7, water 6·4 = 100.

**Anal.**—König, l. c.:

$SiO_2$ 39·00 MnO 42·12 FeO [3·75] ZnO 2·86 MgO 3·83[a] $H_2O$ 8·44 = 100

[a] CaO *trace.*

**Pyr.**—Fuses readily to a black glass; reacts for manganese with the fluxes. Water expelled above 100°. Dissolves in hot hydrochloric acid without gelatinization.

**Obs.**—Occurs closely associated with calcite at the zinc mines of Franklin Furnace, N. J.

Named after Mr. C. S. Bement of Philadelphia.

**508. CARYOPILITE.** Karyopilit *A. Hamberg*, G. För. Förh., **11**, 27, 1889.

Massive. In stalactitic and reniform shapes, compact within, the outer portions showing a concentric radiate-fibrous structure; forming a felted mass as seen under the microscope.

H. = 3–3·5. G. = 2·83–2·91. Color brown on the fracture. Double refraction weak. Extinction probably parallel.

**Comp.**—Approximately $4MnO.3SiO_2.3H_2O$.

**Anal.**—Hamberg, l. c. The material not entirely pure.

| $SiO_2$ | MnO | MgO | CaO | $H_2O$ | PbO | $Fe_2O_3$ | |
|---|---|---|---|---|---|---|---|
| 36·16 | 46·46 | 4·80 | 0·28 | 9·81[a] | 0·37 | 1·33 | $Al_2O_3$ 0·35, alk. 0·20, Cl 0·09 = 99·85 |

[a] Given off between 115° and a low red heat.

Easily soluble in strong acids.

**Obs.**—Occurs at the Harstig mine near Pajsberg, Wermland, Sweden, with crystallized native lead, sarkinite, brandtite.

Named from κάρυον, *walnut*, and πῖλος, *felt.*

**509. NEOTOCITE.** Neotokit *N. Nordenskiöld*, Verz. Finl. Min., 1852. Wittingit *id.*, ib. Vattenhaltigt Manganoxid-silikat *J. F. Bahr*, Öfv. Ak. Stockh., **7**, 240, 1850. Stratopeit *L. J. Igelström*, ib., 143, 1851 (with mention of "Neotokit" and "Wittingit").

Amorphous. H. = 3–4. G. = 2·64–2·8 Luster dull, sometimes feebly submetallic. Color black to dark brown and liver-brown. Streak dark brown to black. Opaque.

**Comp.**—A hydrated silicate of manganese and iron, but of very doubtful composition.

*Neotocite* is included by Nordenskiöld along with stratopeite, and good authority appears thus to be given for setting aside the older analysis of it by Igelström. In *stratopeite*, G. = 2·64, according to Igelström; in *neotocite* and *wittingite*, G. = 2·7–2·8, according to N. Nordenskiöld.

**Anal.**—1–4, Cleve and A. E. Nordenskiöld, Öfv. Ak. Stockh., **23**, 169, 1866. 5, Nordenskiöld, J. pr. Ch., **100**, 122, 1867 and l. c. 6, 7, Bahr, l. c.

| | G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | $Mn_2O_3$ | MnO | MgO | CaO | $H_2O$[a] | $H_2O$(100°) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Pajsberg, *Stratopeite* | 2·73 | 35·83 | — | 8·20 | — | — | 29·37 | 8·66 | — | 10·03 | 6·08 | PbO 2·13 = 100·30 |
| 2. " " | | 35·05 | — | 1·36 | — | — | 38·49 | 5·27 | 0·47 | 9·81 | 6·91 | PbO 3·31 = 100·67 |
| 3. Gestrikland, *Neotocite* | 2·70 | 35·79 | — | 10·90 | 13·93 | — | 20·51 | 2·44 | 0·52 | 8·48 | 7·29 | = 99·86 |
| 4. " " | 2·94 | 34·38 | 1·57 | 18·58 | 2·88 | — | 22·67 | 2·50 | — | 9·30 | 8·07 | = 99·95 |
| 5. Bredvik, *Wittingite* | | 39·72 | — | 2·06 | — | 34·76 | | 1·21 | 0·69 | 12·25 | 9·73 | = 100·42 |
| 6. Klapperud | 2·88 | 36·20 | 1·11 | 0·70 | — | 47·91 | — | 4·43 | 0·61 | 9·43 | — | = 100·39 |
| 7. " | 2·98 | 34·72 | 1·09 | 10·45 | — | 42·64 | — | 0·36 | 0·56 | 9·76 | — | = 99·58 |

[a] Above 100°.

**Pyr., etc.**—Yields much water. Reactions with borax for manganese and iron. Difficultly fusible to infusible.

**Obs.**—Occurs with rhodonite at Pajsberg, Filipstad, Sweden (*stratopeite*); Gestrikland (*neotocite*) in Sweden; at Ingoa (*ib.*), Finland; at Wittingi (*wittingite*) in Storkyro, Finland; at Bredvik (*ib.*) in West Gothland; at Klapperud in Dalecarlia.

Named from *νεότοκος*, *of recent origin.* This name antedates *stratopeite.*

A hydrated manganese silicate near neotocite and stratopeite from the Dillenburg mining region, Germany, has been investigated by A. Schneider, Jb. preuss. G. Landesanstalt, 472 *et seq.*, 1887. The manganese ore (Kieselmangan) is a heterogeneous mass varying from yellowish brown to reddish brown in color. It has been derived from the alteration of a silicate of manganese protoxide, which last appears in the ore in thin layers and kernels surrounded by reddish layers. H. = 3–4. G. = 2·465. Luster greasy. Color amber-yellow; streak yellow-brown. Doubly refracting. Optically biaxial, positive. Composition approximately given by anal. 1 by Bärwald, but the material not entirely pure. Anal. 2 gives the composition of dark red-brown portions, amorphous, H. = 4, G. = 2·675, mixed with limonite, calcite, etc.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MnO | CaO | MgO | $H_2O$ | $CO_2$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 35·64 | 2·59 | 3·02 | 39 26 | 1·75 | 1·31 | 13·94 | 0·60 | alk. *undet.* = 98·11 |
| 2. | 30·21 | 2·30 | 12·49 | 29·16 | 6·04 | 0·98 | 16·62 | 2·40 | = 100·20 |

Klipsteinite is another hydrated manganese silicate, but impure. See p. 381. See also hydrorhodonite, p. 381, hydrotephroite, p. 458, epigenite or neotesite, p. 458.

**Penwithite** *J. H. Collins*, Min. Mag., **2**, 91, 1878; **3**, 89, 1879.

Massive. Fracture conchoidal. Brittle. H. = 3·5. G. = 2·49. Luster vitreous. Color dark amber to reddish brown. Transparent. Analysis:

$\frac{3}{8}$ $SiO_2$ 36·40 MnO 37·62 FeO 2·52 $H_2O$ 21·80 $MnO_2$ *tr.* $U_2O_3$ 0·30 Cu *tr.* = 98·64

Formula $MnSiO_3 + 2H_2O$. B.B. fuses with difficulty. Occurs with quartz and rhodochrosite in the district of Penwith (whence name), West Cornwall.

## APPENDIX TO HYDROUS SILICATES.

**Allophite** *Websky*, Zs. G. Ges., **25**, 399, 1873.

In dense, micro-crystalline masses, on fracture dull, and easily polished to a greasy luster by the hand. G. = 2·641 Leffler. Color pale grayish green. In appearance very similar to pseudophite; distinguished from serpentine by inferior hardness. Analysis.—Leffler, l. c.:

$SiO_2$ 36·23 $Al_2O_3$ 21·92 $Fe_2O_3$ 2·18 $Cr_2O_3$ 0·85 MgO 35·53 $H_2O$ 2·97 = 99·68

The water goes off only at a high temperature. Occurs at Langenbielau, Silesia; also at Reichenstein. From a quarry of limestone occurring in the gneiss.

**Antillite** *C. U. Shepard*, App. Cat. Meteorites, Amherst, Mass., 1872.

Massive and crystalline, presenting minute coppery laminæ with a fibrous cleavage. H. = 3·5–4. G. = 2·52. Color dark greenish brown. An analysis gave: $SiO_2$ 39·30, MgO 36·12, FeO 6·70, $H_2O$ 16·79, with traces of $Cr_2O_3$, CaO, $K_2O$ = 98·91. This composition approaches that of serpentine or deweylite.

**Aquacreptite** *C. U. Shepard*, Am. J. Sc., **46**, 256, 1868.

Massive, occurring in irregular polyhedral fragments, with flat or concave surfaces. H. = 2·5. G. = 2·05–2·08. Luster dull. Color yellowish brown. Streak orange-yellow. Brittle. Adheres to the tongue. Falls to pieces in water, with a crackling noise. Analysis.—J. H. Eaton, l. c.:

G. = 2·05 $SiO_2$ 43·03 $Al_2O_3$ 5·56 $Fe_2O_3$ 12·30 MgO 19·58 $H_2O$ 17·40 = 97·87

Decomposed by hydrochloric acid. Found in a vein in serpentine at West Chester, Pa.

**Arctolite.** Arktolite *Blomstrand*, "Ett högnordiskt mineral," G. För. Förh., **5**, 210, 1880.

Occurs in a crystalline limestone, forming small irregularly curved crystalline plates, generally compact, occasionally showing prismatic angles of 54°–56°, Sjögren. H. = 5. G = 3·03. Colorless or yellowish to greenish. Analysis:

| | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| $\frac{2}{2}$ | 44·93 | 0·38 | 23·55 | 1·24 | 13·28 | 10·30 | 1·73 | 0·79 | 3·54 | = 99·74 |

This corresponds to $H_2O.(Ca,Mg)O.Al_2O_3.3SiO_2$. B.B. fuses with difficulty to a white enamel; partially attacked by acids with the separation of flocculent silica

Found in 1861 on Hvitholm, near Spitzbergen

**Balvraidite** *Heddle,* Min. Mag., **4**, 117, 1880.

Structure saccharoidal. H. = 6. G. = 2·91. Color pale purplish brown. Analysis of dark variety:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 46·04 | 20·11 | 2·52 | 0·79 | 8·30 | 13·47 | 2·72 | 1·36 | 4·71 = 100·02 |

B.B. fuses with intumescence to a vesicular pale blue glass.

Occurs in a granular limestone at Balvraid, Inverness-shire, Scotland.

**Barettite** *Bombicci* [Atti della Soc. Ital. di Sc. Nat., **11**], Jb. Min., 750, 1868; Min., **2**, 773, 1875.

In nodular, radiated, and fibrous masses. H. = 2·5. G. = 2·5. Color apple-green. Streak white. Feel soapy. Analysis by Sestini: $SiO_2$ 30·96, $Al_2O_3$ 1·59, FeO 7·17, CaO 33·67, MgO 9·96, $CO_2$ 9·11, $H_2O$ 1·20, alkalies with $SO_3$ and $P_2O_5$ 6·34 = 100. From Traversella in the province of Ivrea.

**Bhreckite** or **Vreckite** *Heddle,* Min. Mag., **3**, 57, 1879.

Fine granular, scaly; soft and friable. Occurs as a light apple-green coating on quartz crystals. An analysis gave:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $H_2O$ | alk. |
|---|---|---|---|---|---|---|---|---|
| 34·92 | 7·16 | 12·71 | 2·11 | 0·41 | 16·08 | 8·26 | 17·77[a] | *tr.* = 99·42 |

[a] 1·03 at 100° C.

Soluble in hydrochloric acid. From a cavity in a boulder of syenitic granite, found on the hill of Ben Bhreck, near Tongue, in Sutherland, Scotland.

**Bravaisite** *E. Mallard,* Bull. Soc. Min., **1**, 5, 1878.

In thin layers and schistose masses consisting of fine crystalline fibers, mostly parallel in position. Unctuous to the touch. Paste-like when wet. H. = 1–2. G. = 2·6. Color gray to greenish gray. Optically —. Extinction parallel. Double refraction strong; 2E = 40°. Analysis:

$SiO_2$ 51·4 $Al_2O_3$ 18·9 $Fe_2O_3$ 4·0 CaO 2·0 MgO 3·3 $K_2O$ 6·5 $H_2O$ 13·3 = 99·4

B.B. fuses easily to a white glass. In the closed tube gives off water and becomes brown. Partially attacked by acids.

Found in layers in the coal and bituminous schists of Noyant, Allier Dept., France. Named after the French crystallographer, M. Bravais. Starkl compares bravaisite with the *Weisserde* of Anna-Capelle and elsewhere in Austria, cf. p. 616, and Jb. G. Reichs., **33**, 654, 1883.

**Chonicrite.** Chonikrit *v. Kobell,* J. pr. Ch., **2**, 51, 1834.

Massive, crystalline granular, or compact. H. = 2·5–3. G. = 2·91. Luster weak silky, to glimmering or dull. Color white. Analysis, Kobell:

$SiO_2$ 35·69 $Al_2O_3$ 17·12 FeO 1·46 MgO 22·50 CaO 12·60 $H_2O$ 9·00 = 98·37

Fuses with intumescence at 3·5–4 to a grayish white glass, and is decomposed by hydrochloric acid, the silica separating in powder.

Forms, with pyrosclerite, seams in serpentine on Elba. Named from χωνεία, *fusion,* and κριτός, *test,* its fusibility distinguishing it from some allied minerals.

Stated by Groth to be essentially decomposed feldspar mixed with diallage.

**Davreuxite** *De Koninck,* Bull. Ac. Belg., **46**, 240, 1878.

In aggregates of slender laminæ appearing like acicular crystals; parallel extinction; resembles asbestus. Cleavage transverse. Color white with a tinge of flesh-red. Luster pearly. Analysis of material free from impurity, except quartz:

$\frac{3}{3}$ $SiO_2$ 55·94 $Al_2O_3$ 33·59 MnO 5·25 MgO 1·10 $H_2O$ 4·19 $Fe_2O_3$ or FeO *tr.* = 100·07

The amount of quartz was determined as from 13 to 18 p. c.; in the above analysis 16·63 p. c. Slightly attacked by acids. Occurs in quartz veins in the Ardennes schists, at Ottré, Belgium. Named after M. Ch. Davreux.

Lacroix shows that davreuxite is simply a hydrated mica. Optically —. 2E = 70°. Bx ⊥ cleavage (001). Bull. Soc. Min., **9**, 5, 1886.

**Dermatin** *Breithaupt,* Char., 104, 1832. Massive, reniform, or in crusts on serpentine, of a resinous luster and green color. Feel greasy; odor, when moistened, argillaceous. Apparently (5th Ed., p. 471) a hydrous silicate of iron and magnesium near deweylite, but probably a mixture. From Waldheim in Saxony. The name is from δέρμα, *skin,* alluding to its occurrence as an incrustation.

**Duporthite** *J. H. Collins,* Min. Mag., **1**, 226, 1877.

In fibrous masses occupying fissures in serpentine. H. = 2. G. = 2·78. Luster silky. Color greenish to brownish gray. Flexible in thin fibers like asbestus. Analysis gave:

| $SiO_2$ | $Al_2O_3$ | $FeO$ | $MgO$ | $CaO$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|
| 49·21 | 27·26 | 6·20 | 11·14 | 0·39 | 0·49 | 3·90 $H_2O$ hygroscopic 0·68 = 99·27 |

About half the water goes off only at an elevated temperature. From Duporth, near St. Austell, Cornwall.

**Ephesite** *J. L. Smith*, Am. J. Sc., **11**, 59, 1851, **48**, 254, 1869.

An alteration-product of corundum into fibrolite subsequently into potash mica, and containing more or less of the original mineral. From the emery locality at Gumuch-dagh near Ephesus.

*Lesleyite* of Lea (Proc. Ac. Philad., 44, 1867) from Unionville, Penn., is a similar mixture of damourite and corundum. Cf. S. P. Sharples, Am. J. Sc., **47**, 319, 1869, and later Genth, Am. Phil. Soc., **13**, 387, 1873.

**Forchhammerite** *Heddle*, Enc. Brit., **16**, 415, 1883.

Massive, granular. Luster subresinous to dull. Color dark green. Composition stated to be $FeSiO_3.6H_2O$. Färöer Is.

**Ginilsite** *Fischer*, *Rg.*, Min. Chem., 704, 1875; Zs. G. Ges., **28**, 236, 1876.

Massive. Color grayish yellow. G. = 3·404. Anal.—1, made in Rammelsberg's laboratory; 2, Rg., l. c.

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $MgO$ | $CaO$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. | 38·75 | 4·83 | 16·32 | 9·48 | 26·52 | 3·73 | = 99·63 |
| 2. | 37·83 | 7·77 | 15·63 | 9·73 | 26·67 | 3·30 | = 100·93 |

Corresponds (Rg.) to $8(Ca,Mg)O.2(Fe,Al)_2O_3.7SiO_2,4H_2O$. Earlier analyses by Fellenberg and others, giving very different results (58 p. c. $SiO_2$, etc.) are discarded by Rammelsberg. B.B. fuses on the edges to a dark glass.

From Ginilsalp, Grisons, Switzerland.

**Groppite** *Svanberg*, Öfv. Ak. Stockh., **3**, 14, 1846.

Crystalline, with one distinct cleavage affording a broad cleavage surface, and two others less distinct. Fracture splintery. H. = 2·5. G. = 2·73. Thin splinters translucent. Color rose-red to brownish red. Streak paler. Analysis.—Svanberg, l. c:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $MgO$ | $CaO$ | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 45·01 | 22·55 | 3·06 | 12·28 | 4·55 | 0·21 | 5·23 | 7·11 insol. 0·13 = 100·13 |

In a matrass yields water. B.B. whitens, and on thin edges shows only incipient fusion. From a limestone at Gropptorp in Sweden.

Pisani found for a related mineral occurring in green grains in anhydrite, Bull. Soc. G., **22**, 25, 1864:

$SiO_2$ 48·20 $Al_2O_3$ 19.70 FeO 3·38 MgO 12·80 CaO 1·64 alk. [7·22] $H_2O$ 7·06 = 100

**Hydrosilicite** *Waltershausen*, Vulk. Gest., 305, 1853.

An amorphous substance or crust from Palagonia and Aci Castello, Sicily, which afforded:

| $SiO_2$ | $Al_2O_3$ | $MgO$ | $CaO$ | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 44·90 | — | 4·60 | 33·32 | 2·11 | 1·86 | 13·21 | = 100 |
| 43·32 | 3·14 | 8·66 | 28·70 | 1·70 | | 14·48 | = 100 |

**Leidyite** *G. A. König*, Proc. Acad. Philad., 84, 1884.

In verruciform incrustations, consisting of fine scales with silky luster; also stalactitic; crystalline (?). H. = 1–2. Luster resinous. Color grass-, blue-, or olive-green. Streak white. Analysis:

$SiO_2$ 51·40 $Al_2O_3$ 16·82 FeO 8·50 MgO 3·07 CaO 3·15 $H_2O$ 17·08 = 100·02

B.B. fuses with intumescence to a light yellow green glass. In the closed tube gives off water and becomes brown. Soluble readily in hydrochloric acid, with partial gelatinization; after ignition insoluble.

Found with grossular garnet. zoisite, and quartz, at Leiperville, Delaware Co., Penn. Named after Dr. Joseph Leidy (1823–1891).

**Leucotile.** Leukotil *Hare*, Inaug. Diss. Breslau, 1879.

In fibers irregularly grouped on serpentine. Luster silky. Color green. Analysis:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $MgO$ | $CaO$ | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 28·98 | 6·99 | 8·16 | 29·78 | 7·37 | 1·32 | *tr.* | 17·29 = 99·89 |

Easily soluble in hydrochloric and sulphuric acids. B.B. fuses and becomes slightly yellow and yellowish brown. From Reichenstein, Silesia.

**Lillite** *Reuss*, Ber. Ak. Wien, **25**, 550, 1857. From Přibram, Bohemia, with pyrite, and arising, apparently, through the agency of decomposing pyrite. H. ≐ 2; G. = 3·043. Earthy, like glauconite; blackish green. Analysis afforded: $SiO_2$ 32·48, $Fe_2O_3$,FeO 54·95, $H_2O$ 10·20, $CaCO_3$ 1·96, $FeS_2$ 0·63 = 100·22.

**Melopsite** *Breith.*, Handb., **2**, 360, 1841. Melopsite is translucent, white, yellowish, grayish, or greenish, has a small conchoidal fracture, adheres a little to the tongue, and resembles in texture the flesh of an apple (whence the name from μῆλον, *apple*, and ὄψον, *meat, etc.*). According to Plattner, it consisted of silica, alumina, a little magnesia and iron oxide with ammonia, water, and some bitumen. An analysis by Goppelsröder (J. pr. Ch., **105**, 126, 1868) gave:

$SiO_2$ 44·15 $Al_2O_3$ 4·95 $Fe_2O_3$ 0·02 MgO 31·59 CaO 3·40 $H_2O$ 11·54(160°) $H_2O$ 4·02(ign.)=99·67

**Næsumite** *C. W. Blomstrand*, Öfv. Ak. Stockh., **25**, 209, 1868. A chalk-white mineral, from Näsum, Sweden. It occurs mixed with the phosphate attacolite. After calculating out the phosphoric acid the analysis gave:

$SiO_2$ 50·91 $Al_2O_3$ 27·86 $Fe_2O_3$ 1·36 MnO 0·36 CaO 13·82 $H_2O$ 4·39 = 98·70

**Nefedieffite.** Nefediewit *P. Pusirevsky*, Vh. Min. Ges., **7**, 15, 1872.

Amorphous, very similar to lithomarge. H. = 1·5. G. = 2·335. Fracture conchoidal. Color white to rose-red. Feel greasy. A hydrous silicate of aluminium and magnesium, but of doubtful composition. Analysis:

$\frac{3}{3}$ $SiO_2$ 60·76 $Al_2O_3$ 20·94 CaO 1·06 MgO 6·80 $Na_2O$ 0·40 $H_2O$ 9·92 = 99·88

This corresponds to $3H_2O.MgO.Al_2O_3.5SiO_2$. Scarcely soluble in acids.

Occurs with fluorite in limestone at Nerchinsk in Eastern Siberia.

**Neolite.** Neolith *Scheerer*, Pogg., **71**, 285, 1847.

In silky fibers stellately grouped; also massive. H. = 1–2. G. = 2·77, after drying. Color green. Luster silky or earthy. Composition uncertain; as the mineral is formed through the agency of infiltrating waters through rocks containing magnesia, it is not safe to assume that there are no impurities present. Anal.—1, 2, Scheerer, l. c. 3, Id., ibid., **84**, 375, 1851. 4, Richter, ib., p. 376.

| | $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Arendal | 52·28 | 7·33 | 3·79 | 0·89 | 31·24 | 0·28 | 4·04 | = | 99·85 |
| 2. " | 47·35 | 10·27 | 7·92 | 2·64 | 24·73 | — | 6·28 | = | 99·19 |
| 3. Eisenach | 51·35 | 9·02 | 0·79 | — | 30·19 | 1·93 | 6·50 | = | 99·78 |
| 4. " | 51·44 | 8·79 | 0·88[a] | — | 31·11 | 2·00 | 6·50 | = | 100·72 |

[a] $Fe_2O_3$.

Occurs in the iron mines of Arendal, and in cavities in basalt near Eisenach. Also compact massive and earthy in fissures at Rochlitz in the Riesengebirge, Bohemia, of a pistachio-green color, or brownish; G. = 2·625 to 2·837. Named from νέος, *new*, and λίθος, *stone*.

**Nigrescite** *F. Hornstein*, Zs. G. Ges., **19**, 342, 1867.

Amorphous. Fracture uneven and splintery. H. = 2. G. = 2·845. Color, when fresh, apple-green; on exposure becomes gray to black; opaque and earthy, and, on drying, as light as wad. Loses 16·5 per cent hygroscopic water. Analysis:

$\frac{3}{3}$ $SiO_2$ 52·29 $Al_2O_3$ 5·14 FeO 15·71 MnO 0·23 MgO 18·11 CaO 2·59 $H_2O$ 6·29 = 100·36

Perhaps the product of the alteration of a magnesia-iron augite or amphibole.

Found in rounded masses in basalt, at Dietesheim, in the valley of the Main.

**Pelhamine** *C. U. Shepard*, Contr. Min., 1876. A serpentinous substance (altered asbestus) forming irregular seams and masses at the asbestus mine at Pelham, Mass., resembling a black serpentine. Color dark greenish gray. H. = 5. G. = 2·9–3·2. B.B. infusible. Analysis: $SiO_2$ 38·40, $Al_2O_3$ 2·80, FeO 15·52, MgO [39·88], $H_2O$ 3·40 = 100.

**Persbergite** *Igelström*, 1860, also Öfv. Ak. Stockh., **40**, No. 9, 91, 1883.

Occurs in red or grayish green bladed crystals embedded in granulyte at Persberg, Sweden. Analysis:

SiO 41·20 $Al_2O_3(Fe_2O_3)$ 27·50 MgO,CaO, etc. 18·22 $H_2O$ 13·08 = 100

Stated to be an alteration-product of nephelite.

**Picrofluite** *Arppe* Act. Soc. Fenn., **6**; Vh. Min. Ges., 148, 1852.

Amorphous. Luster greasy to dull. Color white, inclining to yellow and blue. H. = 2·5. G. = 2·74. Probably a mixture of fluorite with a magnesian silicate. Anal.—1, Galindo. 2, Arppe.

| | $SiO_2$ | FeO | MnO | MgO | CaO | $H_2O$ | F |
|---|---|---|---|---|---|---|---|
| 1. Lupikko | 29·00 | 1·54 | 0·78 | 28·79 | 22·72 | 8·97 | 11·16 = 102·96 |
| 2. " | 32 16 | 3·50 | — | 25·19 | 19·86 | 9·08 | *und.* |

B.B. fuses easily with intumescence. Completely soluble in acids; evolves silicon fluoride with sulphuric acid.

Occurs at Lupikko in Finland, some versts south of Pitkäranta, with chalcopyrite and sphalerite.

Picrosmine. Pikrosmin *Haidinger*, Min. Mohs., 3, 157, 1825.

A doubtful magnesian silicate. The mineral first described by Haidinger occurred with magnetic iron ore at the iron mine of Engelsberg, near Pressnitz in Bohemia. He mentions it as massive, with cleavages: perfect ‖ *b* (010), less so *a* (100), imperfect prismatic, 62° 11′. He further refers to a certain figure (25) as exhibiting these cleavage forms with one other form (*o*). On the strength of this statement Magnus and some later authors copied this figure (omitting the form named) as giving the crystalline form of picrosmine(!).

Haidinger also gives: H. = 2·5–3. G. = 2·66, cleavable massive; 2·596, columnar. Luster of cleavage-face pearly, elsewhere vitreous. Color greenish white; also dark green, gray. Streak white. Subtranslucent to opaque. Odor bitter argillaceous when moistened. Dx. obtained: double refraction strong; optical axes in the columnar variety in a longitudinal plane; bisectrix negative, normal to the sides of the columns.

Named from πικρός, *bitter*, and ὀσμή, *odor*. Haidinger instituted the species on the physical characters and cleavage of the massive and fibrous mineral, without a knowledge of the chemical composition, except blowpipe characters which suggested the presence of silica, magnesia, and water. He suggests that much of common asbestus may belong to it.

The original locality is mentioned above; the talcose or chloritic schist of Mt. Greiner in Tyrol, and the limestone of the vicinity of Waldheim, Saxony, have been reported as other localities. Des Cloizeaux obtained the above optical characters from the Pressnitz mineral, and also from another from Zermatt.

An analysis of the original mineral was made in 1826 by Magnus, Pogg., **6**, 53:

$SiO_2$ 54·89 $Al_2O_3$ 0·79 $Fe_2O_3$ 1·40 MnO 0·42 MgO 33·35 $H_2O$ 7·30 = 98·15

As corrected by Rg., this is: $SiO_2$ 54·88, $Al_2O_3$ 0·79, MgO 32·62, FeO 1·26, MnO 0·42, $H_2O$ 7·32 = 97·29.

This corresponds approximately to $H_2Mg_2Si_2O_7$ or $2MgO.2SiO_2.H_2O$, which has accordingly been accepted as the composition of not only picrosmine but also of such other substances as have with more or less reason been referred to it. The original mineral was doubtless a pseudomorph, and the species has a very uncertain claim to recognition. Most so-called picrosmine is simply serpentine.

Frenzel has given (Min. Mitth., **3**, 512, 1880) the following analyses of a mineral which he refers to picrosmine from the Plötzbachthal above Haslau near Zwickau. Structure columnar. H. = 3. G. = 2·80. Luster dull, greasy. Color greenish gray to green, but on the surface gray, brown to black.

| $SiO_2$ | $Al_2O_3$ | FeO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|
| 60·45 | 0·50 | 6·34 | 26·01 | 1·25 | 5·05 | = 99·60 |
| 59·80 | 0·12 | 6·30 | 25·18 | 3·30 | 5·40 | = 100·10 |

B.B. becomes white and fuses in thin splinters; gives the bitter odor like picrosmine.

Pihlite. Pihlit *Sefström*, Svanberg, Ak. H. Stockh., 155, 1839.

A white, micaceous mineral having about the same composition as the pseudomorphous cymatolite, and perhaps like that only a mechanical mixture of mica and feldspar—see under spodumene, p. 368. In granite at Brattstad, near Sala, Sweden.

Pilinite *A. von Lasaulx*, Jb. Min., 358, 1876.

In very minute (·005 mm. to ·01 mm.) prismatic crystals, having a rhombic section of about 120° and 60°; forming a fine felt-like mass, the needles often bent; resembles asbestus. Cleavage: basal, perfect; prismatic, distinct. G. = 2·263. Luster of needles silky. Colorless to white. Extinction parallel. Analysis, Bettendorf, l. c.:

$SiO_2$ 55·70 $Al_2O_3,Fe_2O_3$ 18·64 CaO 19·51 $Li_2O$ [1·18] $H_2O$ 4·97 $MgO,Na_2O,K_2O$ *tr.* = 100

Corresponds approximately to $CaO.Al_2O_3.5SiO_2.H_2O$. Fuses easily with strong intumescence to a sponge-like bead. Insoluble in acids, even on boiling.

Occurs with quartz, epidote, and stilbite in cavities in the granite of Striegau, Silesia. Named from πίλινος, *made of felt.*

Pilolite *Heddle*, Min. Mag., 2, 206, 1879.

A name given to some kinds of mountain cork, anals. 1–4, and mountain leather, anals. 5–7. Structure fibrous, more or less flexible and tough. Color white to pale buff, gray, etc. They occur at various localities in Scotland, in granular limestone, in granite veins, and in veins in sandstones and slates. Named from πῖλος, *felt.* Analyses.—Heddle, l. c., p. 217:

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | above 100° | at 100° | |
| 1. Portsoy | 51·43 | 7·52 | 2·06 | 2·49 | 1·30 | 0·58 | 9·35 | 14·16 | 10·88 | = 99·67 |
| 2. Cabrach | 51·00 | 12·88 | 0·09 | 2·68 | 0·08 | — | 7·54 | 14·10 | 10·64 | = 99·01 |
| 3. Tod Head | 51·61 | 6·63 | — | 2·70 | 2·77 | 1·11 | 10·81 | 15·73 | 9·27 | = 100·63 |
| 4. Tay Port | 54·37 | 11·27 | 0·21 | 1·09 | 0·33 | 0·98 | 9·49 | 13·15 | 9·26 | = 100·15 |
| 5. Tod Head | 52·48 | 6·33 | 0·60 | 2·11 | 2·88 | 1·34 | 11·95 | 15·71 | 5·99 | = 99·39 |
| 6. Lead Hills | 51·45 | 7·98 | 0·97 | 3·29 | 1·49 | 1·97 | 10·15 | 15·74 | 5·96 | = 99·00 |
| 7. Boyne Burn | 51·10 | 6·81 | 2·27 | 2·82 | 1·01 | 0·86 | 10·16 | 14·70 | 9·20 | = 98·93 |

The above agree approximately with $4MgO.Al_2O_3.10SiO_2.15H_2O$.

**Polyhydrite** *Breithaupt,* Handb , **2**, 334, 1841.

From St. Cristoph, at Breitenbrunn, in Saxony. Amorphous; H. = 2–3; G. = 2·095–2·142; luster dull; color liver-brown; streak lighter, grayish. According to Plattner contains $SiO_2$,$Fe_2O_3$,FeO, with some $Al_2O_3$,MnO, and 29·20 p. c. of water. Decomposed in hydrochloric acid.

**Pyknotrop** *Breithaupt,* Char., 110, 1832. An alteration-product related to serpentine, from Waldheim, Saxony. Cf. N.-Z., Min., 635, 1885.

**Pyroïdesine** *C. U. Shepard,* Cat. Meteorites, 1872. A substance near serpentine. The mean of two analyses gave: $SiO_2$ 42·45, MgO 33·07, FeO 6·85, $H_2O$ 16·40. De Regla, Cuba.

**Quincite** *Berthier.* In light carmine-red particles disseminated through a limestone deposit. Anal.—$SiO_2$ 54, FeO 8, MgO 19, $H_2O$ 17 = 98. From near the village of Quincy, France. Strong concentrated acid dissolves the magnesia and iron, and leaves the silica in a gelatinous state. The color is attributed to organic matter. Dufr. Min., **2**, 430, 1856.

**Restormelite** *A. H. Church,* J. Ch. Soc., **23**, 166, 1870. A massive grayish green agalmatolite-like mineral from Restormel Mine in Cornwall. H. = 2. G. = 2·58. Analysis:

$SiO_2$ 45·66 $Al_2O_3$ 35·10 FeO 1·11 MgO 0·85 $K_2O$ 2·30 $Na_2O$ 4·39 $H_2O$ 11·68 = 101·09

**Rubislite** *Heddle,* Trans. Soc. Edinb., **29**, 112, 1879.

A dark green compact granular or fine foliated aggregate. G. = 2·44. Analysis:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 37·85 | 10·92 | 9·84 | 9·01 | 0·46 | 4·22 | 8·00 | 3·33 | 16·13 = 99·76 |

Completely decomposed by hydrochloric acid. B.B. fuses to a brown slag. From the granite of Rubislaw, near Aberdeen, Scotland.

**Stübelite** *Breithaupt,* B. H. Ztg., **24**, 322, 1865.

Reniform and botryoidal massive. Fracture conchoidal, distinct. Brittle. H. = 4–5. G. = 2·223–2·263. Luster vitreous, brilliant. Color velvet to pitchy black. Streak dark brown. Analysis by Stübel, l. c.:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ | CuO | MgO | $H_2O$ | Cl |
|---|---|---|---|---|---|---|---|
| 26·99 | 5·37 | 10·18 | 21·89 | 15·25 | 1·03 | 16·85 | 0·77 = 98·33 |

Occurs at the island of Lipari. Named from Dr. Alphonse Stübel.

**Talcosite** *G. H. F. Ulrich,* Contrib. Min. Victoria, Melbourne, 1870.

In thin seams and threads with scaly structure. H. = 1–2. G. = 2·46–2·5. Luster pearly. Color silver-white, faint greenish, or yellowish. Scales flexible but not elastic. Resembles talc. Analysis, C. Newbery:

$\frac{3}{2}$ $SiO_2$ 49·04 $Al_2O_3$ 46·03 $H_2O$ 4·36 $Cr_2O_3$,FeO, etc. *tr.* = 99·43

Occurs with selwynite at Mount Ida near Heathcote, Victoria.

**Venerite** *T. S. Hunt,* Trans. Amer. Inst. Mng. Eng., **4**, 325, 1876.

Occurs as a greenish, earthy-looking "clay ore," in irregular layers in the schists connected with the magnetite of Jones mine, near Springfield, Berks Co., Penn. The purer portions have a pea-green or apple-green color when moist; become greenish white on drying, and fall to powder. Under the microscope is seen to consist mostly of minute, shining, transparent scales, with some impurities. Analysis by G. W. Hawes, on material purified by washing, gave:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | CuO | MgO | $H_2O$ | insol. |
|---|---|---|---|---|---|---|---|
| 28·93 | 13·81 | 5·04 | 0·27 | 16·55 | 17·47 | 12·08 | 6·22 = 100·37 |

After deducting the insoluble portion, this becomes: $SiO_2$ 30·73, $Al_2O_3$ 14·67, $Fe_2O_3$ 5·35, FeO 0·29, CuO 17·58, MgO 18·55, $H_2O$ 12·83 = 100. It is a heterogeneous substance, apparently a kind of chlorite impregnated with oxide of copper. Named in allusion to the alchemistic symbol for copper.

XYLOTILE *Glocker*, Synopsis, 97, 1847, *Bergholz*, of Sterzing, and *Holzasbest*.
Probably an altered asbestus. It occurs delicately fibrous; glimmering in luster; wood-brown, light or dark, and also green in color; with G. = 2·4–2·45 for the brown, and 2·56 for the greenish, Kenngott. Hauer finds (Ber. Ak. Wien, **11**, 388, 1853):

| | $SiO_2$ | $Fe_2O_3$ | FeO | MgO | CaO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|
| 1. | 44·31 | 17·74 | 3·73 | 8·90 | 2·27 | 21·57 | = | 98·52 |
| 2. | 45·53 | 18·03 | 3·36 | 11·08 | *tr.* | 22·01 | = | 100·01 |
| 3. | 47·96 | 16·05 | 1·87 | 12·37 | *tr.* | 21·64 | = | 99·89 |

Of the water in the analyses, 9·20, 7·90, and 8·13 p. c. passed off at 100° C.; and, excluding the mean of these determinations, reduces the mean of the above results to $SiO_2$ 50·43, $Fe_2O_3$ 18·97, FeO 3·28, MgO 11·82, CaO 0·85, $H_2O$ 14·63 = 99·98. Kenngott considers it as probably altered chrysotile.

*Xylite* of Hermann is also probably only a hydrous asbestus. It has a brown color and asbestiform structure. Hermann obtained (J. pr. Ch., 34, 180, 1845): $SiO_2$ 44·06, $Fe_2O_3$ 37·84, CaO 6·58, MgO 5·42, CuO 1·36, $H_2O$ 4·70 = 99·96. H. = 3. G. = 2·935.

## TITANO-SILICATES, TITANATES.

510. **Titanite** $CaTiSiO_5$ Monoclinic
$\grave{a} : \dot{\bar{b}} : \dot{c} = 0·7547 : 0·8543 \quad \beta = 60° 17'$
511. **Keilhauite** $15CaTiSiO_5.(Al,Fe,Y)_2(Si,Ti)O_5$
Axial ratio like titanite.

512. **Guarinite** $CaTiSiO_5$ Orthorhombic
$\breve{a} : \bar{b} : \dot{c} = 0·9892 : 1 : 0·3712$
513. **Tscheffkinite**

514. **Astrophyllite** $(Na,K)_4(Fe,Mn)_4Ti(SiO_4)_4$ Orthorhombic
$\breve{a} : \bar{b} : \dot{c} = 0·9902 : 1 : 4·7101$

The following are closely related species, chiefly Titano-silicates of the cerium metals, calcium and sodium:

515. **Johnstrupite** Monoclinic $\grave{a} : \dot{\bar{b}} : \dot{c} = 1·6229 : 1 : 1·3911 \quad \beta = 86° 56'$
516. **Mosandrite** "
517. **Rinkite** " $\grave{a} : \dot{\bar{b}} : 5\dot{c} = 1·5688 : 1 : 1·4610 \quad \beta = 88° 47'$

518. **Perovskite** $CaTiO_3$ Isometric
519. **Dysanalyte** $6(Ca,Fe)TiO_3.(Ca,Fe)Nb_2O_6$ Isometric

This section includes a number of silicates which contain titanium, but whose relations are not altogether clear; also the titanate, Perovskite, and niobo-titanate, Dysanalyte, which is intermediate between Perovskite and the species Pyrochlore, Microlite, Koppite of the following chapter.

In general the part played by titanium in the many silicates in which it enters is more or less uncertain. It is probably in most cases, as shown in the preceding pages, to be taken as replacing the silicon; in others, however, it seems to play the part of a basic element; in schorlomite (p. 443) it may enter in both relations. Of the species which follow, Titanite is usually taken as a salt of meta-disilicic acid $H_2Si_2O_5$, in which one Si atom is replaced by Ti; it may, however, be regarded as a basic orthosilicate, $Ca(TiO)SiO_4$. The most satisfactory formula of Astrophyllite (see above) makes it an orthosilicate with the titanium as base, but with no clear relations to other species; if this view is maintained it would naturally be placed at the end of the section of orthosilicates (pp. 529 *et seq.*). Johnstrupite, Mosandrite, Rinkite are species of closely similar but complex composition. According to Brögger's view they are to be regarded as orthosilicates analogous to the epidotes to which they are related in form—they would then follow the Epidote Group, p. 526; Groth, however, suggests for them a metasilicate formula (the titanium replacing silicon) and a relation to the pyroxenes.

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**510. TITANITE.** Nouv. substance minerale (fr. Chamouni) *Pictet*, J. Phys., **31**, 368, 1787; = Pictite *Delameth.*, T. T., **2**, 282, 1797. Titanit (fr. Passau) *Klapr.*, Beitr., **1**, 245, 1795; = Titane siliceo-calcaire *Daubenton*, Tabl., 1799, *H.*, Tr., **4**, 1801; = Braun Menakerz *Wern.*, Min. Syst., 1808, Leonh. Tasch., **3**, 311, 1809. Schorl rayonnante en gouttière [or channeled Actinolite, the cryst. being twins with a reënt. angle] *Saussure*, Voy. Alpes, **4**, 103, 1796; = Sphene *H.*, Tr., **3**, 1801; = Gelb Menakerz *Wern.*, 1808, l. c.

Séméline (fr. Marone, Dauphiné) *Fl. de Bellevue*, J. Phys., **51**, 443, 1800. Spinthère *H.*, Tr., **4**, 1801.

Ligurite (fr. Stura, Apennines (Liguria)) *Viviani*, Mem. Acc. Genova, **3**, J. Phys., **77**, 236, 1813. Greenovite (fr. St. Marcel) *Dufr.*, Ann. Mines, **17**, 529, 1840. Lederite *Shep.*, Am. J. Sc., **39**, 357, 1840. Eukolit-titanit *Scheerer*, B. H. Ztg., **7**, 389, 1853. Aspidelite *Weibye*. Grothite *Dana*, Min., 386, 1868. Alshedite *Blomstrand*, Minnesskrift Fys. Sällsk. Lund, No. 3, p. 7, 1878. Leucoxene pt. *Gümbel*. Titanomorphite *Lasaulx*, Jb. Min., 568, 1879; Zs. Kr., **4**, 162, 1879. Sfeno *Ital.*

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 0{\cdot}75467 : 1 : 0{\cdot}85429$; $\beta = {}^{*}60^\circ\ 17' = 001 \wedge 100$ Des Cloizeaux[1].

$100 \wedge 110 = 33^\circ\ 14'\ 30''$, $001 \wedge \bar{1}01 = 65^\circ\ 56'\ 41''$, $001 \wedge 011 = 36^\circ\ 34'\ 23''$.

**Forms**[2]:
$a$ (100, $i$-$\bar{i}$, P)
$b$ (010, $i$-$\grave{i}$, q)
$c$ (001, $O$, y)

$O$ (720, $i$-$\frac{7}{2}$)
$o$ (310, $i$-$\bar{3}$)
$m$ (110, $I$, r)
$\tau$ (130, $i$-$\grave{3}$)

$S$ (205, $-\frac{2}{5}$-$\bar{i}$)
$T$ (5·0·12, $-\frac{5}{12}$-$\bar{i}$)?
$x$ (102, $-\frac{1}{2}$-$\bar{i}$)
$Y$ (101, $-$ 1-$\bar{i}$)
$\pi$ (201, $-$ 2-$\bar{i}$)

$N$ ($\bar{2}$·0·11, $\frac{2}{11}$-$\bar{i}$)?
$X$ ($\bar{3}$04, $\frac{3}{4}$-$\bar{i}$)
$v$ ($\bar{1}$01, 1-$\bar{i}$)
$P$ ($\bar{7}$05, $\frac{7}{5}$-$\bar{i}$)

$\epsilon$ (011, 1-$\grave{i}$)
$s$ (021, 2-$\grave{i}$)
$\beta$ (083, $\frac{8}{3}$-$\grave{i}$)
$\zeta$ (041, 4-$\grave{i}$)

$\alpha$ (115, $-\frac{1}{5}$)
$k$ (114, $-\frac{1}{4}$)
$z$ (112, $-\frac{1}{2}$)
$n$ (111, $-$ 1)
$\eta$ (221, $-$ 2)

$\omega$ (994, $-\frac{9}{4}$)
$\nu$ (331, $-$ 3)
$D$ (661, $-$ 6)

$l$ ($\bar{1}$12, $\frac{1}{2}$)
$t_6$ ($\bar{3}$35, $\frac{3}{5}$)
$t_5$ ($\bar{5}$58, $\frac{5}{8}$)
$t_3$ ($\bar{2}$23, $\frac{2}{3}$)
$t_1$ ($\bar{3}$34, $\frac{3}{4}$)
$t$ ($\bar{1}$11, 1)
$\xi$ ($\bar{3}$32, $\frac{3}{2}$)
$w$ ($\bar{2}$21, 2)

$L$ (316, $-\frac{1}{2}$-$\bar{3}$)
$\delta$ (524, $-\frac{5}{4}$-$\bar{\frac{5}{2}}$)

$\Phi$ (736, $-\frac{7}{6}$-$\bar{\frac{7}{3}}$)
$e$ (212, $-$ 1-$\bar{2}$)
$\Psi$ (766, $-\frac{7}{6}$-$\bar{\frac{7}{6}}$)

$W$ ($\bar{2}$14, $\frac{1}{2}$-$\bar{2}$)
$\gamma$ ($\bar{2}$11, 2-$\bar{2}$)
$G$ ($\bar{9}$43, 3-$\bar{\frac{9}{4}}$)
$i$ ($\bar{3}$12, $\frac{3}{2}$-$\bar{3}$)
$f$ ($\bar{5}$34, $\frac{5}{4}$-$\bar{\frac{5}{3}}$)

$\vartheta$ (238, $-\frac{3}{8}$-$\grave{\frac{3}{2}}$)
$B$ (232, $-\frac{3}{2}$-$\grave{\frac{3}{2}}$)
$\kappa$ (124, $-\frac{1}{2}$-$\grave{2}$)
$A$ (122, $-$ 1-$\grave{2}$)
$\lambda$ (7·15·35, $-\frac{3}{7}$-$\grave{\frac{15}{7}}$)?

$\chi$ (132, $-\frac{3}{2}$-$\grave{3}$)
$u$ (131, $-$ 3-$\grave{3}$)
$\iota$ (2·7·14, $-\frac{1}{2}$-$\grave{\frac{7}{2}}$)
$Z$ (274, $-\frac{1}{2}$-$\grave{\frac{7}{2}}$)
$\mu$ (148, $-\frac{1}{2}$-$\grave{4}$)
$\rho$ (151, $-$ 5-$\grave{5}$)
$\psi$ (1·10·10, $-$ 1-$\grave{10}$)

$U$ ($\bar{2}$33, 1-$\grave{\frac{3}{2}}$)
$l_3$ ($\bar{4}$65, $\frac{6}{5}$-$\grave{\frac{3}{2}}$)
$l_2$ ($\bar{3}$54, $\frac{5}{4}$-$\grave{\frac{5}{3}}$)
$l_1$ ($\bar{2}$43, $\frac{4}{3}$-$\grave{2}$)
$M$ ($\bar{1}$32, $\frac{3}{2}$-$\grave{3}$)
$K$ ($\bar{2}$85, $\frac{8}{5}$-$\grave{4}$)
$\phi$ ($\bar{1}$82, 4-8)

Also doubtful forms noted by Busz (cf. Gdt., l. c., p. 220):
$y_2$ ($\bar{1}$·1·20), $y_1$ ($\bar{1}$·1·10), $t_7$ ($\bar{9}$·9·16), $t_4$ ($\bar{9}$·9·14), $t_2$ ($\bar{7}$·7·10), $E$ ($\bar{7}$72), $L_1$ (7·2·12), $I$ ($\bar{1}\bar{7}$·8·16), $\varDelta$ (13·8·22), $G$ ($\bar{9}$43), $\Sigma$ (1·21·10), $\vartheta_3$ ($\bar{4}$65).

$oo''' = 24^\circ\ 39'$
$mm''' = {}^{*}66^\circ\ 29'$
$\tau\tau' = 53^\circ\ 55'$

$ax = {}^{*}39^\circ\ 17'$
$cx = 21^\circ\ 0'$
$cY = 32^\circ\ 12'$
$c\pi = 42^\circ\ 49'$
$cX = 51^\circ\ 51'$

$\epsilon\epsilon' = 73^\circ\ 9'$
$ss' = 112^\circ\ 3'$

$\beta\beta' = 126^\circ\ 22'$
$\zeta\zeta' = 142^\circ\ 45\frac{1}{2}'$

$cz = 25^\circ\ 41'$
$cn = 38^\circ\ 16'$
$c\eta = 49^\circ\ 15'$
$cm = 65^\circ\ 30'$
$mn = 27^\circ\ 14'$
$cl = 40^\circ\ 34'$
$ct_1 = 57^\circ\ 55'$
$ct = 70^\circ\ 23'$
$c\xi = 85^\circ\ 6'$

$cw = 92^\circ\ 50\frac{1}{2}'$
$ce = 33^\circ\ 57'$
$c\gamma = 93^\circ\ 20'$
$ci = 84^\circ\ 3\frac{1}{2}'$
$c\kappa = 21^\circ\ 19'$
$c\chi = 43^\circ\ 32'$
$cu = 57^\circ\ 19'$
$cM = 59^\circ\ 24'$

$az = 94^\circ\ 15'$
$an = 35^\circ\ 3\frac{1}{2}'$

$a't = 60^\circ\ 53'$
$a'l = 85^\circ\ 44\frac{1}{2}'$
$zz' = 30^\circ\ 16'$
$nn' = 43^\circ\ 49'$
$\eta\eta' = 54^\circ\ 18'$
$ll' = 46^\circ\ 7\frac{1}{2}'$
$tt' = 69^\circ\ 9'$
$ee' = 22^\circ\ 44'$
$\kappa\kappa' = 35^\circ\ 17'$
$\chi\chi' = 78^\circ\ 6\frac{1}{2}'$
$uu' = 100^\circ\ 41\frac{1}{2}'$

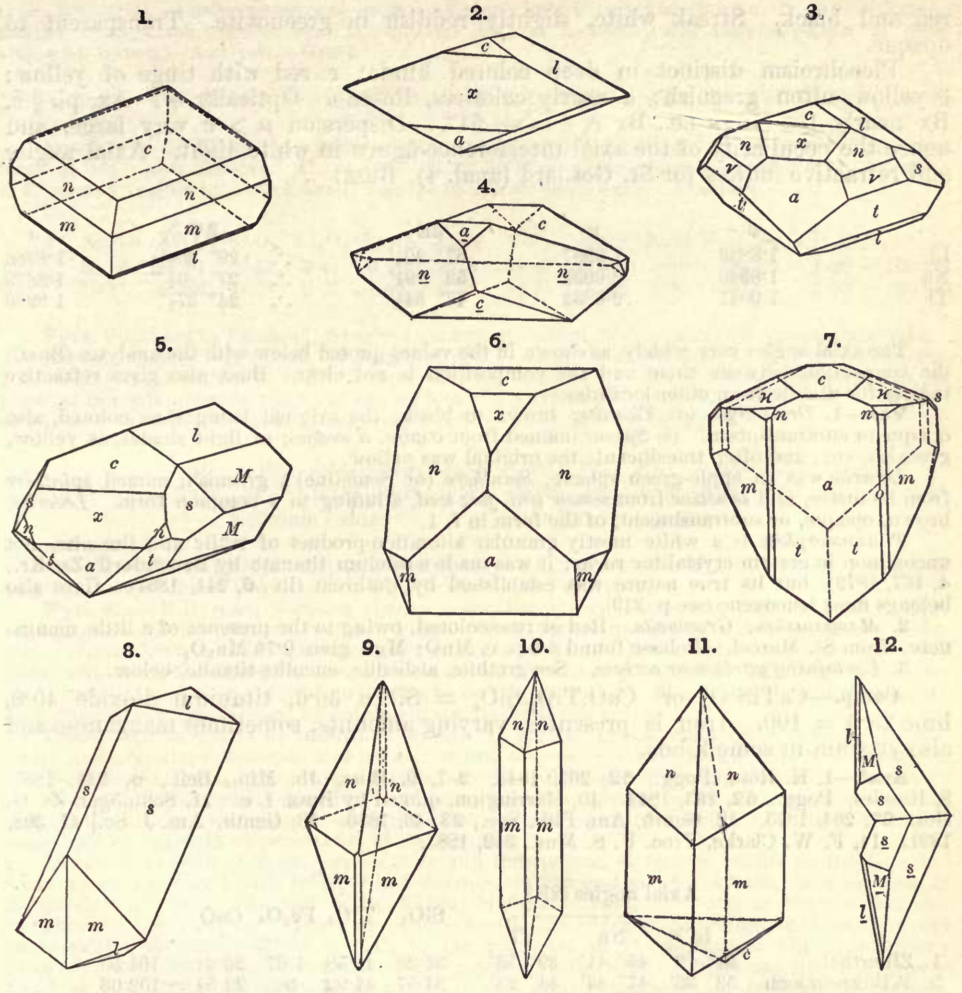
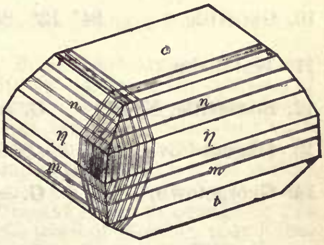


Fig. 1, *Lederite*, Diana, N. Y. 2, 5, after Rose. 3, Eisbruckalp, after Busz. 4, Nordmark, Flink. 7, Rothenkopf, Hbg. 8, *Pictite*, Dx. 9, 10, Norway, Bgr. 11, A. C. Lane. 12, Schwarzenstein, Hbg.

Twins: tw. pl. (1) *a* rather common, both contact-twins and cruciform penetration-twins; the former sometimes yielding forms apparently hemimorphic (f. 7). (2) *c* rather rare. (3) enclosed polysynthetic lamellæ[3], approximately ∥ *η* (221), f. 13, sometimes giving rise to easy parting. Crystals very varied in habit; often wedge-shaped and flattened ∥ *c*. Also prismatic by extension of *m* (110); less often *n* (111), f. 6; *s* (021), f. 8; again *l* ($\bar{1}12$) and *M* ($\bar{1}32$), f. 5, this the prismatic zone of Rose. Faces *a*, *l* ($\bar{1}12$) often striated ∥ their intersection with *m*; also *s* ∥ edge *p*/*s*. Sometimes massive, compact; rarely lamellar.

13.



Pitcairn, G. H. Williams[3].

Cleavage: *m* rather distinct; *a*, *l* ($\bar{1}12$) imperfect; in greenovite, *n* (111) easy, *t* ($\bar{1}11$) less so (Dx.). Parting[3] often easy ∥ *η* (221) due to twinning lamellæ. H. = 5–5·5. G. = 3·4–3·56; 3·541 Chester, Pirsson. Luster adamantine to resinous. Color brown, gray, yellow, green, rose-red and black. Streak white, slightly reddish in greenovite. Transparent to opaque.

Pleochroism distinct in deep colored kinds: $\mathfrak{c}$ red with tinge of yellow; $\mathfrak{b}$ yellow, often greenish; $\mathfrak{a}$ nearly colorless, Rosenb. Optically +. Ax. pl. ∥ *b*. Bx nearly ⊥ *x* (102), i.e., Bx $\wedge \dot{c} = +51°$. Dispersion $\rho > v$ very large, and hence the peculiarity of the axial interference-figure in white light. Axial angles and refractive indices for St. Gothard (anal. 4), Busz:

| | β | γ | 2E | | 2V | α |
|---|---|---|---|---|---|---|
| Li | 1·8839 | 1·9987 | 57° 20½′ | ∴ | 29° 30½′ | 1·8766 |
| Na | 1·8940 | 2·0093 | 52° 29⅜′ | ∴ | 27° 0⅛′ | 1·8879 |
| Tl | 1·9041 | 2·0232 | 47° 54⅜′ | ∴ | 24° 37½′ | 1·8989 |

The axial angles vary widely, as shown in the values quoted below with the analyses (Busz); the connection between them and the composition is not clear. Busz also gives refractive indices for titanite from other localities.

**Var.**—1. *Ordinary*. (*a*) *Titanite;* brown to black, the original being thus colored, also opaque or subtranslucent. (*b*) *Sphene* (named from *σφήν, a wedge*); of light shades, as yellow, greenish, etc., and often translucent; the original was yellow.

*Ligurite* was an apple-green sphene; *Spinthere* (or Semeline) a greenish; named *spinthère* from its luster, and *séméline* from *semen lini, flax-seed,* alluding to a common form. *Lederite*, brown, opaque, or subtranslucent, of the form in f. 1.

*Titanomorphite* is a white mostly granular alteration-product of rutile and ilmenite, not uncommon in certain crystalline rocks; it was made a calcium titanate by Bettendorff (Zs. Kr., **4**, 167, 1879), but its true nature was established by Cathrein (ib., **6**, 244, 1881). Here also belongs most leucoxene (see p. 219).

2. *Manganesian; Greenovite.* Red or rose-colored, owing to the presence of a little manganese; from St. Marcel. Delesse found 3·6 p. c. MnO; Mgc. gives 0·76 $Mn_2O_3$.

3. *Containing yttrium or cerium.* See grothite, alshedite, eucolite-titanite, below.

**Comp.**—$CaTiSiO_5$ or $CaO.TiO_2.SiO_2$ = Silica 30·6, titanium dioxide 40·8, lime 28·6 = 100. Iron is present in varying amounts, sometimes manganese and also yttrium in some kinds.

**Anal.**—1, H. Rose, Pogg., **62**, 261, 1844. 2–7, 9, Busz, Jb. Min., Beil., **5**, 341, 1887. 8, Rosales, Pogg., **62**, 263, 1844. 10, Harrington, quoted by Busz, l. c. 11, Schmöger, Zs. G. Ges., **27**, 204, 1875. 12, Genth, Am. Phil. Soc., **23**, 46, 1886. 13, Genth, Am. J. Sc., **41**, 398, 1891. 14, F. W. Clarke, Proc. U. S. Mus., 352, 1885.

| | Axial angles (2E) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Li | Na | Tl | $SiO_2$ | $TiO_2$ | $Fe_2O_3$ | CaO |
| 1. Zillerthal | 51° 3′ | 45° 41′ | 39° 53′ | 32·29 | 41·58 | 1·07 | 26·61 = 101·55 |
| 2. Wildkreuzjoch | 52° 36′ | 47° 44′ | 44° 23′ | 34·57 | 44·92 | *tr.* | 22·54 = 102·03 |
| 3. Eisbruckalp | 54° 52′ | 50° 21′ | 45° 27′ | 30·87 | 42·43 | — | 27·51 = 100·81 |
| 4. St. Gothard | 57° 21′ | 52° 30′ | 47° 55′ | 29·12 | 42·09 | — | 27·90 MnO *tr.* = 99·11 |
| 5. Monroe | 63° 52′ | 60° 14′ | 56° 29′ | 30·92 | 34·44 | 7·84 | 23·93 $Al_2O_3$ 2·61, MnO [0·32 = 100·06 |
| 6. Val Maggia | 69° 2′ | 63° 27′ | 58° 31′ | 30·08 | 39·55 | — | 28·26 MnO 1·72 = 99·61 |
| 7. Laacher See | 72° 10′ | 68° 9′ | 62° 53′ | 30·10 | 38·12 | 1·86 | 29·59 = 99·67 |
| 8. Arendal | 76° 28′ | 71° 17′ | 66° 24′ | 31·20 | 40·92 | 5·63 | 22·25 = 100 |
| 9. Renfrew | 90° 57′ | 85° 59′ | 80° 18′ | 30·58 | 41·41 | 1·35 | 22·55 $Al_2O_3$ 2·55, MgO [0·29 = 98·73 |
| 10. Grenville | 94° 12′ | 88° 17′ | 85° 29′ | 32·09 | 37·06 | 1·16[a] | 28·50 = 98·81 |
| 11. Waldheim | | | | 31·37 | 37·45 | 3·13 | 22·38 $Y_2O_3$ 0·88, $Al_2O_3$ [4·79 = 100 |
| 12. Statesville, N. C. | G. = 3·477 | | | 29·45 | 38·33 | 1·61 | 29·11 MnO, MgO *tr.*, ign. [0·60 = 99·10 |
| 13. Magnet Cove | G. = 3·457 | | | 30·84 | 39·35 | 0·73 | 28·26 MgO *tr.*, ign. 0·57 [= 99·75 |
| 14. Georgetown, D. C. | G. = 3·452 | | | 30·10 | 40·82 | *tr.*[b] | 28·08 MgO 0·40, ign. 0·54 [= 99·94 |

[a] FeO. [b] MnO.

GROTHITE is a titanite from the Plauen Grund near Dresden, investigated by P. Groth (Jb. Min., 44, 1866). Form and angles like titanite. Cleavage (parting) distinct. H. = 6·5;

G. = 3·52–3·60. Luster vitreous to greasy. Color clove to blackish brown; in thin splinters reddish brown and translucent. The altered mineral is earthy and isabella-yellow to pale yellowish brown. Analysis.—Groth:

$\frac{2}{2}$ $SiO_2$ 30·51 $TiO_2$ 31·16 $Fe_2O_3$ 5·83 $Al_2O_3 + Y_2O_3$ 2·44 MnO 1·02 CaO 31·34 = 102·30

ALSHEDITE of Blomstrand occurs in imperfect crystals with parting parallel $\eta$ (221), two faces at 54½°; also massive. H. = 3·36. G. = 5. Color pale brown to ash-gray. Opaque. B.B. readily fusible to a black bead; soluble in hydrochloric acid. Analyses:

| | $SiO_2$ | $TiO_2$ | $SnO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Y_2O_3$ | CaO | MnO | MgO | $K_2O,Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 28·26 | 36·61 | 0·47 | 3·41 | 4·25 | 2·78 | 21·06 | 0·98 | 0·48 | 0·70 | 1·20 = 100·20 |
| 2. | 30·61 | 35·86 | 0·38 | 3·47 | 3·61 | 2·57 | 20·51 | 0·82 | 0·32 | 0·58 | 1·89 = 100·62 |

From Slättkåra in Småland, Sweden; occurs embedded in the quartz of a pegmatyte vein.

*Eucolite-titanite.* A variety of titanite from Norway in crystals prismatic ∥ $\dot{c}$, often twins ∥ *a*; resembling eucolite in color, luster, etc., and shown by Brögger and Lindström to be peculiar in containing the metals of the cerium and yttrium groups. Bx $\wedge \dot{c} = +57°$. Dispersion $\rho > v$; strongly marked. Anal.—G. Lindström, quoted by Brögger:

| | $SiO_2$ | $TiO_2$ | $ZrO_2$ | $Ce_2O_3$ | $Y_2O_3$ | CaO | FeO | MgO | $Na_2O$ | $K_2O$ | ign. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| G. = 3·59 | $\frac{3}{3}$ 30·22 | 34·78 | 0·18 | 2·57[a] | 0·59[b] | 24·38 | 3·84 | 0·50 | 0·86 | 0·27 | 0·31 = 98·50 |

[a] Cerium oxides. [b] Yttrium earths.

Occurs with a whitish feldspar, elæolite, magnetite, spreustein, zircon, etc., on the island Stokö and elsewhere in the Langesund fiord; also from Fredriksvärn.

**Pyr., etc.**—B.B. some varieties change color, becoming yellow, and fuse at 3 with intumescence, to a yellow, brown, or black glass. With borax they afford a clear yellowish green glass. Imperfectly soluble in heated hydrochloric acid; and if the solution be concentrated along with tin, it becomes of a fine violet color. With salt of phosphorus in R.F. gives a violet bead; varieties containing much iron require to be treated with the flux on charcoal with metallic tin. Completely decomposed by sulphuric and hydrofluoric acids.

**Obs.**—Titanite occurs in embedded crystals, in granite, gneiss, mica schist, syenite, chlorite schist, and granular limestone; also in beds of iron ore, and volcanic rocks, and often associated with pyroxene, amphibole, chlorite, scapolite, zircon, apatite, etc. Microscopic examination shows it to be a common accessory constituent of many massive igneous rocks. In cavities in gneiss and granite, it often accompanies adularia, smoky quartz, apatite, chlorite, etc.; the crystals are sometimes coated with or penetrated by the chlorite.

Occurs in crystals of a pale green color and transparent, at various points in the Grisons, Switzerland, associated with feldspar and chlorite; in fine crystals at Tavetsch; in mica slate in the St. Gothard region; Zermatt in the Valais; Maderanerthal in Uri; also at Mont Blanc, and elsewhere in the Alps; on crystals of calcite at Chalanches and Maromme, in Dauphiné (the *spinthère* H.); in small reddish crystals in the protogine of Pormenaz and Chamouni (*pictite* Saus.); in large, broad, yellowish or reddish green crystals, with colorless apatite, in a talcose schist at Ala, Piedmont (*ligurite*); in pale yellowish green transparent or translucent crystals, lanceolate in form, lining fissures in titanic iron at Arendal, in Norway (*aspidelite* Weibye); with magnetite at Nordmark, Sweden; at Achmatovsk, Ural; at St. Marcel, in Piedmont, with manganesian epidote and romeine (*greenovite* Dufr.); at Val Maggia, Piedmont; at Schwarzenstein and Rothenkopf in the Zillerthal, Pfitsch, Pfunders, Tyrol; Felberthal in Pinzgau; with epidote and albite at Zöptau, Moravia, in crystals of varied habit; at Frugård, in Finland, of a brownish black color; in the syenite of Biellese, Italy (containing yttrium). Small crystals occur in syenite at Strontian in Argyleshire, near Criffel in Galloway; at Craig Cailleach in Perthshire; in Inverness; near Tavistock; near Tremadoc, in North Wales, with brookite; at Crow Hill, near Newry, Ireland.

Occasionally it is found among volcanic rocks, as at Lake Laach (*semeline* of F. de Bellevue), and at Andernach on the Rhine.

In *Maine*, in fine crystals at Sandford, also at Thurston. In *Mass.*, good crystals in gneiss, in the east part of Lee; at Bolton with pyroxene and scapolite in limestone; at Pelham; in honey-yellow crystals (G. = 3·541 Pirsson) with diaspore at Chester. In *Conn.*, at Trumbull. In *N. York*, at Roger's Rock on Lake George, abundant in small brown crystals, along with graphite and pyroxene; at Gouverneur, in black crystals in granular limestone with scapolite; in Diana near Natural Bridge, Lewis Co., in large dark brown crystals, among which is the variety *lederite* (f. 1); at Rossie, Fine, Pitcairn and Pierrepont, St. Lawrence Co., in pale red and brown crystals with apatite, pargasite, and feldspar; in Macomb near Pleasant Lake; in Orange Co., in large crystals abundant in limestone, near Duck-cedar pond, in the town of Monroe; near Edenville in light brown crystals in limestone; five miles south of Warwick, in large grayish brown crystals, with zircon, hornblende, and iron ore; also in small crystals a mile south of Amity; in Westchester Co., near Peekskill, in an aggregate of feldspar, quartz, and hornblende; also near

West Farms, in small reddish brown prisms; at Brewster, at the Tilly Foster iron mine in very fine transparent greenish crystals, sometimes 2 in. long, often twins, with magnetite, apatite, etc.; this occurrence (discovered in 1891) is similar to that at Nordmark, Sweden. In *N. Jersey*, at Franklin Furnace, of a honey-yellow color. In *Penn.*, Bucks Co., three miles west of Attleboro', associated with wollastonite and graphite; a small number of fine large crystals of a rich greenish brown tinge, in part symmetrical cruciform twins up to 2½ inches in length, have been found at Bridgewater Station, Delaware Co. In *N. Carolina*, at Statesville, Iredell Co., yellowish white with sunstone; also Buncombe Co., Alexander Co., and other points.

Occurs in *Canada*, in amber-colored crystals, in the granitoid trachytes of Yamaska, Shefford, and Brome Mts.; in clove- or chocolate-brown crystals, often large, at Argenteuil and Grenville, Argenteuil Co.; also Buckingham, Templeton, Wakefield, Hull, Ottawa Co.; at N. Burgess, of a honey-yellow, and N. Elmsley, Lanark Co.; near Eganville, Renfrew Co., Ontario, in very large dark brown crystals with apatite, amphibole, zircon; similarly at other points where apatite is abundant.

**Alt.**—Titanite occurs of little hardness, dull in luster, and hydrated from alteration. Crystals of this kind, found in a decomposing feldspar, with zircon at Green River, Henderson Co., North Carolina, have been named by C. U. Shepard (Am. J. Sc., **22**, 96, 1856) *Xanthitane*, see below.

Titanite (leucoxene, titanomorphite, see above and p. 219) is a not uncommon alteration-product of ilmenite and rutile. On the other hand rutile, octahedrite, and perovskite have been described as derived from the alteration of titanite.

**Artif.**—Formed in crystals by heating together $3SiO_2$, $4TiO_2$, and calcium chloride; also the manganesian (greenovite) by adding manganese chloride (Hautefeuille).

A stanno-silicate of calcium ($CaSnSiO_5$) corresponding to titanite has been obtained in monoclinic crystals by Bourgeois, Bull. Soc. Min., **10**, 54, 1887.

**Ref.**—[1] Min., 145, 1862; $\dot{c}$ here (Dx.) = $2\dot{c}$ Dana, Min., 1868; with Naumann, Hbg., etc., $a = 001$, $c = \bar{1}01$ ($y$), $m = 011$ ($r$), $x = \bar{1}02$, $n = \bar{1}23$; also for *hkl* (Dx.) and *pqr* (N.) we have: $h = \frac{p+r}{2}$, $k = \frac{q}{2}$, $l = -p$.

[2] For lists of forms, see Mlr., Min., 394, 1852, also Trans. Cambr. Phil. Soc., **7**, 210, 1842, or Pogg., **55**, 626, 1852; Dx., l. c., and **2**, XXIII, 1874; Hbg., Min. Not., **6**, 23, 1864; Zeph., Ber. Ak. Wien, **60** (1), 815, 1869; Hbg., l. c., **11**, 28, 1873; Busz, Jb. Min., Beil., **5**, 370, 1887 (who adds many new forms); Gdt., Index, **3**, 215, 1891. Cf. also Rose, Leonh. Taschenbuch, **2**, 393, 1821; Hbg., Min. Not., l. c., *et al.*; Zeph., Zillerthal, l. c.; Schrauf, Sulzbach, Ber. Ak. Wien, **62** (2), 704, 1870; Lewis, Phil. Mag., **3**, 455, 1877; Hintze, Zermatt, Zs. Kr., **2**, 310, 1878 (cf. Gdt., l. c., p. 222); Erem., Vh. Min. Ges., **16**, 254, 1881; Rath, Zs. Kr., **5**, 255, 1880; Flink, Nordmark. Ak. H. Stockh., Bihang, **12** (2), 2, 69, 1886. See also A. C. Lane, on the common forms of titanite in rocks, Min. Mitth., **9**, 207, 1887.

[3] On parting produced by twinning, Eremeyev, Jb. Min., 405, 1872; also l. c., and Zs. Kr., **5**, 500, 1881; G. H. Williams, Am. J. Sc., **29**, 486, 1885; Mügge, Jb. Min., **2**, 98, 1889. Mügge shows that the parting plane often deviates somewhat widely from $\eta$ (221). Light absorption measured photometrically, Pulfrich, Zs. Kr., **6**, 155, 1881.

XANTHITANE *C. U. Shepard*, Am. J. Sc., **22**, 96, 1856. *L. G. Eakins*, ibid., **35**, 418, 1888, and U. S. G. Surv., Bull. **60**, 135, 1890.

An alteration-product of titanite. Color light yellow, friable, mixed with impurities to an undetermined extent. It is called by Eakins a clay containing titanium in place of silicon. Analysis of material from Green river, Henderson Co., N. C., by Eakins:

| | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $P_2O_5$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| G. = 2·941 | 1·76 | 61·54 | 17·59 | 4·46 | 0·90 | *tr.* | 4·17 | 9·92 = 100·34 |

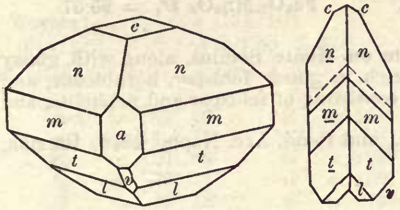
Material of analysis dried at 100°; the air-dried mineral loses 6·02 p. c. at 100°.

PYROMELANE *C. U. Shepard*, Am. J. Sc., **22**, 96, 1856, Min., 253, 1857. In angular grains from the gold-washings of McDowell Co., N. C. H. = 6·5; G. = 3·87; luster resinous; color reddish to yellowish brown and black; subtranslucent. B.B. infusible, but becomes black and opaque (whence the name); soluble in the fluxes, giving reactions of titanic acid and iron. Stated to be "essentially a titanate of alumina and iron with traces of lime and glucina," and "may contain zirconia also"; but the evidence of such a composition is not given. Probably only a variety of titanite.

CASTELLITE. Castellit *Breith.*, B. H. Ztg., **25**, 113, 1866. Monoclinic. In very small and exceedingly thin 8-sided tables, having for the angles of the rhombic prism 62°. Cleavage: prismatic? H. = 5·5–6. G. = 3·150. Luster vitreous, somewhat adamantine. Color wine-yellow to wax-yellow; streak colorless. Fragile. According to Plattner it acts B.B. like titanite, giving evidence of the presence of titanic acid, lime, and silica, but with less of the first and more of the last than in titanite. Occurs in the phonolyte of Holenkluk Mtn., near Proboscht, and in that of Sollodiz—a rock containing also sanidine, hornblende, augite, ilmenite, and apatite.

**511. KEILHAUITE.** Keilhauit *A. Erdmann,* Ak. H. Stockh., 355, 1844. Yttrotitanit *Scheerer*, Pogg., **63**, 459, 1844.

Monoclinic. In habit and angles near titanite.



Norway, Forbes.

**Forms:** *a* (100, *i-ī*), *c* (001, *O*); *m* (110, *I*), *v* (1̄01, 1-ī); *n* (111, − 1); *l* (1̄12, ½), *t* (1̄11, 1).

Forbes[1] measured: *am* = 33°, *av* = 55°, *cn* = 36° 30′. Cf. also angles for titanite, p. 712.

Cleavage: *n* quite distinct. H. = 6·5. G. = 3·52–3·77. Luster vitreous to resinous. Brownish black; in splinters brownish red and translucent; also dull brown and pale grayish brown. Streak-powder grayish brown to pale dirty yellow.

Optically +. Ax. plane ∥ *b* as in titanite. Axial angles, Busz[2]:

$2H_r = 60° 39'$ Li $\quad 2H_y = 58° 39'$ Na $\quad 2H_{gr} = 57° 28'$ Tl (in Monobromnaphtalin).
$2E_r = 112° 31'$ $\quad 2E_y = 108° 34'$ $\quad 2E_{gr} = 106° 37'$

**Comp.**—A titano-silicate of calcium, aluminium, ferric iron, and the yttrium metals.

Rammelsberg calculates for his analysis: $15CaSiTiO_5.(Al,Fe,Y)_2(Si,Ti)O_5$.

**Anal.**—1, 2, Rg., Pogg., **106**, 296, 1859. 3, Id., Min. Ch., Erg., 269, 1886. Also Erdmann, Forbes, 5th Ed., p. 387.

| | G. | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Y_2O_3$ | $Ce_2O_3$ | CaO | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Buö, *mass.* | 3·716 | 29·48 | 26·67 | 5·45 | 6·75 | 8·16 | | 20·29 | 0·54 | MgO 0·94, $K_2O$ 0·60 = 98·88 |
| 2. " *cryst.* | 3·773 | 28·50 | 27·04 | 6·24 | 5·90 | 12·08 | | 17·15 | 3·59 | = 100·50 |
| 3. Narestö, *mass.* | 3·57 | 30·81 | 36·63 | — | 1·12 | 6·27[a] | — | 25·03 | 1·13 | = 100·99 |

[a] At. weight 100·3.

**Pyr., etc.**—B.B. fuses with intumescence easily to a black shining glass. Yields an iron-colored glass with borax, which in the inner flame becomes blood-red. With salt of phosphorus gives an iron color and a silica skeleton, and in the inner flame a violet bead. Reaction for manganese with soda. Decomposed by hydrochloric acid.

**Obs.**—Occurs near Arendal, Norway; on the islands Buö, Askerö, Alve, and Narestö, in a feldspathic rock, both in crystals and massive. Crystals weighing 2½ lbs., and masses of 15 to 20 lbs., are mentioned by Forbes. A dull brown massive kind from Alve gave G. = 3·72; and a pale grayish brown 3·603; a specimen from near Narestö, G. = 3·519. The Alve keilhauite has two cleavages inclined to one another 42°. Also from Snarum, Norway.

Named after Prof. Keilhau of Norway.

**Ref.**—[1] Ed. N. Phil. J., **1**, 69, 1855; also Forbes and Dahll, Nyt Mag., **8**, 223, 1855. [2] Jb. Min., Beil., **5**, 342, 1887.

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**512. GUARINITE.** *Guiscardi,* Rend. Acc. Napoli, Mem. **2**, 408, 1857, Zs. G. Ges., **10**, 14, 1858.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·9892 : 1 : 0·3712$ Lang-Guiscardi[1].

100 ∧ 110 = 44° 41⅓′, 001 ∧ 101 = 20° 36⅙′, 001 ∧ 011 = *20° 22′.

**Forms:** *a* (100, *i-ī*), *b* (010, *i-ĭ*), *c* (001, *O*); *g* (310, *i-3̄*), *f* (210, *i-2̄*), *m* (110, *I*), *d* (120, *i-2̆*), *k* (011, 1-ĭ), *q* (021, 2-ĭ).

Angles: *gg‴* = 36° 30′, *ff‴* = 52° 38′ *af* = *26° 19′, *mm‴* = 89° 23′, *dd′* = 53° 38′, *kk′* = 40° 44′, *qq′* = 73° 11′.

In minute thin tables, flattened ∥ *b* (010), nearly tetragonal in form.

H. = 6. G. = 3·487. Luster of cleavage-face somewhat adamantine. Color sulphur-yellow, honey-yellow, pale or dark. Streak uncolored, or whitish gray. Transparent to translucent. Ax. pl. ∥ *c*. Axial angle large, Dx.

**Comp.**—$CaTiSiO_5$ or $CaO.TiO_2.SiO_2$, same as for titanite = Silica 30·6, titanium dioxide 40·8, lime 28·6 = 100.

**Anal.**—Guiscardi, l. c.

$SiO_2$ 33·64 $TiO_2$ 33·92 CaO 28·01 $Fe_2O_3,Mn_2O_3$ *tr.* = 95·57

**Pyr., etc.**—Same as in titanite.

**Obs.**—Found in small cavities in a grayish trachyte on Monte Somma, along with glassy feldspar and nephelite. The mass of the trachyte is rich in glassy feldspar, hornblende, and melanite. In one case in the common rock of Somma, consisting of feldspar and nephelite, and here along with titanite.

**Ref.**—[1] Lang, Min. Mitth., 81, 1871; Guiscardi, l. c., and Rend. Acc. Napoli, 1876; Brezina, Min. Mitth., 285, 1874; Dx., Min., 2, xxiii, 1874.

**513. TSCHEFFKINITE.** ?Mineral de Coromandel *Beud.*, Tr., 2, 652, 1832. Tschewkinit *G. Rose*, Reis. Ural, 2, 1842.

Massive, amorphous.

H. = 5–5·5. G. = 4·508–4·549 G. Rose. Luster vitreous. Color velvet-black. Streak dark brown. Subtranslucent to opaque.

**Comp.**—Related to keilhauite, but uncertain. The mineral, as analyzed, seems to be in all cases an alteration-product, more or less heterogeneous, and the composition of the original mineral is as yet very uncertain.

Hermann makes thoria present in tscheffkinite from the Ural; Damour proved its absence in the Indian mineral.

Des Cloizeaux states that the latter consists of a brown material not acting on polarized light, and small colorless grains which are strongly doubly refracting. The mineral has H. = 5·5–6; G. = 4·26; luster vitreous, inclining to resinous; color brownish black, subtranslucent.

Cross found the mineral analyzed by Eakins to consist mainly of a reddish and yellowish brown transparent amorphous substance, probably the original mineral, traversed by cracks filled with a secondary reddish brown, opaque, ocherous matter; bands of secondary minerals, probably calcite and titanite, were also noted with others not identified.

**Anal.**—1, H. Rose, Pogg., **62**, 591, 1844. 2, Hermann, Bull. Soc. Moscou, **39** (1), 57, 1866. 3, Damour, Bull. G. Fr., **19**, 550, 1862. 4, R. C. Price, Am. Ch. J., **10**, 38, 1888. 5, 6, L. G. Eakins, Am. J. Sc., **42**, 36, 1891.

| | G. | $SiO_2$ | $TiO_2$ | $ThO_2$ | $Y_2O_3$ | $Ce_2O_3$ | $(La,Di)_2O_3$ | $Fe_2O_3$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | alk. | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Ural | 4·53 | 21·04 | 20·17 | — | — | 47·29 | | — | — | 11·21 | 0·83 | 0·22 | 3·50 | 0·12 | — |
| | | | | | | | | | | | | | | | [= 104·38 |
| 2. " | 4·55 | 20·68 | 16·07 | 20·91 | 3·45 | 22·80 | | — | — | 9·17 | 0·75 | — | 3·25 | — | 0·42 |
| | | | | | | | | | | | | | | | [UO 2·50 = 100 |
| 3. So. India | | 19·03 | 20·86 | — | — | 38·38 | | — | 7·72 | 7·96 | 0·38 | 0·27 | 4·40 | — | 1·30 |
| | | | | | | | | | | | | | | | [= 100·30 |
| 4. Virginia | 4·4 | 23·28 | 21·16 | 2·29[a] | — | 11·89 | 20·34[b] | 5·63 | — | 5·56 | — | 0·64 | 5·48 | 0·32[c] | 1·90 |
| | | | | | | | | | | | | | | | [BeO 2·15 = 100·64 |
| 5. " | 4·33 | 20·21 | 18·78 | 0·85 | 1·82[d] | 20·05 | 19·72 | 1·88 | 3·60 | 6·91 | — | 0·55 | 4·05 | 0·06[c] | 0·94 |
| | | | | | | | | | | | | | | | [$Ta_2O_5$ 0·08 = 99·50 |
| 6. " | 4·38 | 21·49 | 18·99 | 0·75 | 1·64[e] | 19·08 | 17·16 | 2·89 | 3·65 | 5·92 | — | 0·48 | 5·24 | 0·04[c] | 2·06 |
| | | | | | | | | | | | | | | | [$Ta_2O_5$ 0·08 = 99·47 |

[a] $ZrO_2$. [b] Incl. 15·38 $Di_2O_3$, 4·96 $La_2O_3$. [c] $Na_2O$. [d] Incl. $Er_2O_3$, molec. wght. 308. [e] Do. 312.

**Pyr., etc.**—B.B. glows, then intumesces strongly, becomes brown, and fuses to a black glass. Gives with the fluxes reactions for iron, manganese, and titanium. Gelatinizes with hydrochloric acid. The Indian mineral in a closed tube yields a little water. B.B. fuses with intumescence to a black scoria, feebly magnetic. With salt of phosphorus it gives in R.F. a pale brown glass, opaline, which becomes milky in the O.F. With borax it affords a hyacinth-brown glass, transparent in the R.F. and pale brown and opaque in the O.F. Attacked readily by nitric acid, especially if heated, depositing gelatinous silica mixed with titanic oxide and black grains of titanic iron.

**Obs.**—From the Ilmen Mountains in the Ural; only a few specimens have been found; the tscheffkinite in collections is mostly *uralorthite* (p. 523), which it much resembles. Also from S. India, probably Kanjamalai Hill, Salem distr. (cf. Mallet, Rec. G. Surv. India, 25, 123, 1892).

An isolated mass weighing 20 lbs. has been found on Hat Creek, near Massie's Mills, Nelson Co., Virginia (anal. 4 by Price); also found, south of this point, in Bedford Co., in the same state (anal. 5, 6 by Eakins); at the latter locality it exists in some quantity as reported by H. M. Engle.

Named after the Russian general, Tschevkin (Chevkin).

**514. ASTROPHYLLITE.** Astrophyllit *Scheerer*, B. H. Ztg., **13**, 240, 1854.

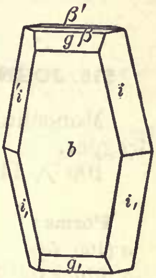
Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·99025 : 1 : 4·7101$ Brögger[1].

$100 \wedge 110 = 44° 43\frac{1}{6}'$, $001 \wedge 101 = 78° 7\frac{2}{3}'$, $001 \wedge 011 = 78° 0\frac{5}{6}'$.

| **Forms:** | | | | |
|---|---|---|---|---|
| | *q* (101, 1-ĭ) | *l* (111, 1) | *x* (212, 1-$\bar{2}$) | λ (767, 1-$\frac{7}{6}$) |
| *b* (010, *i*-ĭ) | β (0·1·50, $\frac{1}{50}$-ĭ) | *z* (616, 1-$\bar{6}$) | *i* (434, 1-$\frac{4}{3}$) | *n* (565, $\frac{6}{5}$-$\frac{6}{5}$) |
| *m* (110, *I*) | *g* (038, $\frac{3}{8}$-ĭ) | | | |

| | | | |
|---|---|---|---|
| *mm‴* = 89° 26′ | *ll″* = 163° 0½′ | *zz‴* = 18° 22′ | *bx* = 64° 9′ |
| *qq′* = 156° 15′ | *ll‴* = 88° 12′ | *xx‴* = 51° 42′ | *bi* = 53° 59½′ |
| *gg′* = 120° 58′ | *ii′* = 104° 40′ | *λλ‴* = 79° 26′ | *bλ* = 50° 17′ |
| *bg* = *29° 31′ | *ii″* = 160° 50′ | *nn″* = 98° 37′ | *bl* = *45° 54′ |
| *ll′* = 89° 18′ | *ii‴* = 72° 1′ | *bz* = 80° 49′ | *bn* = 40° 41½′ |

Crystals often elongated in the direction of *ć*; or elongated ‖ axis *ă* by development of the brachypinacoid (‖ cleavage). Faces strongly striated ‖ intersection-edge with *b*; *b* horizontally striated. Also lengthened into thin strips or blades; sometimes arranged in stellate groups.



Cleavage: *b* perfect; *c* very imperfect. Percussion-figure on a cleavage surface shows two rays crossing at angles of approx. 90° (81° to 85°), and nearly ‖ the dome 014. Laminæ brittle, not elastic like muscovite. H. = 3. G. = 3·3–3·4; 3·324 Pisani; 3·375, Colorado, Koenig. Luster submetallic, pearly. Color bronze-yellow to gold-yellow. Powder resembling that of mosaic gold. Translucent in thin leaves.

Pleochroism strong: 𝔠 lemon-yellow, 𝔟 orange-yellow, 𝔞 deep orange-red. Absorption 𝔞 > 𝔟 > 𝔠. Optically +. Ax. pl. ‖ *c*. $Bx_a \perp a$. $Bx_o \perp$ cleavage (*b*) or nearly so, but varying somewhat from secondary causes. Axial angles variable:

Norway $2H_{o.r} = 122° 18'$ Li $2H_{o.y} = 124° 52'$ Bkg. $2H_o = 114° 37\frac{1}{2}'–123° 28'$ Bgr.
Colorado $2H_{o.r} = 121° 38'$ Li $2H_{o.y} = 124° 14'$ $2H_{o.gr} = 125° 6'$ Tl Bkg.

Indices:

$\alpha = 1·678$ $\beta = 1·703$ $\gamma = 1·733$ $\gamma - \alpha = 0·055$ Lévy-Lcx.

**Comp.**—Perhaps (Bgr.) an orthosilicate $\overset{I}{R}_4\overset{II}{R}_4Ti(SiO_4)_4$ with $\overset{I}{R}$ = H,Na,K and $\overset{II}{R}$ = Fe,Mn chiefly, including also the $Fe_2O_3$. This formula is confirmed by Eakins.

**Anal.**—1, Pisani, C. R., **56**, 846, 1863. 2, Scheerer, Pogg., **122**, 113, 1864. 3, Meinecke, ibid. 4, Sieveking, ibid. 5, Bäckström, Zs. Kr., **16**, 509, 1890. 6, Koenig, Am. Phil. Soc., **16**, 509, 1877. 7, L. G. Eakins, Am. J. Sc., **42**, 34, 1891.

| | G. | $SiO_2$ | $TiO_2$ | $ZO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | ign. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. "Brevik" | 3·324 | 33·23 | 7·09 | 4·97 | 4·00 | 3·75 | 23·58 | 9·90 | 1·27 | 1·13 | 2·51 | 5·82 | 1·86 |
| | | | | | | | | | | | | | [= 99·11 |
| 2. " | | 32·21 | 8·24 | — | 3·02 | 7·97 | 21·40 | 12·63 | 1·64 | 2·11 | 2·24 | 3·18 | 4·41 |
| | | | | | | | | | | | | | [= 99·05 |
| 3. " | | 32·35 | 8·84 | — | 3·46 | 8·05 | 18·06 | 12·68 | 2·72 | 1·86 | 4·02 | 2·94 | 4·53 |
| | | | | | | | | | | | | | [= 99·51 |
| 4. " | | 33·71 | 8·76 | — | 3·47 | 8·51 | 25·21 | 10·59 | 0·05 | 0·95 | 3·69 | 0·65 | 4·85 |
| | | | | | | | | | | | | | [= 100·44 |
| 5. Eikaholm | | 33·02 | 11·11 | 3·65 | 0·98 | 2·53 | 21·76 | 11·96 | 0·92 | 1·26 | 2·77 | 5·78 | 3·47 |
| | | | | | | | | | | | | | [F 0·97 = 100·18 |
| 6. Colorado | 3·375 | 34·68 | 13·58 | 2·20 | 0·70 | 6·56 | 26·10 | 3·48 | 0·30 | — | 2·54 | 5·01 | 3·54 |
| | | | | | | | | | | | | | [CuO 0·42, $Ta_2O_5$? 0·80 = 99·81 |
| 7. " | | 35·23 | 11·40 | 1·21 | *tr.* | 3·73 | 29·02 | 5·52 | 0·13 | 0·22 | 3·63 | 5·42 | 4·18 |
| | | | | | | | | | | | | | [$Ta_2O_5$ 0·34 = 100·03 |

**Pyr., etc.**—B.B. swells up and fuses easily to a black magnetic enamel. With soda or borax, a strong manganese reaction. Decomposed by hydrochloric acid with separation of silica in scales.

**Obs.**—Occurs on the small islands in the Langesund fiord, near Brevik, Norway, in zircon-syenite, embedded in lamellar feldspar, also in leucophanite and in natrolite (spreustein), and associated with catapleiite, ægirite, large prisms of black mica, and numerous other species. Similarly associated at Kangerdluarsuk, Greenland.

With arfvedsonite and zircon at St. Peter's Dome, Pike's Peak, El Paso Co., Colorado.

Named from *ἀστρον*, *star*, and *φύλλον*, *leaf*, in allusion to the stellate aggregation and foliated micaceous structure.

**Ref.**—[1] Zs. Kr., **16**, 200, 1890; the fundamenta. angles are taken as corrected by Brögger (letter of April 30, 1890), further the axes *a* and *b* are exchanged as required by the ratio obtained; the domes *β*, *g* cannot be taken as macrodomes unless the calculated ratio of the lateral axes is regarded as of no value.

The form was first made orthorhombic by Nordenskiöld (Öfv. Ak. Stockh., **27**, 561, 1870) and Des Cloizeaux (Min., **1**, 497. 1862), was later made monoclinic by Bücking, Zs. Kr., **1**, 433, 1877, and triclinic by Brögger, ibid., **2**, 278, 1878. Brögger finally (1890) shows, however, that the variation in angle and optical character earlier noted is probably without significance, being due to deformation produced by pressure.

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### 515. JOHNSTRUPITE. *W. C. Brögger*, Zs. Kr., **16**, 74, 1890.

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c} = 1{\cdot}6229 : 1 : 1{\cdot}3911$; $\beta = 86° \, 55\frac{3}{4}' = 001 \wedge 100$ Brögger.

$100 \wedge 110 = 59° \, 19\frac{1}{3}'$, $001 \wedge 101 = 39° \, 17\frac{3}{4}'$, $001 \wedge 011 = 54° \, 15'$.

**Forms:**
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)

*t* (710, *i*-7̄)
*k* (410, *i*-4̄)
*n* (310, *i*-3̄)
*l* (520, *i*-$\bar{\frac{5}{2}}$)

*f* (210, *i*-2̄)
*m* (110, *I*)
*z* (120, *i*-2̀)

*d* (101, − 1-ī)
*x* (201, − 2-ī)
*e* (301, − 3-ī)

*δ* (1̄01, 1-ī)
*ξ* (2̄01, 2-ī)
*ϵ* (3̄01, 3-ī)

Also, doubtful, *h* (160), *o* (103), *s* (319), *ρ* (236).

$kk''' = 44° \; 6\frac{1}{2}'$
$nn''' = 56° \; 45'$
$ff''' = 78° \; 2'$

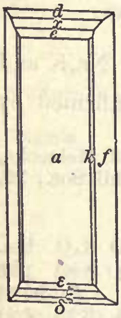
$af = {}^*39° \; 1'$
$mm''' = 116° \; 39'$
$zz' = 34° \; 18'$

$ad = 47° \; 38'$
$ax = {}^*29° \; 27\frac{1}{2}'$
$ae = 20° \; 49\frac{1}{2}'$

$a'\delta = 51° \; 10\frac{1}{2}'$
$a'\xi = {}^*31° \; 1'$
$a'\epsilon = 21° \; 38'$

Des Cloizeaux pointed out a similarity in form between mosandrite and zoisite, and Brögger shows that johnstrupite, mosandrite, and rinkite, very near to each other in composition, are all similar in angle to both zoisite and epidote. He thus compares the prismatic zone of johnstrupite with the orthodomes of epidote and vice versa (cf. also p. 517):

| | | |
|---|---|---|
| Johnstrupite | $100 \wedge 210 = 39° \; 1'$ | $100 \wedge 101 = 48° \; 15'$<br>$100 \wedge \bar{1}01 = 51° \; 53'$ |
| Zoisite | $010 \wedge 120 = 38° \; 58'$ | $010 \wedge 021 = 55° \; 14'$ |
| Epidote | $100 \wedge 10\bar{2} = 42° \; 5'$<br>$100 \wedge 30\bar{2} = 35° \; 7'$ | $100 \wedge 110 = 55° \; 0'$ |



Twins: with tw. pl. *a*. In crystals prismatic ‖ $\acute{c}$ and flattened ‖ *a* (100); the prism *f* (210) most prominent. Faces in prismatic zone vertically striated.

Cleavage: *a* distinct. G. = 3·29. Luster on *a* vitreous, on fracture surfaces resinous to greasy. Color brownish green. Streak yellowish green.

Pleochroism very weak: 𝔠 bright greenish yellow, 𝔟 brownish yellow, 𝔞 bright yellow. Absorption $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$. Optically +. Ax. pl. ‖ *b*. $Bx_o \wedge \acute{c} = \pm 2\frac{1}{4}°$. $Bx_a$ nearly ⊥ *a* (100). Dispersion $\rho > v$, strongly marked; inclined, hardly distinct (0° 13′ for red and green). Axial angles, Bgr.:

Barkevik $2H_{a.r} = 79° \; 5\frac{1}{2}'$ $2H_{o.r} = 125° \; 40'$ $\therefore 2V_r = 71° \; 10\frac{1}{2}'$
$2H_{a.y} = 77° \; 42'$ $2H_{o.y} = 127° \; 40'$ $\therefore 2V_y = 69° \; 54'$ $2E_y = 124° \; 40'$ $\beta = 1{\cdot}546$
$2H_{a.gr} = 75° \; 59\frac{1}{2}'$ $2H_{o.gr} = 131° \; 11'$ $\therefore 2V_{gr} = 68° \; 20'$.

**Comp.**—A complex silicate of the cerium metals, calcium and sodium chiefly with titanium and fluorine.

Brögger calculates the following molecular ratio:

| $\overset{I}{R}_2O$ | CaO | MgO | $\overset{III}{R}_2O_3$ | $\overset{IV}{R}O_2$ | $SiO_2$ | F | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 2·61 | 11·87 | 0·98 | 1·45 | 3·00 | 12 | 7·48 | 1·87 |

And the formula is written, analogous to the epidotes, $\left[\begin{matrix} F_6\overset{IV}{R}_3 \\ F\overset{III}{R} \end{matrix}\right](\overset{I}{R}_2)_4\overset{II}{R}_{13}\overset{III}{R}_2(SiO_4)_{12}$.

Here $\overset{I}{R}_2 = 3Na_2, 1H_2$; $\overset{II}{R} = 12Ca, 1Mg$; $\overset{III}{R}_2 = 1(Ce + Y), 1(Al + Fe)$; $\overset{III}{R} = Ce$; $\overset{IV}{R} = \frac{3}{4}Ti, \frac{1}{4}Zr$, also Th and Ce. Further the group in brackets is regarded as corresponding to the bivalent group $(\overset{III}{R}OH)$ in epidote.

**Anal.**—Bäckström, quoted by Brögger.

| | $SiO_2$ | $TiO_2$ | $ZrO_2$ | $ThO_2$ | $CeO_2$ | $Ce_2O_3$ | $Y_2O_3$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $Na_2O$ | $K_2O$ | $H_2O$ | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G. = 3·29 | 30·50 | 7·57 | 2·84 | 0·79 | 0·80 | 12·71[a] | 1·11 | 1·52 | 0·50 | 27·76 | 1·63 | 6·67 | 0·12 | 1·41 | 5·98 = 101·91 |

[a] Incl. $La_2O_3, Di_2O_3$.

**Obs.**—Only known from one of the ledges near Barkevik in the Langesund fiord, Norway; it is associated with wöhlerite, rosenbuschite, eucolite, ægirite, fluorite, elæolite, sodalite, etc.

Named after Prof. Fr. Johnstrup of Copenhagen.

**Ref.**—Dx., Min., 1, 531, 1862, Weibye, Jb. Min., 774, 1849, Bgr., Zs. Kr., **16**, 74, 1890. Crystals earlier described (Bgr., Zs. Kr., **2**, 275, 1878) as mosandrite proved to be låvenite (p. 375).

## 516. MOSANDRITE. *Erdmann*, Berz. JB., **21**, 178, 1841.

Crystals long prismatic ‖ *c* and flattened ‖ *a*, but without terminations so far as observed; vertical faces strongly striated. Forms noted in the prismatic zone, the same as in johnstrupite, and angles nearly the same.

**Forms**: *a* (100, $i\text{-}\bar{i}$), *b* (010, $i\text{-}\grave{i}$), *t* (710, $i\text{-}\bar{7}$), *k* (410, $i\text{-}\bar{4}$), *n* (310, $i\text{-}\bar{3}$), *l* (520, $i\text{-}\bar{\frac{5}{2}}$), *f* (210, $i\text{-}\bar{2}$), *m* (110, *I*), *z* (120, $i\text{-}\grave{2}$), *h* (160, $i\text{-}\grave{6}$).

Sections ‖ *b* show tw. lamellæ ‖ *a*.

Cleavage: *a* rather perfect. H. = 4. G. = 2·93–3·03. Luster of cleavage-face between vitreous and greasy, of other surfaces resinous. Color reddish brown, but altering to dull greenish or yellowish brown. Streak-powder pale yellow or grayish brown. Thin splinters translucent, bright red by transmitted light. Optical characters as with johnstrupite.

**Comp.**—Very near johnstrupite, p. 720.

Brögger calculates the molecular ratio as follows:

| $\overset{I}{R}_2O$ | $\overset{II}{R}O$ | $\overset{III}{R}_2O_3$ | $\overset{IV}{R}O_2$ | $SiO_2$ | F | $H_2O$ |
|---|---|---|---|---|---|---|
| 1·04 | 10·18 | 1·20 | 4·19 | 12 | 2·57 | 10·25 |

The formula is written, also analogous to the epidotes, $\left[\left.\begin{matrix} F_2 \\ (OH)_6 \end{matrix}\right\}\overset{IV}{R}_4\right](\overset{I}{R}_2)_7\overset{II}{R}_{10}\overset{III}{R}_2(SiO_4)_{12}$.

Here $\overset{I}{R}_2 = 6H_2, 1Na_2(K_2)$; $\overset{II}{R} = 10Ca$ (a little Mg,Mn), $\overset{III}{R} = \frac{2}{3}Ce, \frac{1}{3}Y$ and a little Fe; $\overset{IV}{R} = \frac{2}{5}Ti, \frac{2}{5}Zr, \frac{1}{5}Ce$ and a little Th.

**Anal.**—1, Berlin, Pogg., **88**, 156, 1853. 2, Bäckström, quoted by Brögger, Zs. Kr., **16**, 80, 1890.

| | $SiO_2$ | $TiO_2$ | $ZrO_2$ | $ThO_2$ | $CeO_2$ | $Ce_2O_3$ | $Y_2O_3$ | $Fe_2O_3$ | MnO | CaO | MgO | $Na_2$ | $K_2O$ | $H_2O$ | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 29·93 | 9·90 | — | — | — | 26·56[b] | — | 1·83 | — | 19·07 | 0·75 | 2·87 | 0·52 | 8·90 | — = 100·33 |
| 2. | [30·71[a]] | 5·33 | 7·43 | 0·34 | 6·34 | 10·45[b] | 3·52 | 0·56 | 0·45 | 22·53 | 0·63 | 2·44 | 0·38 | 7·70 | 2·06 = 100·87 |

[a] A direct determination gave 29·61.

[b] Incl. $(La,Di)_2O_3$.

**Pyr., etc.**—In the closed tube gives water. B.B. fuses with intumescence at 3 to a brown glass. With salt of phosphorus in R.F. gives a violet bead (titanium), and with borax in O.F. gives an amethystine bead (manganese). Decomposed by hydrochloric acid, with separation of silica and formation of a dark red solution, which, on heating, gives off chlorine and becomes yellow.

**Obs.**—Occurs on the small island Låven in the Langesund fiord, also on the neighboring island Stokö, and on the reefs near Barkevik; it is associated with leucophanite, eucolite, elæolite, ægirite, black mica. Readily undergoes alteration.

Named after the Swedish chemist G. G. Mosander (1797–1858).

### 517. RINKITE. *Lorenzen*, Medd. Grönl., **7**, 1884, and Zs. Kr., **9**, 248, 1884.

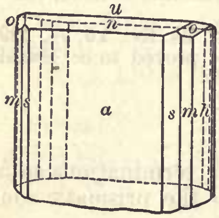
Monoclinic. Axes: $\grave{a} : \bar{b} : \grave{c} = 1{\cdot}5688 : 1 : 0{\cdot}2922$; $\beta = 88^\circ\ 47\frac{1}{4}' = 001 \wedge 100$ Lorenzen.

$100 \wedge 110 = 57^\circ\ 28\frac{3}{4}'$, $001 \wedge 101 = 10^\circ\ 30\frac{1}{2}'$, $001 \wedge 011 = 16^\circ\ 17'$.

**Forms:** *a* (100, *i*-$\bar{\imath}$), *s* (320, *i*-$\frac{3}{2}$), *m* (110, *I*), *h* (120, *i*-2̀); *n* (101, − 1-$\bar{\imath}$), *u* ($\bar{1}$01, 1-$\bar{\imath}$); *o* (341, − 4-$\frac{4}{3}$).

The domes 101, $\bar{1}$01 correspond to 105, $\bar{1}$05 of johnstrupite.

Angles: *ss‴* = 92° 33′, *mm‴* = 114° $57\frac{1}{2}'$, *am* = *57° $28\frac{3}{4}'$, *hh′* = 35° 22′, *an* = *78° $16\frac{3}{4}'$, *a′u* = 80° 37′, *nu* = *21° $5\frac{5}{6}'$.



Crystals flattened ∥ *a*; with a zonal structure parallel the faces, and with twinning lamellæ ∥ *a*.

Cleavage: *a* distinct. H. = 5. G. = 3·46. Luster vitreous to greasy. Color yellowish brown to straw-yellow. Pleochroic. Absorption $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$. Optically +. Ax. pl. ⊥ *b* and inclined $7\frac{1}{2}$ to $\grave{c}$. $Bx_a$ nearly normal to *a*. Dispersion horizontal distinct, also $\rho > v$.

**Comp.**—Near johnstrupite and mosandrite.

Brögger suggests $[F_8Ti_4]Na_9Ca_{11}Ce_3(SiO_4)_{12}$.

**Anal.**—Lorenzen, mean of five partial analyses:

| $SiO_2$ | $TiO_2$ | $Ce_2(La,Di)_2O_3$ | $Y_2O_3$ | FeO | CaO | $Na_2O$ | F | |
|---|---|---|---|---|---|---|---|---|
| 29·08 | 13·36 | 21·25 | 0·92 | 0·44 | 23·26 | 8·98 | 5·82 | = 103·11, less O 2·45 = 100·66 |

**Pyr., etc.**—Fuses B.B. rather easily to a black shining glass with continued intumescence. Dissolves in the borax bead, giving a yellow color in the O.F.; with salt of phosphorus, in R.F. violet (titanium), in O.F. colorless but with more of the mineral becomes enamel-like.

Easily decomposed by dilute acids with separation of silica carrying titanium.

**Obs.**—Occurs in sodalite-syenite at Kangerdluarsuk, Greenland, with arfvedsonite, ægirite, eudialyte, lithia mica, steenstrupine.

Named after Dr. Rink, at one time director of the Danish-Greenland commerce.

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### 518. PEROVSKITE. Perowskit *G. Rose*, Pogg., **48**, 558, 1839, Reis. Ural, **2**, 128, 1842. Perofskite.

Isometric or pseudo-isometric. Observed forms[1]:

*a* (100, *i*-*i*)
*d* (110, *i*)
*o* (111, 1)
*k* (520, *i*-$\frac{5}{2}$)
*e* (210, *i*-2)
*g* (320, *i*-$\frac{3}{2}$)
*Δ* (11·8·0, *i*-$\frac{11}{8}$)
*ϑ* (430, *i*-$\frac{4}{3}$)
*λ* (540, *i*-$\frac{5}{4}$)
*p* (221, 2)
*m* (311, 3-3)
*n* (211, 2-2)?
*ρ* (944, $\frac{9}{4}$-$\frac{9}{4}$)
*β* (322, $\frac{3}{2}$-$\frac{3}{2}$)
*z* (942, $\frac{9}{4}$-$\frac{9}{2}$)[2]
*Θ* (10·4·3, $\frac{10}{3}$-$\frac{5}{2}$)
*Γ* (832, 4-$\frac{8}{3}$)
*F* (643, 2-$\frac{3}{2}$)
*x* (432, 2-$\frac{4}{3}$)[2]

Crystals in general (Ural, Zermatt) cubic in habit and often highly modified, but the planes often irregularly distributed. Cubic faces striated parallel to the edges and apparently penetration-twins, as if of pyritohedral individuals. Again (Tyrol) the cubic faces less developed and the forms *m* (311), *ρ* (944) prominent. Also (Zermatt) in reniform masses showing small cubes.

Cleavage: cubic, rather perfect. Fracture uneven to subconchoidal. Brittle. H. = 5·5. G. = 4·017 Achmatovsk, Rose, 4·03–4·039 Zermatt, Dmr. Luster adamantine to metallic-adamantine. Color pale yellow, honey-yellow, orange-yellow, reddish brown, grayish black. Streak colorless, grayish. Transparent to opaque. Usually exhibits anomalous double refraction.

Geometrically considered, perovskite conforms to the isometric system; optically, however, it is uniformly biaxial and usually positive. The molecular structure (also as developed by etching, Baumhauer) seems to correspond to orthorhombic symmetry. (See the authors referred to under [2].) Sections (‖ *a*) of cubic crystals from the Ural and Zermatt show tw. lamellæ parallel to both sets of cubic edges, with diagonal extinction; the bisectrix is normal to a dodecahedral face, the axial angle variable (up to 90°), the character +, also −. Similar sections from the Tyrolese crystals, in which the forms *m* (311) and *ρ* (944) often predominate, show fine tw. lamellæ parallel the diagonals, while the bisectrix is ⊥ *a*, the optical character +, the axial angle small, sometimes sensibly 0°.

In general the form and optical character are partially explained by the assumption of an orthorhombic form, with a prismatic angle of 90° (corresponding to the two pair of cubic faces), and twinned with *p* (111) as tw. pl., and also *m* (110) in some cases. It seems more probable, however, as urged by Klein, especially as the structure differs in specimens from different localities, that the form was originally isometric and that the optical anomalies are due to secondary causes, but the subject still requires much elucidation. The transformation of the molecular structure to the isotropic condition by increase of temperature has not been accomplished, although this is readily done with boracite, to which perovskite is closely related in structure and optical characters.

**Comp.**—Calcium titanate, $CaTiO_3$ = Titanium dioxide 58·9, lime 41·1 = 100. Iron is present in small amount replacing the calcium.

**Anal.**—1, Brooks, Pogg., **62**, 596, 1841. 2, Jacobson, ibid. 3, Brun, Zs. Kr., **7**, 389, 1882. 4, Damour, Ann. Mines, **6**, 512, 1854. 5, Mauro, quoted by Strüver, Trans. Acc. Linc., **4**, 210, 1880. 6, Sauer, Zs. G. Ges., **37**, 445, 1885. Also an approximate analysis, showing a large amount of iron, by Kastle, Am. J. Sc., **34**, 141, 1887; further by Eakins, ib., **37**, 219, 1889.

| | G. | $TiO_2$ | CaO | FeO | | |
|---|---|---|---|---|---|---|
| 1. Achmatovsk, *brown* | | 59·00 | 36·76 | 4·79 | MgO,MnO 0·11 | = 100·07 |
| 2. “ *black* | | 58·96 | 39·20 | 2·06 | MgO,MnO *tr.* | = 100·22 |
| 3. Zermatt, *yellow* | 3·974 | 59·39 | 39·80 | 0·91 | | = 100·10 |
| 4. “ | | 59·23 | 39·92 | 1·14 | | = 100·29 |
| 5. Val Malenco | 3·95 | 58·66 | 41·47 | — | | = 100·13 |
| 6. Oberwiesenthal | | 58·66 | 38·35 | 2·07 | | = 99·08 |

**Pyr., etc.**—In the forceps and on charcoal infusible. With salt of phosphorus in O.F. dissolves easily, giving a greenish bead while hot, which becomes colorless on cooling; in R.F. the bead changes to grayish green, and on cooling assumes a violet-blue color. Entirely decomposed by boiling sulphuric acid.

**Obs.**—Occurs in small crystals or druses of crystals, all of dark colors, associated with crystallized chlorite, and magnetic iron in chlorite slate, at Achmatovsk, near Zlatoust, in the Ural; at Schelingen in the Kaiserstuhl, in white or yellowish granular limestone, with mica, magnetite, and pyrochlore or koppite (questioned by Knop, Zs. Kr., 1, 284, 1877); in the valley of Zermatt, near the Findelen glacier, where crystalline masses occur, in talcose schist, as large as the fist, and the interior, if not the whole, is of a light yellow color, along with garnet, vesuvianite, titanite, zircon, corundum, rutile, titanic iron, serpentine, etc.; at Wildkreuzjoch, between Pfitsch and Pfunders in Tyrol, but rare (cf. Hbg., l. c., and Rath, Pogg., **144**, 595, 1871). At Mte. Lagazallo, Val Malenco, Sondrio, northern Italy, with magnetite and amianthus. Rare on the island Låven in the Langesund fiord, associated with leucophanite. Bgr., Zs. Kr., **16**, 508, 1890.

Sometimes noted in microscopic octahedral crystals as a rock constituent; thus in nephelite- and melilite-basalts; as of Wartenberg in Bohemia; Hochbohl near Owen in Würtemberg; the Saxon Erzgebirge, basaltic lava of Scharteberg in the Eifel (doubly refracting, Hussak), etc.; also in serpentine (altered peridotyte) at Syracuse, N. Y. (cf. Williams, Am. J. Sc., **34**, 137, 1887); in peridotyte of Elliott Co., Ky. (Diller, ib., **37**, 219, 1889). Also noted as a result of the alteration of titanite (Schneider, Jb. Min., **1**, 99, 1889).

Named after von Perovski of St. Petersburg.

**Artif.**—Formed in crystals by making lime act at a high temperature on titanium silicate (Ebelmen); also by Hautefeuille (cf. Fouqué-Lévy, Synth. Min., 176, 1882). The artificial crystals show the optical characters of the natural mineral.

**Ref.**—[1] See Rose, l. c., also Dx., Ann. Ch. Phys., **13**, 338, 1845; Kk., Min. Russl., **1**, 199, 1853, **6**, 388, 1874, **7**, 375, 1878, **8**, 39, 1881; Mlr., Min., 461, 1852; Hbg., Wildkreuzjoch, Min. Not., **4**, 20, 1861, **10**, 38, 1871, **11**, 1, 1873.

[2] On the optical characters, see Dx., l. c. and Opt. Propr., **2**, 81, 1858; N. R., 84, 1867; Zs. G. Ges., **26**, 932, 1874; Jb. Min., 160, 1877, **43**, 372, 1878. Also Ben Saude, Preisschrift, Göttingen, 1882; Mallard, Bull. Soc. Min., **5**, 233, 1882; Klein, Jb. Min., **1**, 245, 1884, and 175 ref. (the latter a notice of Ben Saude). On the results of etching, see Baumhauer, Zs. Kr., **4**, 187, 1879.

**519. DYSANALYTE.** *A. Knop*, Zs. Kr., **1**, 284, 1877. Perovskite of former writers.

Isometric; in cubes.

Cleavage: cubic. H. = 5–6. G. = 4·13. Luster submetallic. Color iron-black. Opaque.

**Comp.**—A titano-niobate of calcium and iron approximating (anal. 3) to $6RTiO_3.RNb_2O_6$.

Mar calculates for anal. 4 the molecular ratio, $TiO_2 : (Nb,Ta)_2O_5 : Y_2O_3,Fe_2O_3 : CaO = 0·54 : 0·027 : 0·05 : 0·60$.

**Anal.**—1, 2, Seneca, Lieb. Ann., **104**, 371, 1857. 3*a*, Knop, l. c.; 3*b*, same, deducting $SiO_2$. 4, F. W. Mar, Am. J. Sc., **40**, 403, 1890.

| | G. | $TiO_2$ | $Nb_2O_5$ | $Ta_2O_5$ | $Y_2O_3$[a] | FeO | $Ce_2O_3$[b] | CaO | $Na_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Kaiserstuhl | 4·02 | 58·95 | — | — | — | 6·23 | — | 35·69 | — | = 100·87 |
| 2. " | | 59·30 | — | — | — | 5·99 | — | 35·94 | — | = 101·23 |
| 3*a*. " | | 40·57 | 22·73 | — | — | 6·12[c] | 5·58 | 19·36 | 3·50 | $SiO_2$ 2·31, MgO, [$K_2O,Al_2O_3$,F *tr*. = 100·17 |
| 3*b*. " | | 41·47 | 23·23 | — | 5·42 | 6·24[d] | 5·72 | 19·77 | 3·57 | = 100 |
| 4. Magnet Cove | 4·18 | 44·12 | 4·38 | 5·08 | — | 5·66[e] | 0·10 | 33·22 | — | MgO 0·74, $SiO_2$ [0·08, magnetite 0·73 = 99·53 |

[a] Yttrum earths. [b] Cerium oxides. [c] Incl. 0·42 MnO. [d] 0·43 MnO. [e] $Fe_2O_3$.

**Obs.**—Found in the granular limestone of Vogtsburg, Kaiserstuhlgebirge, Baden. The mineral has previously been called perovskite, but is in fact intermediate between the titanate, perovskite, and the niobates, pyrochlore and koppite. Named, in allusion to the difficulty of the analysis, from *δυσανάλυτος*, *hard to undo.*

A related mineral, which has also long passed as perovskite, occurs with magnetite, brookite, rutile, etc., at Magnet Cove, Arkansas. It is in octahedrons or cubo-octahedrons, black or brownish black in color and submetallic in luster. The amount of niobium (and tantalum) present is much smaller than in the mineral from the Kaiserstuhl and it hence is more closely allied to perovskite. Ben Saude has shown that sections ‖ *a* (100) and *o* (111) show twinning lamellæ analogous to perovskite.

HYDROTITANITE *Koenig*, Proc. Acad. Philad., 82, 1876. An altered form of the so-called perovskite (dysanalyte) from Magnet Cove, Arkansas. G. = 3·681. Soft. Color yellowish gray. An analysis afforded:

$TiO_2$ 82·82 $Fe_2O_3$ 7·76 MgO 2·72 CaO 0·80 $H_2O$ 5·50 V *tr*. = 99·60.

This does not correspond to any definite formula.

# Oxygen Salts.

## 3. NIOBATES, TANTALATES.

The Niobates and Tantalates are chiefly salts of metaniobic and metatantalic acid, $RNb_2O_6$ and $RTa_2O_6$; also in part Pyroniobates, $R_2Nb_2O_7$, etc. Titanium is prominent in a number of the species, which are hence intermediate between the niobates and titanates. Niobium and tantalum also enter into the composition of a few silicates, as wöhlerite, p. 376, låvenite, p. 375, etc.

### 1. Pyrochlore Group. Isometric.

| | | |
|---|---|---|
| 520. | **Pyrochlore** | $RNb_2O_6.R(Ti,Th)O_3.NaF$ |
| | | Also $R_2Nb_2O_7.R(Ti,Th)O_3.NaF$, etc. |
| 520A. | **Koppite** | $R_2Nb_2O_7.\frac{2}{5}NaF$ |
| 521. | **Hatchettolite** | $2R(Nb,Ta)_2O_6.R_2(Nb,Ta)_2O_7.R = UO_2$, Ca, Fe, etc. |
| 522. | **Microlite** | $Ca_2Ta_2O_7$ pt. |

### 2. Fergusonite Group. Tetragonal.

| | | | |
|---|---|---|---|
| 523. | **Fergusonite** | $(Y,Er,Ce)(Nb,Ta)O_4$ | $\acute{c} = 1{\cdot}4643$ |
| 524. | **Sipylite,** | essentially $ErNbO_4$ | $1{\cdot}4767$ |

### 3. Columbite Group. Orthorhombic.

| | | | $\breve{a} : \bar{b} : \acute{c}$ |
|---|---|---|---|
| 525. | **Columbite** | $(Fe,Mn)Nb_2O_6$<br>$(Fe,Mn)(Nb,Ta)_2O_6$ | $0{\cdot}8285 : 1 : 0{\cdot}8898$ |
| 526. | **Tantalite** | $FeTa_2O_6$ | |
| | Manganocolumbite | $MnNb_2O_6.MnTa_2O_6$ | |
| | Manganotantalite | $MnTa_2O_6$ | |
| 526A. | **Skogbölite** | $FeTa_2O_6$ | $0{\cdot}8170 : 1 : 0{\cdot}6511$ |
| | Ixiolite | | |

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| | | | | |
|---|---|---|---|---|
| 527. | **Tapiolite** | $Fe(Nb,Ta)_2O_6$ | Tetragonal | $\acute{c} = 0{\cdot}6464$ |

### 4. Samarskite Group. Orthorhombic.

528. **Yttrotantalite** $\overset{\text{II}}{R}_2\overset{\text{III}}{R}_2(Ta,Nb)_4O_{15}$, $\overset{\text{III}}{R} = Y,Er$; also $\overset{\text{II}}{R} = Ca, Fe$, etc.

$\breve{a} : \bar{b} : \acute{c} = 0{\cdot}5411 : 1 : 1{\cdot}1330$

| | | |
|---|---|---|
| 529. **Samarskite** | $\overset{\text{II}}{R}_3\overset{\text{III}}{R}_2(Nb,Ta)_6O_{21}$, $\overset{\text{II}}{R} = Ca,Fe,UO_2$; $\overset{\text{III}}{R} =$ Y, Ce, etc. | $\breve{a} : \bar{b} : 2\acute{c} = 0{\cdot}5456 : 1 : 1{\cdot}0356$ |
| 530. **Annerödite** | Pyroniobate of uranium, yttrium, etc. | $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}8257 : 1 : 0{\cdot}8943$ |
| 531. **Hielmite** | $4RO.3Ta_2O_5$? | $2\breve{a} : \bar{b} : \acute{c} = 0{\cdot}9290 : 1 : 1{\cdot}0264$ |

### 5. Æschynite Group. Orthorhombic.

| | | |
|---|---|---|
| 532. **Æschynite** | $\overset{\text{III}}{R}_2Nb_4O_{13}.\overset{\text{III}}{R}_2(Ti,Th)_6O_{13}$ | $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}4866 : 1 : 0{\cdot}6737$ |
| 533. **Polymignite** | $R((Nb,Ta)O_3)_3.5\overset{\text{III}}{R}((Ti,Zr)O_3)_3$ | $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}7121 : 1 : 0{\cdot}5121$<br>or $\acute{c} : \bar{b} : \breve{a} = 0{\cdot}5121 : 1 : 0{\cdot}7121$ |
| 534. **Euxenite** | $\overset{\text{III}}{R}(NbO_3)_3,\overset{\text{III}}{R}_2(TiO_3)_3.\frac{3}{2}H_2O$ | $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}364 : 1 : 0{\cdot}303$ |
| 535. **Polycrase** | $\overset{\text{III}}{R}(NbO_3)_3.2\overset{\text{III}}{R}_2(TiO_3)_3.3H_2O$ | $\breve{a} : b : \acute{c} = 0{\cdot}3462 : 1 : 0{\cdot}3124$ |

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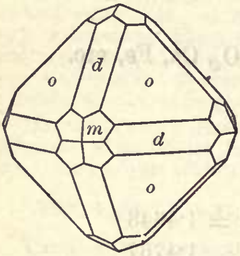
### 1. Pyrochlore Group. Isometric.

**520. PYROCHLORE.** Pyrochlor (fr. Fredriksvärn) *Wöhler*, Pogg., **7**, 417, 1826. Hydrochlor, Fluochlor, *Herm.*, J. pr. Ch., **50**, 186, 187, 1850.



Miask, Kk.

Isometric. Observed forms:

*a* (100, *i-i*); *d* (110, *i*); *o* (111, 1); *m* (311, 3-3), *n* (211, 2-2)?

Commonly in octahedrons; also in irregular embedded grains.

Cleavage: octahedral, sometimes distinct. Fracture conchoidal. Brittle. H. = 5–5·5. G. = 4·2–4·36; 4·32, Miask, Rose; 4·203, ib., Hermann; 4·359, ib., Rg.; 4·203–4·221, Fredriksvärn, Hayes; 4·228, ib., Rg. Luster vitreous or resinous, the latter on fracture surfaces. Color brown, dark reddish or blackish brown. Streak light brown, yellowish brown. Subtranslucent to opaque.

**Comp.**—Chiefly a niobate of the cerium metals, calcium and other bases, with also titanium, thorium, fluorine. Probably essentially a metaniobate with a titanate, $RNb_2O_6.R(Ti,Th)O_3$; the part played by the fluorine in this and the following species is doubtful.

Rammelsberg (Min. Ch., Erg., 191, 1886) calculates for the pyrochlore from Miask $[5RNb_2O_6.4R(Ti,Th)O_3] + 4NaF$; for that from "Brevik" $[5RNb_2O_6.2R(Ti,Th)O_3] + 4NaF$; Fredriksvärn $[R_2Nb_2O_7.RTiO_3] + NaF$. Brögger (Zs. Kr., **16**, 511, 1890) suggests that the metaniobate may represent the original composition, the pyroniobate be a result of alteration.

**Anal.**—1–3, Rg., Ber. Ak. Berlin, 183, 1871. Also earlier anals., 5th Ed., p. 513.

| | G. | $Nb_2O_6$ | $TiO_2$ | $ThO_2$ | $Ce_2O_3$ | CaO | FeO | UO | MgO | $Na_2O$ | F |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Miask | 4·359 | $\frac{8}{3}$ 53·19 | 10·47 | 7·56 | 7·00 | 14·21 | 1·84 | — | 0·22 | 5·01 | — |
| 2. "Brevik" | 4·220 | 58·27 | 5·38 | 4·96 | 5·50 | 10·93 | 5·53 | | — | 5·31 | 3·75<br>[ign. 1·53 = 101·16 |
| 3. Fredriksvärn | 4·228 | 47·13 | 13·52 | — | 7·30 | 15·94 | 10·03 | — | 0·19 | 3·12 | 2·90<br>[ign. 1·39 = 101·52 |

**Pyr., etc.**—Pyrochlore from Miask gives but traces of water in the closed tube. B.B. infusible, but turns yellow and colors the flame reddish yellow. When ignited it glows momentarily as if taking fire, the same phenomenon as observed with gadolinite. With borax and salt of phosphorus in both flames gives a light green bead, becoming colorless on cooling. A saturated bead of borax gives a greenish gray enamel in R.F., while that with salt of phosphorus is reddish gray. Decomposed by concentrated sulphuric acid with evolution of fluorine (G. Rose). Pyrochlore from Norway gives water in the closed tube, and B.B. fuses with difficulty to a dark brown slaggy mass. With borax in R.F. gives a dark red bead, which by flaming turns to a grayish blue to pure blue enamel. Dissolves with effervescence in salt of phosphorus, giving in O.F. a yellow bead while hot, becoming grass-green on cooling (uranium). In R.F. the bead is made dark red to violet (titanium). Fused with soda gives a green color (manganese). All varieties are decomposed by fusion with potassium bisulphate. Most specimens are sufficiently decomposed by hydrochloric acid to give a blue color when the concentrated solution is boiled with metallic tin; this color disappears after a time, and almost immediately if diluted with water.

**Obs.**—Occurs embedded in elæolite-syenite at Fredriksvärn and Laurvik, Norway, with zircon, polymignite, amphibole, and xenotime; on the island Lövö, opposite Brevik; on Stokö, Lille Arö, and other points in the Langesund fiord (Bgr., Zs. Kr., **16**, 509, 1890); near Miask in the Ural.

Lacroix mentions an octahedral mineral resembling the Norwegian pyrochlore as occurring with astrophyllite and zircon, in the syenite of St. Peter's Dome, Pike's Peak, Colorado (C. R., **109**, 39, 1889).

Named from *πῦρ*, *fire*, and *χλωρός*, *green*, because B.B. it becomes yellowish green.

**520A. Koppite.** *Knop*, Jb. Min., 67, 1875.

Isometric; in minute embedded dodecahedrons, G. = 4·45–4·56. Color brown. Transparent.

**Comp.**—Essentially a pyroniobate of cerium, calcium, etc.; formula as given by Rammelsberg (Min. Ch., Erg., 191), $5R_2Nb_2O_7.2NaF$.

**Anal.**—1, Knop, l. c. and Zs. G. Ges., **23**, 656, 1871. 2, G. H. Bailey, J. Ch. Soc., **49**, 153, 1886. An earlier analysis by Bromeis is quoted by Knop.

| | $Nb_2O_5$ | $TiO_2$ | $ZrO_2$ | $(Ce,La,Di)_2O_3$ | FeO | CaO | MgO | $Na_2O$ | $K_2O$ | F |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 61·90 | — | — | 10·10 | 2·20[a] | 16·00 | — | 7·52 | 4·23 | 1·28 |
| 2. | 61·64 | 0·52 | 3·39 | 6·89 | 3·01 | 16·61 | 1·62 | 3·58 Na | 0·36 K | *tr.* |

[a] MnO 0·40.

**Obs.**—Occurs with apatite in a granular limestone near Schelingen, Kaiserstuhlgebirge, Baden.

Named after Prof. Hermann Kopp of Heidelberg.

**521. HATCHETTOLITE.** *J. L. Smith*, Am. J. Sc., **13**, 365, 1877. *O. D. Allen.* ibid., **14**, 128, 1877.

Isometric. In octahedrons with also the subordinate forms *a* (100, *i-i*) and *m* (311, 3-3).

Fracture subconchoidal. Brittle. H. = 5. G. = 4·77–4·90. Luster resinous. Color yellowish brown. Translucent.

**Comp.**—A tantalo-niobate of uranium, near pyrochlore, approximating to $R(Nb,Ta)_2O_6 + H_2O$ with $R = UO_2 : Ca = 1·3$ and $Nb : Ta = 2 : 1$. The water present may be due to alteration.

**Anal.**—1, 2, 3, Smith, l. c. 4, 5, Allen, l. c.

<table>
<tr><th></th><th>$Ta_2O_5$</th><th>$Nb_2O_5$</th><th>$TiO_2$</th><th>$WO_3$</th><th>$SnO_2$</th><th>$UO_3$</th><th>CaO</th><th>$Y_2O_3$[a]</th><th>FeO</th><th>$K_2O$</th><th>$Na_2O$</th><th>$H_2O$</th><th></th></tr>
<tr><td>1.</td><td colspan="2">66·01</td><td>—</td><td colspan="2">0·75</td><td>15·20</td><td>7·72</td><td>2·00</td><td>2·08</td><td>0·50</td><td>—</td><td>5·16</td><td>Pb *tr.* = 99·42</td></tr>
<tr><td>2.</td><td colspan="2">67·86</td><td>—</td><td colspan="2">0·60</td><td>15·63</td><td>7·09</td><td>0·86</td><td>2·51</td><td>1·21</td><td>—</td><td>4·42</td><td>= 100·18</td></tr>
<tr><td>3.</td><td colspan="2">67·25</td><td>—</td><td colspan="2">0·91</td><td>16·01</td><td>7·11</td><td>0·64</td><td>2·12</td><td>*undet.*</td><td>—</td><td>5·02</td><td>= 99·06</td></tr>
<tr><td>4.</td><td>29·83</td><td>34·24</td><td>1·61</td><td colspan="2">0·30</td><td>15·50</td><td>8·87</td><td>—</td><td>2·19</td><td>*tr.*</td><td>1·37</td><td>4·49</td><td>MgO 0·15, Pb *tr.* = 98·55</td></tr>
<tr><td>5.</td><td>29·60</td><td colspan="2">35·94</td><td colspan="2">—</td><td>—</td><td>8·89</td><td>—</td><td>2·33</td><td>—</td><td>—</td><td>—</td><td></td></tr>
</table>

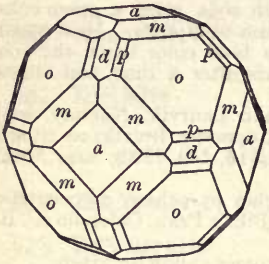
[a] With cerium oxide.

From analysis 4, Allen deduces the formula $R_2(Nb,Ta)_2O_7 + 2R(Nb,Ta)_2O_6 + 4H_2O$, with $R = UO_2,Ca,Fe,Mg,Na_2$. Allen calls attention to the close relation to pyrochlore, and suggests that the original mineral in this case may have been anhydrous and hence analogous to it in composition. It is united with pyrochlore by some authors, which species, however, contains little or no uranium.

**Pyr.**—Nearly the same as for pyrochlore.

**Obs.**—Occurs associated with samarskite, sometimes implanted upon it in parellel position, in the mica mines of Mitchell Co., North Carolina. Named after the English chemist, Charles Hatchett (1765–1847).

**522. MICROLITE.** Microlite *C. U. Shepard*, Am. J. Sc., **27**, 361, 1835, **32**, 338, 1837 **43**, 116, 1842. Pyrochlore *Hayes*, ib., **43**, 33, 1842, **46**, 158, 1844.



Amelia C. H., Va., after Feist.

Isometric. Observed forms[1]:

*a* (100, *i-i*), *d* (110, *i*), *o* (111, 1), *p* (221, 2), *m* (311, 3-3) *n* (211, 2-2)?

Habit octahedral; crystals often very small. Fracture conchoidal. Brittle. H.=5·5. G.=5·485–5·562, the last from a large crystal, Shepard; 5·405, Hayes; 6·13 Virginia, Hidden. Luster resinous. Color pale yellow to brown, rarely hyacinth-red. Streak pale yellowish or brownish. Transparent to translucent or nearly opaque.

**Comp.**—Essentially a calcium pyro-tantalate, $Ca_2Ta_2O_7$, but containing also niobium, fluorine, and a variety of bases in small amount.

Dunnington calculates $3Ca_2Ta_2O_7 + NbOF_3$. Rammelsberg deduces from the same analysis $[R_2(Ta,Nb)_2O_7.2R(Ta,Nb)_2O_6] + 3NaF$.

**Anal.**—1, Dunnington, Am. Ch. J., 3, 130, 1881. 2, A. Nordenskiöld, G. För. Förh., 3, 282, 1872.

| | G. | $Ta_2O$ | $Nb_2O_5$ | $WO_3$ | $SnO_2$ | CaO | MgO | BeO | $UO_3$ | $Y_2O_3$ | $(Ce,Di)_2O_3$ | $Fe_2O_3$ | MnO | $Na_2O$ | F | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Va. | 5·656 | 68·43 | 7·74 | 0·30 | 1·05 | 11·80 | 1·01 | 0·34 | 1·59 | 0·23 | 0·17 | 0·42[a] | — | 3·15[c] | 2·85 | 1·17 [= 100·25 |
| 2. Utö | 5·25 | 77·3 | | — | 0·8 | 11·7 | 1·8 | — | — | — | — | — | 7·7[b] | — | — | — [= 99·3 |

[a] Incl. 0·13 $Al_2O_3$. [b] FeO *tr.* [c] Incl. 0·29 $K_2O$.

**Pyr., etc.**—B.B. infusible. In salt of phosphorus difficultly soluble, giving in O.F. a bead yellow while hot, and colorless on cooling. In R.F. after long blowing yields a pale bluish green bead. Not attacked by hydrochloric acid, but decomposed on fusion with potassium bisulphate and the solution of the fused mass remains uncolored when boiled with metallic tin. Slowly decomposed by sulphuric acid.

**Obs.**—First found at Chesterfield, Mass., in minute octahedrons in an albite vein, with red and green tourmaline, spodumene, columbite, and a little cassiterite; similarly associated at Branchville, Conn., and at Utö, Sweden. Also in fine crystals up to 1 in. in diameter, and in imperfect crystals (up to 4 lbs.) at the mica mines at Amelia Court House, Amelia Co., Va., with monazite, columbite, spessartite, beryl, fluorite, etc. (cf. Fontaine, Am. J. Sc., **25**, 335, 1883); the crystals, embedded in smoky quartz, are rarely clear, highly polished, and resembling pyrope in color (Hidden, ib., **30**, 82, 1885). Also in the granitic veins of Elba (Corsi, Boll. Com. G., 564, 1881). Cf. pyrrhite, below.

Named from *μικρός*, *small*, alluding to the minute size of the crystals at the original locality.

**Ref.**—[1] See Feist, Zs. Kr., **11**, 255, 1885.

A mineral related to microlite, from Haddam, Conn., is called *haddamite* by C. U. Shepard (Am. J. Sc., **50**, 93, 1870; Min. Contr., 1877). What its true character is, if it be a distinct species, has not been determined.

PYRRHITE *G. Rose*, Pogg., **48**, 562, 1840, Reis. Ural., **2**, 1842.

Isometric; in octahedrons. Cleavage not observed. H. = 6. Luster vitreous. Color orange-yellow. Subtranslucent. In composition probably a niobate, related to pyrochlore, and perhaps identical with microlite.

B.B. infusible, but blackens, and colors the flame deep yellow. In fragments difficultly soluble in salt of phosphorus, but in fine powder it is readily taken up by this salt, as well as by borax, forming a clear glass when cold if only a small portion is used, while if saturated it is yellowish green, becoming somewhat more intense in R.F. Fused with soda on charcoal, it spreads out and is absorbed by the coal, giving a slight white coating, somewhat resembling oxide of zinc; it yields no metallic spangles when the surface of the coal is removed and rubbed in the mortar. Insoluble in hydrochloric acid (G. Rose).

Pyrrhite was found by von Perovski of St. Petersburg at Alabashka, near Mursinka in the Ural, where it occurs in drusy feldspar cavities, containing also lepidolite, albite, and topaz. The largest crystal was but three lines long. Crystals from San Piero, Elba, referred here by Rath (Zs. G. Ges., **22**, 672, 1870) are regarded by Corsi as microlite, which may also be true of the Uralian mineral (ref. above). Cf. also Schrauf, Ber. Ak. Wien, **63** (1), 187, 1871.

Named from *πυῤῥός*, *yellowish red* or *fire-like*.

To Rose's pyrrhite J. E. Teschemacher refers small orange-red, isometric octahedrons, found with albite on San Miguel, one of the Azores (J. Nat. H. Bost., **4**, 499, 1844; Proc. id., **2**, 108, 1846), along with tetragonal octahedrons of *azorite* (p. 484). The crystals are a half to two lines long, and those of minute size are transparent. They are called *azor-pyrrhite* by Hubbard, who mentions a similar mineral (G. = 4·1–4·3) in the sanidine-bombs of the Laacher See (Ber. nied. Ges., June 7, 1886) associated with titanite and noselite. Cf. also Osann (Jb. Min., **1**, 115, 1887, **1**, 117, 1888), who has further investigated the mineral from the Azores and finds the hardness below 6 and by chemical tests identifies Nb(Ti?)Ti, Fe, Na, Ca. It is hence, as urged by him, probably near pyrochlore, and may be identical with it; the specific gravity seems to be less than that of the pyrrhite from the Ural and Elba.

The chemical and blowpipe trials of A. A. Hayes (Am. J. Sc., **9**, 423, 1850, detailed in 5th Ed., p. 763) on specimens by Teschermacher made the crystals consist of niobate of zirconium, colored apparently by oxides of iron, uranium, and manganese, but the results are not conclusive.

## 2. Fergusonite Group. Tetragonal.

**523. FERGUSONITE.** *Haidinger*, Ed. Phil. Trans., **10**, 274, 1826. Tyrite *Forbes*, Ed. N. Phil. J., **1**, 67, 1855; Phil. Mag., **13**, 91, 1857. Bragite *Forbes* and *Dahll*, Nyt Mag., **8**, 227, 1855. Yttrotantalite pt. (yellow).

Tetragonal; with pyramidal hemihedrism. Axis $\dot{c} = 1·4643$; $001 \wedge 101 = 55° \, 40\frac{1}{6}'$ Miller[1].

**Forms**[2]: *c* (001, *O*); *g* (320, $i\text{-}\frac{3}{2}$); *s* (111, 1); *z* (321, $3\text{-}\frac{3}{2}$).

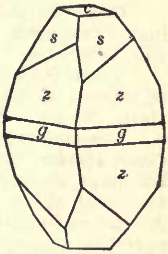
Angles: $cs = 64° \, 13\frac{1}{2}'$, $ss' = {}^*79° \, 6'$, $cz = 79° \, 16\frac{1}{2}'$, $zz''' = 88° \, 1'$.

The form is near that of the scheelite group, p. 985.

Crystals pyramidal or prismatic in habit, sometimes with basal plane prominent and often showing the hemihedral form, the pyramid of the third series, *z* (321).

Cleavage: *s* (111) in traces. Fracture subconchoidal. Brittle. H. = 5·5–6. G. = 5·838 Allan; 5·800 Turner; diminishing to 4·3 when largely hydrated. Luster externally dull, on the fracture brilliantly vitreous and submetallic. Color brownish black; in thin scales pale liver-brown. Streak pale brown. Subtranslucent to opaque.

**Comp.**—Essentially a metaniobate (and tantalate) of yttrium with erbium, cerium, uranium, etc., in varying amounts; also iron, calcium, etc. General formula $\overset{\text{III}}{R}(Nb,Ta)O_4$ with $\overset{\text{III}}{R} = Y,Er,Ce$.



Haidinger.

Water is usually present and sometimes in considerable amount, but probably not an original constituent; the specific gravity falls as the amount increases, cf. anals. 12, 13, and Hidden & Mackintosh, l. c.

**Anal.**—1–9, Rg., Ber. Ak. Berlin, 406, 1871, and Min. Ch., 362, 1875; 2–5, of the so-called yellow (or brown) yttrotantalite. 10, W. H. Seamon, Ch. News, **46**, 204, 1882. 11, J. L. Smith, Am. J. Sc., **13**, 367, 1877. 12, 13, Hidden & Mackintosh, Am. J. Sc., **38**, 482, 1889. Earlier anals., 5th Ed., p. 525.

| | G. | $Nb_2O_5$ | $Ta_2O_5$ | $UO_2$ | $WO_3$ | $SnO_2$ | $Y_2O_3$ | $Er_2O_3$ | $Ce_2O_3$ | FeO | CaO | $\dot{H}_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Greenland, *Ferg.* | 5·577 | 44·45 | 6·30 | 2·58 | 0·15 | 0·47 | 24·87 | 9·81 | 7·63[a] | 0·74 | 0·61 | 1·49<br>[= 99·10 |
| 2. Ytterby, *yw.* | 4·774 | 28·14 | 27·04 | 2·13 | — | — | 24·45 | 8·26 | — | 0·72 | 4·17 | 5·12<br>[= 100·03 |
| 3. " *brn.* | 5·056 | 40·16 | 8·73 | 1·98 | 0·91 | | 38·26 | | — | 3·09 | 3·40 | 4·47<br>[= 101·00 |
| 4. " " | 4·751 | 39·93 | 9·53 | 1·20 | 0·21 | 0·23 | 26·25 | 11·79 | 1·79 | 0·60 | 3·04 | 5·20<br>[= 99·77 |
| 5. " " | 4·650 | 49·85 | | — | — | — | 38·01 | | — | 2·91 | 3·29 | 6·19<br>[= 100·25 |
| 6. Heile, *Tyrite* | 4·77-4·86 | 45·82 | — | 6·21 | — | 0·45 | 18·69 | 11·71 | 9·26[b] | 1·50 | 2·39 | 4·88<br>[= 100·91 |
| 7. " " | " | 45·60 | — | 5·38 | — | 0·45 | 22·31 | 13·97 | 4·54[c] | 0·82 | 2·05 | 4·88<br>[= 100 |
| 8. " *Bragite* | 5·267 | 43·36 | 2·04 | 8·16 | — | 0·83 | 22·68 | 13·95 | 3·33 | — | 2·21 | 4·18<br>[= 100·74 |

| | G. | $Nb_2O_5$ | $Ta_2O_5$ | $UO_2$ | $WO_3$ | $SnO_2$ | $Y_2O_3$ | $Er_2O_3$ | $Ce_2O_3$ | FeO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9. Kårarfvet, *Yttr., gry.* | 4·306 | 14·41 | 43·44 | 1·56 | — | — | 28·81 | 1·73 | 0·47 | 1·51 | — | 7·14 | = 99·07 |
| 10. Burke Co., N. C. | 5·6 | 43·78 | 4·08 | 5·81 | 0·76 | | 37·21 | | 4·15[d] | 1·81 | 0·65 | 1·62 | = 99·87 |
| 11. Rockport, Mass. | 5·681 | 48·75 | | 0·25 | — | — | 46·01 | | 4·23 | — | — | 1·65 | = 100·89 |
| | | | | | $UO_3$ | $ThO_2$ | | | | | | | |
| 12. Llano Co., Tex. | 5·67 | 46·27 | — | — | 1·54 | 3·38 | 42·33[e] | | — | 0·98[f] | 0·14[g] | 2·02[h] | F 0·91, $Al_2O_3$ 0·09, PbO 1·43, ZnO 0·24 = 99·33 |
| 13. " " | 4·42 | 42·79 | — | 3·93 | 3·12 | 0·83 | 31·36[k] | | — | 3·75[f] | 2·74 | 8·19[i] | F 0·50, $Al_2O_3$ 0·85, PbO 1·94 = 100 |

[a] Incl. 5·63 $Di_2O_2, La_2O_3$. [b] Incl. 3·56 $Di_2O_3, La_2O_3$. [c] Incl. 1·51 $Di_2O_3, La_2O_3$. [d] Incl. 3·49 $Di_2O_3, La_2O_3$. [e] Incl. 23·95 of at. wght. 110·55; 18·38, at. wght. 113·3. [f] $Fe_2O_3$. [g] Incl. 0·04 MgO. [h] At 110° 0·04. [i] Do. 0·62. [k] At. wght. 121·77.

On the absorption spectra of the rare earths in fergusonite, see Krüss and Nilson, Öfv. Ak. Stockh., **44**, 373, 1887; on metallic acids, ib., p. 267.

**Pyr., etc.**—Fergusonite from Greenland gives in the closed tube a little water. B.B. infusible; on charcoal its color becomes pale yellow. With borax dissolves with difficulty, giving a yellow bead while hot, the insoluble portion being white; the saturated bead is yellowish red, and is made opaque by flaming. Slowly dissolved by salt of phosphorus, leaving a white insoluble residue; in O.F. the bead is yellow, while in R.F. it is colorless, or, if saturated, slightly reddish, becoming opaque on cooling; treated with tin the bead remains uncolored, while the insoluble residue is made flesh-red. Decomposed by soda without dissolving, leaving a reddish slag; with soda on charcoal affords globules of metallic tin (Berzelius). When evaporated with sulphuric acid yields a white residue, which, treated with hydrochloric acid and metallic zinc, gives a bluish green color. Tyrite decrepitates and yields much water in the closed tube (Forbes).

**Obs.**—Fergusonite was discovered by Giesecke, near Cape Farewell in Greenland, disseminated in quartz, and named after Robert Ferguson of Raith. Also found at Ytterby, Sweden, and Kårarfvet. In the granite of Königshain, near Görlitz, Silesia (Woitschach).

*Tyrite* is associated with euxenite at Hampemyr on the island of Tromö, and Helle on the mainland; at Näskul, about ten miles east of Arendal. *Bragite* of Forbes and Dahll is from Helle, Narestö, Alve, and Askerö, Norway.

Fergusonite is found in the U. S., at Rockport, Mass., in granite; on the allanite of Amelia Court House, Va. (?, sipylite); in the Brindletown gold district, Burke Co., N. C., in gold-washings, and similarly near Golden P. O., Rutherford Co.; also from near Spruce Pine, Mitchell Co.; with zircon near Storeville, Anderson Co., S. Carolina (Hidden, Am. J. Sc., **41**, 440, 1891). At the gadolinite locality (p. 511) in Llano Co., Texas, it occurs in considerable quantity with cyrtolite, thorogummite, magnetite, etc., in masses sometimes weighing over a pound, also in large rough crystals; the mineral is often hydrated to a greater or less extent, cf. anals. 12, 13.

**Ref.**—[1] Min., 465, 1852. Haidinger gives 79° 32′.

RUTHERFORDITE *C. U. Shepard*, Am. Assoc., **4**, 312, 1850, Am. J. Sc., **12**, 209, 1851. *T. S. Hunt*, ib., **14**, 344, 1852.

In crystals and grains, without cleavage. H. = 5·5. G. = 5·55–5·69. Luster vitreo-resinous. Color blackish brown. Opaque, in thin fragments translucent. Occurs at the gold mines of Rutherford Co., North Carolina, along with rutile, brookite, zircon, and monazite.

Shepard later announced (Am. J. Sc., **20**, 57, 1880) that rutherfordite was probably identical with fergusonite, and of the correctness of this there seems little doubt.

KOCHELITE *M. Websky*, Zs. G. Ges., **20**, 250, 1868.

Tetragonal? In columnar incrustations passing into rounded, apparently square octahedrons, occasionally showing prismatic planes. Color brownish isabella-yellow to honey-yellow. Translucent. Luster dull greasy. H. = 3–3·5. G. = 3·74 (?). An incomplete analysis gave:

| $Nb_2O_5$ | $ZrO_2$ | $ThO_2$ | $SiO_2$ | $Y_2O_3$ | $UO_3$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 29·49 | 12·81 | 1·23 | 4·49 | 17·22 | 0·43 | 1·41 | 12·48 | 2·10 | 6·52 | PbO?$Na_2O$? loss 11·82 = 100 |

In the closed tube yields water, and the mineral turns reddish. B.B. in the forceps fuses only on the edges to a black glass, coloring the flame yellow. With salt of phosphorus reacts for iron, but in R.F. fuses to a clear bead, showing only a faint reaction for uranium. With soda on charcoal yields a yellowish white enamel, but no metallic globules.

Occurs as an incrustation upon a mixture of titanic iron and crystals of fergusonite in a coarse granite in the Kochelwiese, near Schreiberhau in Silesia.

The composition is near that of fergusonite, but further investigation is needed. The density is remarkably low for a mineral containing so large a percentage of metallic acids.

**524. SIPYLITE.** *J. W. Mallet*, Am. J. Sc., **14**, 397, 1877; **22**, 52, 1881.

Tetragonal. Axis $\dot{c} = 1·4767$; 001 ∧ 101 = 55° 53$\frac{3}{5}$′ Mallet.

Rarely in octahedral crystals; $pp'$ = *79° 15′, $pp''$ = 128° 50′ (127° meas.). Usually imperfectly crystalline, or in irregular masses.

Cleavage: $p$ (111), distinct. Fracture small conchoidal and uneven. Brittle. H. = 6 nearly. G. = 4·89. Luster resinous and pseudo-metallic. Color brownish black to brownish orange; in splinters red-brown. Streak light cinnamon-brown to pale gray. Translucent.

**Comp.**—A niobate of erbium chiefly, also the cerium metals, etc.

**Anal.**—W. G. Brown, l. c.

| $Nb_2O_5$ | $WO_3$ | $SnO_2$ | $ZrO_2$ | $Er_2O_3$ | $Ce_2O_3$ | $La_2O_2$ | $Di_2O_3$ | UO | FeO | BeO | MgO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 48·66[a] | 0·16 | 0·08 | 2·09 | 27·94[b] | 1·37 | 3·92[c] | 4·06[d] | 3·47 | 2·04 | 0·62 | 0·05 | 2·61 | 0·16 | 0·06 | 3·19 |

[MnO,$Li_2O$,F *tr.* = 100·48

[a] With $Ta_2O_5$ about 2 p. c. [b] With $Y_2O_3$ about 1 p. c. [c] $Di_2O_3$ *tr.* [d] $Ce_2O_3$ *tr.*

Taking together the acid oxides of niobium, tantalum, tungsten, tin, and zirconium as $Nb_2O_5$, and reducing all the basic elements to the form RO, and neglecting the water, the ratio RO : $Nb_2O_5$ = 221 : 100 is obtained, which corresponds to the formula: $R_3Nb_2O_8 + 4R_2Nb_2O_7$. Mallet prefers to include the water, making the hydrogen basic, and deduces on this supposition the formula: $R_3Nb_2O_8$. This view is supported by the fact that in form sipylite is very near fergusonite.

**Pyr.**—B.B. decrepitates, and glows brilliantly, becomes pale greenish yellow and opaque; infusible. In the closed tube gives off acid water. With borax in O.F. gives a yellow bead, pale on cooling; in R.F. assumes a greener tint. Boiled in strong HCl partially dissolves, the solution reacting for zirconium with turmeric paper; when metallic tin is added and the solution diluted, a sapphire-blue color is obtained (niobium). Decomposed completely, though slowly, in boiling concentrated sulphuric acid.

**Obs.**—Occurs sparingly, embedded in, or more commonly adherent to, masses of allanite and magnetite, at the northwest slope of Little Friar Mountain, Amherst Co., Virginia. Named from *Sipylus*, one of the children of Niobe, in allusion to the names niobium and tantalum.

Delafontaine (C. R., **87**, 933, 1878) states that sipylite contains yttrium, erbium (in small quantities), philippium (see samarskite), and also the ytterbium of Marignac (see gadolinite, p. 510).

ADELPHOLITE. Adelfolit *N. Nordenskiöld*, Beskrifn. Finl. Min., 1855, Jb. Min., 313, 1858; *A. E. Nd.*, Öfv. Ak. Stockh., **20**, 452, 1863, Pogg., **122**, 615, 1864.

Tetragonal. Angles undetermined. H. = 3·5–4·5. G. = 3·8. Luster greasy. Color brownish yellow to brown and black. Streak white or yellowish white. Subtranslucent. A niobate of iron and manganese, containing 41·8 p. c. of metallic acids, and 9·7 p. c. of water. From Laurinmäki, in Tammela, Finland, with columbite.

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## 3. Columbite Group. Orthorhombic.

### 525, 526. COLUMBITE—TANTALITE.

**525. Columbite.** Ore of Columbium (fr. Conn.) *Hatchett*, Phil. Tr., 1802. Columbite *Jameson*, Min., 2, 582, 1805. Columbate of Iron. Columbeisen *Germ.* Baierine (fr. Bavaria) *Beud.*, Tr., 2, 655, 1832. Torrelite *Thom.*, Rec. Gen. Sc., 4, 408, 1836. Niobite *Haid.*, Handb., 549, 1845. Greenlandite *Breith.*, B. H. Ztg., **17**, 61, 1858. Dianite *Kbl.*, Ber. Ak. München, Mar. 10. 1860.

Mangantantalite *A. E. Nordenskiöld*, G. För. Förh., **3**, 284, 1877. Manganotantalite *A. Arzruni*, Vh. Min. Ges., **23**, 181, 1887.

**526. Tantalite.** Tantalit *Ekeberg*, Ak. H. Stockh., **23**, 80, 1802. Ferrotantalite *Thom.*, Rec. Gen. Sc., **4**, 416, 1836. Siderotantal *Hausm.*, Handb., **2**, 960, 1847. Ildefonsit *Haid.*, Handb. 548, 1845; = Harttantalerz *Breith.*, Char., 230, 1832, Handb., 874, 1847. See also below.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·82850 : 1 : 0·88976$ E. S. Dana[1].

100 ∧ 110 = 39° 38$\frac{1}{2}$′, 001 ∧ 101 = 47° 2$\frac{1}{2}$′, 001 ∧ 011 = 41° 39$\frac{2}{3}$′.

**Forms**[2]:
$a$ (100, $i$-$\bar{i}$)
$b$ (010, $i$-$\breve{i}$)
$c$ (001, $O$)
$d$ (730, $i$ $\frac{7}{3}$)[9]
$y$ (210, $i$-$\bar{2}$)

$z$ (530, $i$-$\frac{5}{3}$)[2,8]
$m$ (110, $I$)
$g$ (130, $i$-$\breve{3}$)
$l$ (106, $\frac{1}{6}$-$\bar{i}$)[4]
$k$ (103, $\frac{1}{3}$-$\bar{i}$)

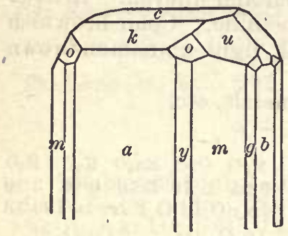
$f$ (102, $\frac{1}{2}$-$\bar{i}$)[5]
$h$ (203, $\frac{2}{3}$-$\bar{i}$)[4]
$q$ (023, $\frac{2}{3}$-$\breve{i}$) tw. pl.
$i$ (011, 1-$\breve{i}$)[5]
$e$ (021, 2-$\breve{i}$)

$\alpha$ (113, $\frac{1}{3}$)[7]
$o$ (111, 1)
$\sigma$ (213, $\frac{2}{3}$-$\bar{2}$)[7]
$x$ (211, 2-$\bar{2}$)[7]
$\beta$ (233, 1-$\frac{3}{2}$)[5]
$t$ (463, 2 $\frac{3}{2}$)[5]

$\pi$ (121, 2-$\breve{2}$)[5]
$u$ (133, 1-$\breve{3}$)
$s$ (263, 2-$\breve{3}$)[5]
$r$ (391, 9-$\breve{3}$)[5]
$n$ (163, 2-$\breve{6}$)
$\phi$ (1·12·3, 4-$\breve{12}$)[7]

The form of columbite bears a rather close relation to that of wolframite (p. 982) as early pointed out by Rose.

1.



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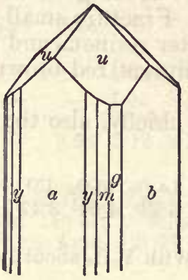

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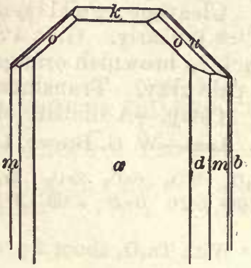

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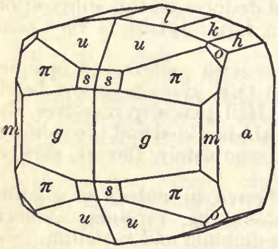

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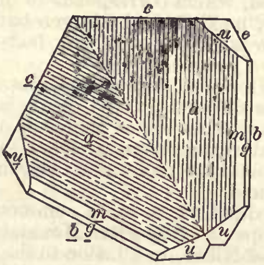

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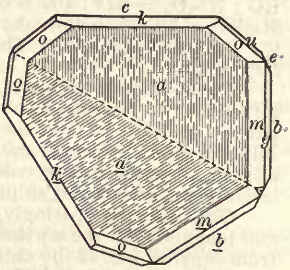
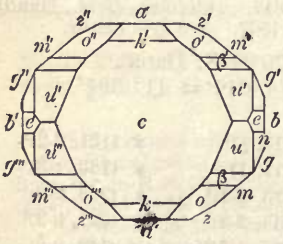


Fig. 1, Middletown. 2, Haddam. 3, Black Hills, Pfd. 4, Greenland, after Schrauf ($b$ (010) in front). 5, Standish, Bodenmais. 6, Standish, Me.

| | | | |
|---|---|---|---|
| $dd'''$ = 39° 6′ | $c\alpha$ = 24° 56′ | $oo'$ = 77° 29′ | $\sigma\sigma'''$ = 27° 7′ |
| $yy'''$ = 45° 0′ | $co$ = 54° 21½′ | $nn'$ = 19° 54′ | $\beta\beta'''$ = 71° 46′ |
| $zz'''$ = 52° 52′ | $c\sigma$ = 37° 46½′ | $ss'$ = 38° 39′ | $ss'''$ = 110° 42′ |
| $mm'''$ = 79° 17′ | $cx$ = 66° 43½′ | $tt'$ = 70° 6′ | $xx'''$ = 41° 10′ |
| $gg'''$ = *136° 10′ | $c\pi$ = 64° 18′ | $\pi\pi'$ = 55° 30′ | $ao$ = 51° 15½′ |
| $gg'$ = 43° 50′ | $cu$ = 43° 48′ | $oo''$ = *108° 43′ | $a\beta$ = 61° 51½′ |
| $ll'$ = 20° 18′ | $cs$ = 62° 28′ | $uu''$ = 87° 36′ | $au$ = 75° 2′ |
| $kk'$ = 39° 23½′ | $cn$ = 61° 9′ | $\alpha\alpha'''$ = 31° 12′ | $a\pi$ = 62° 15′ |
| $ff'$ = 56° 28′ | $\alpha\alpha'$ = 37° 53′ | $uu'''$ = 79° 54′ | $as$ = 70° 40′ |
| $hh'$ = 71° 12′ | $\sigma\sigma'$ = 68° 56′ | $nn'''$ = 118° 20′ | $bo$ = 58° 46′ |
| $qq'$ = 61° 21′ | $uu'$ = 29° 57′ | $oo'''$ = 62° 27½′ | $bn$ = 30° 50′ |
| $ii'$ = 83° 19′ | $\beta\beta'$ = 56° 17′ | $\pi\pi'''$ = 100° 59′ | $bu$ = 50° 3′ |
| $ee'$ = 121° 20′ | | | |

Twins[3]: tw. pl. $e$ common, usually contact-twins, heart-shaped and showing a delicate feather-like striation on $a$ (f. 5), here $c\underline{c}$ = 58° 40′ and $b\underline{b}$ = 121° 20′; also penetration-twins. Further tw. pl. $q$ (0$\bar{2}$3) rare (f. 6), here $c\underline{c}$ = 118° 39′, $b\underline{b}$ = 61° 21′. Crystals short prismatic, often rectangular prisms with the pinacoids, $abc$, prominent; also thin tabular ∥ $a$; the pyramids often but slightly developed, sometimes, however, acutely terminated by $u$ (133) alone (f. 2). Also in large groups of parallel crystals, and massive.

7.



Standish, Me.

Cleavage: $a$ rather distinct; $b$ less so. Fracture subconchoidal to uneven. Brittle. H. = 6. G. = 5·3–7·3, varying with the composition (see below). Luster submetallic, often very brilliant, sub-resinous. Color iron-black, grayish and brownish black, opaque; rarely reddish brown and translucent; frequently iridescent. Streak dark red to black.

**Comp., Var.**—Niobate and tantalate of iron and manganese, $(Fe,Mn)(Nb,Ta)_2O_6$, passing by insensible gradations from normal COLUMBITE, the nearly pure niobate, to normal TANTALITE, the nearly pure tantalate. The iron and manganese also vary widely. Tin and wolfram are present in small amount. The percentage composition for $FeNb_2O_6$ = Niobium pentoxide 82·7, iron protoxide 17·3 = 100; for $FeTa_2O_6$ = Tantalum pentoxide 86·1, iron protoxide 13·9 = 100.

In some varieties, *manganocolumbite* or *manganotantalite*, the iron is largely replaced by manganese. The variety from Branchville, anal. 10, corresponds to $MnNb_2O_6.MnTa_2O_6$; cf. also anal. 33. The manganotantalite of Sanarka (anal. 13) is essentially $MnTa_2O_6$.

The connection between the specific gravity and the percentage of metallic acids is shown in the following table from Marignac, Bibl. Univ., **25**, 25, 1866. See also analyses below.

| | G. | $Ta_2O_5$ | | G. | $Ta_2O$ |
|---|---|---|---|---|---|
| Greenland | 5·36 | 3·3 | Bodenmais | 5·92 | 27·1 |
| Acworth, N. H. | 5·65 | 15·8 | Haddam | 6·05 | 30·4 |
| Limoges | 5·70 | 13·8 | Bodenmais | 6·06 | 35·4 |
| Bodenmais (*Dianite*) | 5·74 | 13·4 | Haddam | 6·13 | 31·5 |
| Haddam | 5·85 | 10·0 | | | |
| | | | *Tantalite* | 7·03 | 65·6 |

CRYST. COLUMBITE and TANTALITE.

**Anal.**—1, Blomstrand, J. pr. Ch., **99**, 44, 1866. 2, Genth, Proc. Ac. Philad., 51, 1889. 3, O. D. Allen, Dana Min., App. III, 30, 1882. 4, Cossa, Rend. Acc. Linc., **3**, 111, 1887. 5, Janovsky, Ber. Ak. Wien, **80** (1), 34, 1879. 6, T. B. Osborne, Am. J. Sc., **30**, 336, 1885. 7–9, Blomstrand, l. c. 10, Comstock. Am. J. Sc., **19**, 131, 1880. 11, Dunnington, Am. Ch. J., **4**, 138, 1882. 12, Comstock, l. c. 13, Blomstrand, Vh. Min. Ges., **23**, 188, 1887.

| | G. | $Nb_2O_5$ | $Ta_2O_5$ | $SnO_2$ | $WO_3$ | FeO | MnO | CaO | MgO | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Greenland | 5·395 | 77·97 | — | 0·73 | 0·13 | 17·33 | 3·28 | — | 0·23 | PbO 0·12, $ZrO_2$ 0·13 = 99·92 |
| 2. Mineral Hill, Pa. | 5·26 | 76·26 | 0·83 | 0·16 | *tr.?* | 7·65 | 11·29 | 0·66 | 0·07 | $UO_3$ 0·18, $Y_2O_3$ 1·78, $Ce_2O_3$ 0·34, $ZrO_2$ 0·67, ign. 0·33 = 100·22 |
| 3. Standish, Me. | 5·65 | 68·99 | 9·22 | 1·61 | | 16·80 | 3·65 | — | — | = 100·27 |
| 4. Craveggia | 5·68 | 65·17 | 13·35 | 0·23 | — | 9·84 | 8·98 | 1·17 | *tr.* | = 98·74 |
| 5. Isergebirge | 5·74 | 62·64 | 16·25[a] | 0·41 | 1·01 | 13·06 | 6·11 | — | — | $ZrO_2$ 0·48, $H_2O$ 0·34 = 100·30 |
| 6. Branchville | 5·73 | 60·70 | 19·20 | — | — | 12·91 | 7·03 | — | — | = 99·84 |
| 7. Bodenmais | 5·75 | 56·43 | 22·79 | 0·58 | 1·07 | 15·82 | 2·39 | — | 0·40 | $ZrO_2$ 0·28, $H_2O$ 0·35 = 100·11 |
| 8. Haddam | 6·15 | 51·53 | 28·55 | 0·34 | 0·76 | 13·54 | 4·55 | — | 0·42 | $ZrO_2$ 0·34, $H_2O$ 0·16 = 100·19 |
| 9. Bodenmais | 6·26 | 48·87 | 30·58 | 0·91 | | 15·70 | 2·95 | — | 0·14 | $H_2O$ 0·40 = 99·55 |
| 10. Branchville | 6·59 | 30·16 | 52·29 | — | — | 0·43 | 15·58 | 0·37 | — | = 98·83 |
| 11. Amelia Co., Va. | 6·48 | 31·40 | 53·41 | *tr.* | — | 5·07 | 8·05 | 1·27 | 0·20 | $Y_2O_3$? 0·82 = 100·22 |
| 12. Northfield | 6·84 | 26·81 | 56·90 | — | — | 10·05 | 5·88 | — | — | = 99·64 |
| 13. Sanarka *Manganotantalite* | 7·301 | 4·47 | 79·81 | 0·67 | | 1·17 | 13·88 | 0·17 | — | ign. 0·16 = 100·33 |

[a] Other determinations gave: $Nb_2O_5$ 62·25, 61·98, 62·03; $Ta_2O_5$ 16·31, 17·12, 16·55, respectively.

The following are analyses by W. P. Headden (Am. J. Sc., **41**, 89, 1891) chiefly of columbite from the Black Hills, S. Dakota. Anals. 14–21 are all from the Etta mine, and show well the variation in the metallic acids, even in specimens from a single locality (also shown in specimens from Haddam and Bodenmais); further the accompanying variation in specific gravity.

| | | G. | $Nb_2O_5$ | $Ta_2O_5$ | $SnO_2$ | FeO | MnO | |
|---|---|---|---|---|---|---|---|---|
| 14. Etta Mine, | Black Hills | 5·890 | 54·09 | 18·20 | 0·10 | 11·21 | 7·07 | CaO 0·21 = 100·88 |
| 15. “ | “ | 6·181 | 47·05 | 34·04 | 0·30 | 11·15 | 7·80 | = 100·34 |
| 16. “ | “ | 6·245 | 46·59 | 35·14 | 0·18 | 7·44 | 10·94 | = 100·29 |
| 17. “ | “ | 6·376 | 40·37 | 41·14 | 0·13 | 8·28 | 9·09 | CaO 0·78, MgO 0·10 = 99·89 |
| 18. “ | “ | 6·515 | 39·94 | 42·96 | *tr.* | 8·59 | 8·82 | = 100·31 |
| 19. “ | “ | 6·612 | 35·11 | 47·11 | 0·35 | 8·37 | 9·26 | = 100·20 |
| 20. “ | “ | 6·707 | 31·31 | 52·49 | 0·09 | 6·10 | 10·71 | = 100·70 |
| 21. “ | “ | 6·750 | 29·78 | 53·28 | 0·13 | 6·11 | 10·40 | = 99·70 |

| | G. | $Nb_2O_5$ | $Ta_2O_5$ | $SnO_2$ | FeO | MnO | |
|---|---|---|---|---|---|---|---|
| 22. Peerless M., Black Hills, | 6·373 | 37·29 | 44·87 | 0·09 | 6·87 | 11·02 | = 100·14 |
| 23. " " | 6·445 | 40·28 | 42·09 | 0·19 | 6·70 | 11·23 | = 100·49 |
| 24. Bob Ingersoll M., " | 5·901 | 57·32 | 23·43 | 0·09 | 6·29 | 13·55 | = 100·68 |
| 25. Sarah M., " | 5·804 | 61·72 | 18·93 | 0·25 | 11·21 | 8·67 | = 100·79 |
| 26. " | 6·565 | 40·07 | 42·92 | 0·20 | 9·73 | 7·24 | = 100·16 |
| 27. Mallory Gulch " | 6·232 | 41·69 | 40·19 | 0·11 | 9·88 | 8·70 | = 100·57 |
| 28. " " " | 6·469 | 37·28 | 44·48 | 0·16 | 9·29 | 8·68 | = 99·89 |
| 29. Yolo M., Nigger Hill Distr. | 6·592 | 24·40 | 57·60 | 0·41 | 14·46 | 2·55 | CaO 0·73 = 100·15[b] |
| 30. Turkey Creek, Col. | 5·383 | 73·45 | 2·74 | 1·35[a] | 11·32 | 9·70 | CaO 0·61 = 99·17 |
| 31. Haddam, Conn. | 5·780 | 60·52 | 19·71 | 0·09 | 12·64 | 7·51 | = 100·47 |
| 32. Mitchell Co., N. C. | — | 70·98 | 9·27 | 0·17 | 12·21 | 7·30 | CaO 0·80 = 100·73 |
| 33. Elk Creek, S. D. | 6·170 | 47·22 | 34·27 | 0·32 | 1·89 | 16·25 | = 99·95 |

[a] Incl. 1·14 $WO_3$. [b] 4·46 of admixed $SnO_2$ deducted.

For other earlier analyses, see 5th Ed.. p. 517; also (incomplete as regards separation of metallic acids) Colorado, G. = 5·15, and Yancey Co., N. C., G. = 5·6, Smith, Am. J. Sc., **13**, 359, 1877; San Roque, Argentine Rep., G. = 5·625, Siewert, Min. Mitth., 224, 1873; Middletown, G. = 6·14, Hallock, Am. J. Sc., **21**, 412, 1881; Turkey Creek, Jefferson Co., Colorado, G. = 5·48, MnO 11·23, Proc. Col. Sc. Soc., **2**, 31, 1886.

Nordenskiöld (l. c.) obtained for the mangantalite from Utö: G. = 6·3, $Nb_2O_5,Ta_2O_5$ 85·5, FeO 3·6, MnO 9·5, CaO 1·2 = 99·8.

MASSIVE TANTALITE.

The following are analyses of tantalite, chiefly massive, in part belonging with normal columbite-tantalite above, in part with skogbölite (and ixiolite) below. The analyses of the crystallized skogbölite and ixiolite are also included.

**Anal.**—1, 2, Rg., Ber. Ak. Berlin, 164, 1871. 3, Comstock, Am. J. Sc., **19**, 131, 1880. 4, Mgc., Bibl. Univ., **25**, 26, 1866. 5, 6, Rg., l. c. 7, A. Nd., Pogg., **101**, 629, 1857. 8–10, W. P. Headden, Am. J. Sc., **41**, 98, 1891; also earlier Schaeffer, ibid., **28**, 430, 1884. 11, 12, Rg., l. c.

| | G. | $Nb_2O_5$ | $Ta_2O_5$ | $SnO_2$ | FeO | MnO | |
|---|---|---|---|---|---|---|---|
| 1. Broddbo? | 6·082 | 40·21 | 42·15 | 0·18 | 16·00 | 1·07[a] | = 99·61 |
| 2. Broddbo | 6·311 | 29·27 | 49·64 | 2·49[b] | 13·77 | 2·88 | ign. 0·75 = 98·80 |
| 3. Yancey Co., N. C. | 6·88 | $\frac{2}{2}$ 23·63 | 59·92 | — | 12·86 | 3·06 | MgO 0·34 = 99·81 |
| 4. Broddbo | 7·03 | 10·88 | 65·60 | 6·10 | 8·95 | 6·61 | = 98·14 |
| 5. Rosendal, Kimito | 7·277 | 13·14 | 70·53 | 0·82 | 14·30 | 1·20 | = 99·99 |
| 6. Härkäsaari, Tammela | 7·384 | 7·54 | 76·34 | 0·70 | 13·90 | 1·42 | = 99·90 |
| 7. Skogböle, *Skogbölite* | 7·85 | — | 84·44 | 1·26 | 13·41 | 0·96 | CuO 0·14, CaO 0·15 = [100·36 |
| 8. Grizzly-Bear Gulch, S. D. | 7·773 | 6·23 | 78·20 | 0·68 | 14·00 | 0·81 | = 99·92 |
| 9. " " " | 8·200 | 3·57 | 82·23 | 0·32 | 12·67 | 1·33 | = 100·12 |
| 10. Coosa Co., Ala. | | 8·78 | 71·37 | 5·38 | 8·44 | 5·37 | = 99·34[c] |
| 11. Skogböle, *Ixiolite* | 7·232 | 19·24 | 63·58 | 1·70 | 9·19 | 5·97 | ign. 0·23 = 99·91 |
| 12. " | 7·272 | 12·26[d] | 69·97 | 2·94 | 14·83 | | = 100 |

[a] Incl. CaO. [b] With trace $WO_3$. [c] Ign. 0·20 deducted. [d] Incl. 1 p. c. $TiO_2$.

**Pyr., etc.**—For *tantalite* B.B. unaltered. With borax slowly dissolved, yielding an iron glass, which, at a certain point of saturation, gives, when treated in R.F. and subsequently flamed, a grayish white bead; if completely saturated becomes of itself cloudy on cooling. With salt of phosphorus dissolves slowly, giving an iron glass, which in R.F., if free from tungsten, is pale yellow on cooling; treated with tin on charcoal it becomes green. If tungsten is present the bead is dark red, and is unchanged in color when treated with tin on charcoal. With soda and niter gives a greenish blue manganese reaction. On charcoal, with soda and sufficient borax to dissolve the oxide of iron, gives in R.F. metallic tin. Decomposed on fusion with potassium bisulphate in the platinum spoon, and gives on treatment with dilute hydrochloric acid a yellow solution and a heavy white powder, which, on addition of metallic zinc, assumes a smalt-blue color; on dilution with water the blue color soon disappears (Kbl.).

For *columbite* nearly as with tantalite. Von Kobell states that when decomposed by fusion with caustic potash, and treated with hydrochloric and sulphuric acids, it gives, on the addition of zinc, a blue color much more lasting than with tantalite; and the variety dianite, when similarly treated, gives, on boiling with tin-foil, and dilution with its volume of water, a sapphire-blue fluid, while, with tantalite and ordinary columbite, the metallic acid remains undissolved. The variety from Haddam, Ct., is partially decomposed when the powdered mineral is evaporated to dryness with concentrated sulphuric acid, its color is changed to white, light gray, or yellow, and when boiled with hydrochloric acid and metallic zinc it gives a beautiful blue. The remarkably pure and unaltered columbite from Arksut-fiord in Greenland is also partially decomposed by sulphuric acid, and the product gives the reaction test with zinc, as above.

**Obs.**—Occurs at Rabenstein, near Zwiesel, and Bodenmais, Bavaria, in granite, with iolite and magnetite; at Tirschenreuth, Bavaria; at Craveggia, Italy; at Tammela, in Finland; at Chanteloube, near Limoges, in pegmatyte with tantalite; near Miask, in the Ilmen Mts., with samarskite; in the gold-washings of the Sanarka region in the Ural; at Hermanskär, near Björskär, in Finland; in Greenland, in cryolite, at Ivigtut (or Evigtok), in brilliant crystals; disseminated through or among the wolframite of Auvergne, and detected by acting with aqua-regia, which dissolves the wolframite and leaves untouched the columbite (Phipson, Ch. News, 160, 1867); at Montevideo, S. A.; San Roque, Argentine Republic.

In the United States, in *Maine*, at Standish, in splendent crystals in granite; also at Stoneham with cassiterite, etc. In *N. Hampshire*, at Plymouth, with beryl; at Acworth, at the mica mine. In *Mass.*, at Chesterfield, some fine crystals, associated with blue and green tourmaline and beryl, in a vein of albitic granite; also Beverly; Northfield, Mass. (anal. 12), with beryl. In *Connecticut*, at Haddam, 2 m. from the village, in a granite vein, some of the crystals several pounds in weight; also at the chrysoberyl locality, but not now accessible; also at the iolite locality, Haddam; near Middletown, in a feldspar vein in fine crystals, some very large; at Branchville, Fairfield Co., in a vein of albitic granite, in large crystals and aggregates of crystals, sometimes weighing many pounds, also in minute thin tabular crystals translucent (*manganocolumbite*, anal. 10) implanted upon spodumene; also at other points in the neighborhood of Branchville in granite veins. In *N. York*, at Greenfield, with chrysoberyl. In *Penn.*, Mineral Hill, Delaware Co. In *Virginia*, Amelia Co., in fine splendent crystals with microlite, monazite (p. 728), etc. In *N. Carolina*, with samarskite crystals in parallel position at the Wiseman's mica mines of Mitchell Co.; also at the Deake mine and other points; Ray's mine in Yancey Co.; Balsam Gap in Buncombe Co.; near Franklin, Macon Co.; White Plains, Alexander Co. In *Colorado*, on microcline at the Pike's Peak region; Turkey Creek, Jefferson Co. (11·23 MnO). In *S. Dakota*, in the Black Hills region, common in the granite veins associated with cassiterite, beryl, etc.; the crystals and crystalline groups are often large, one mass is estimated to have weighed 2000 lbs.; most abundant at the Etta and Bob Ingersoll mines; also at other points in Pennington Co; also in Nigger Hill distr., in Lawrence Co., sometimes associated with stream tin. Cf. Headden, l. c., also W. P. Blake, Am. J. Sc., **28**, 340, 1884, **41**, 403, 1891 (figures and measurements, Pfd.). In *California*, King's Creek distr., Fresno Co.

*Mangantantalite* of Nordenskiöld is from Utö, Sweden, where it occurs with petalite, lepidolite, microlite, etc. *Manganotantalite* of Arzruni is from the gold-washings in the Sanarka region in the Ural.

Massive tantalite occurs in Yancey Co., N. C.; Coosa Co., Ala.; also in the Black Hills, S. Dakota.

Also occurs in Finland, in Tammela, at Härkäsaari near Torro, associated with gigantolite and rose quartz; in Kimito, at Skogböle, in Somero at Kaidasuo, and in Kuortane at Katiala, with lepidolite, tourmaline, and beryl; in Sweden, near Falun, at Broddbo and Finbo; in France, at Chanteloube near Limoges, in pegmatyte. *Ildefonsite* is from Ildefonso, Spain, and has G. = 7·416, H. = 6–7.

The occurrence of columbite in America was first made known by Mr. Hatchett's examination of a specimen sent by Governor Winthrop to Sir Hans Sloane, then President of the Royal Society, which was labeled as found at Neatneague (better Naumeag). Dr. S. L. Mitchill stated (Med. Repos., vol. 8) that it was taken at a spring at New London, Conn. No locality has since been detected at that place. But the rediscovery of it at Haddam, first published by Dr. Torrey (Am. J. Sc., **4**, 52, 1822), and since near Middletown, about 7 m. distant, has led to the belief that the original locality was at one of these places, which are about 30 m. N.W. of New London. Mr. J. Hammond Trumbull in a letter to Prof. Brush (July 16, 1882) discussing this subject, remarks: "The name of Namueg or Naumeag, originally given to the plantation at New London, may have been extended—as were the bounds of the plantation—east of the Thames, to the Mystic, including what is now Groton. I conjectured that the columbite was found near Winthrop's mill a short distance above the head of Mystic, and there used to be a local tradition to that effect; though it had no definite value."

The metal of columbite was named columbium by Hatchett in 1802, from Columbia, a name of America, whence his specimen was received, and thus came the name *columbite* given by Jameson and Thomson (see further below). Rose, after investigating the metal and its compounds, named it anew, calling it *niobium*, and this gave rise to the name *niobite*. *Baierite* is from the German name of Bavaria. *Torrelite* Thomson, named after Dr. J. Torrey, is the ordinary Middletown columbite; and *Greenlandite* Breith. is that from Greenland; both names originated partly in erroneous views of the crystals of the minerals. *Dianite* is the Bodenmais columbite, in which v. Kobell supposed he had discovered the acid of a new metal, which he called *dianium*.

No good reason has been given for substituting *niobium* for *columbium*, and it is contrary to the scientific law of priority; but as it is now accepted by most chemists the common usage is here followed.

Tantalite was named by Ekeberg, from the mythic Tantalus, in playful allusion to the difficulties (tantalizing) he encountered in his attempts to make a solution of the Finland mineral in acids. The name was afterward extended to the American mineral *columbite*, and to the same from other localities; while the name columbite, the metal columbium having been discovered a little prior to tantalum, received a similar extension, so as to include all tantalite.

The subsequent discovery that tantalum and columbium were distinct elements finally established them as independent species.

**Ref.**—[1] On splendent crystals from Standish, Me., Zs. Kr., **12**, 266, 1886; these results differ but little from those of J. D. D. (1837) on the Haddam mineral. The form seems to vary but little with change of composition. Analyses 1–13 (also most and probably all of 14–33) belong to minerals having the *columbite habit and angles;* even the crystals of *manganotantalite* of Arzruni (anal. 13, a manganese tantalate) show the planes *a*, *b*, *c*, *l*, *k*, *u*, *n*, and affords nearly the same ratio (below, from $ck = {}^*19° 19'$, $bu = {}^*50° 30\frac{1}{2}'$). It is plain, therefore, that skogbölite and ixiolite cannot be included in this series; their relation to normal columbite-tantalite needs further investigation (cf. below, p. 737).

The following axial ratios are interesting for comparison, although it is to be noted that the crystals seldom allow of accurate measurements. The axes of Schrauf, ref. [7] below, are based upon angles (only approximate) from crystals of different localities and are hence of no value for comparison. Schrauf made $u = 111$, $g = 110$, etc., see list, p. 737. Cf. also Kk., Min. Russl., **10**, 261, 1891.

| | G. | $Ta_2O_5$ | $\breve{a} : \bar{b} : \acute{c}$ | |
|---|---|---|---|---|
| Greenland | 5·39 | — | 0·8292 : 1 : 0·8776 | Dx. |
| Ilmen Mts. | 5·57 | ? | 0·8302 : 1 : 0·8822 | Kk. |
| Standish | 5·65 | 9·2 | 0·8285 : 1 : 0·8898 | E. S. D. |
| Haddam | 5·95 | 29? | 0·8292 : 1 : 0·8778 | J. D. D. |
| Sanarka | 7·3 | 79·8 | 0·8304 : 1 : 0·8732 | Arz. |

[2] J. D. D., Am. J. Sc., **32**, 149, 1837, and Min., p. 370, 1837, and App., p. 65; in Min., p. 354, 1854, the forms, 530, 740, 035, are added as doubtful.

[3] Rose, twins, Bodenmais, Pogg., **64**, 171, 1845. [4] Mlr., Min., p. 471, 1852. [5] Dx., Greenland, Ann. Mines, 8, 398, 1855. [7] Schrauf, Greenland, Ber. Ak. Wien, **44** (1), 445, 1861. [8] Maskelyne, Montevideo, Phil. Mag., **25**, 41, 1863. [9] Penfield, quoted by W. P. Blake, Am. J. Sc., **41**, 403, 1891.

**526A. Skogbölite.** *A. E. Nordenskiöld*, Beskr. Finl. Min., 30, 1855. Tantalit mit zimmtbraunem Pulver, *Berzelius*. Tammela-tantalit *N. Nordenskiöld*, Act. Soc. Fenn., **1**, 119, read April 25, 1832, Pogg., **50**, 656, 1840.

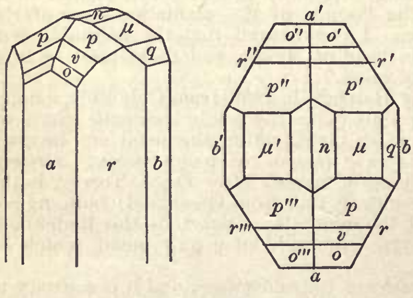
Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·81696 : 1 : 0·65106$.
$100 \wedge 110 = 39° 14\frac{5}{6}'$, $001 \wedge 101 = 38° 33\frac{1}{6}'$, $001 \wedge 011 = 33° 4'$, N. Nordenskiöld.

**Forms:** *a* (100, *i*-$\bar{i}$), *b* (010, *i*-$\breve{i}$), *r* (490, *i*-$\frac{9}{4}$), *n* (016, $\frac{1}{6}$-$\breve{i}$), *μ* (011, 1-$\breve{i}$), *q* (031, 3-$\breve{i}$), *p* (111, 1), *v* (322, $\frac{3}{2}$-$\frac{\bar{3}}{2}$), *o* (211, 2-$\bar{2}$). Also *x* (131, 3-$\breve{3}$)?

Angles: $rr' = 57° 6'$, $nn' = 12° 23'$, $\mu\mu' = 66° 8'$, $qq' = 125° 47'$, $pp' = {}^*67° 28\frac{1}{2}'$, $pp'' = 91° 38\frac{1}{2}$, $pp''' = {}^*53° 58'$, $vv' = 90° 6'$, $oo' = 106° 21\frac{1}{2}'$.

Measured: $pp'' = 91° 45'$, $rr' = 57° 3$, $bq = 29\frac{1}{2}°$ (27° 7′ calc.), $nn' = 12°$, $vv' = 90°$, $oo' = 110°$.

1. 2.



Figs. 1, 3, *Skogbölite*, N. Nd.

In prismatic crystals (f. 1) the angle of the prism near that of yttrotantalite and samarskite.

Cleavage indistinct. Fracture uneven. H. = 6·0–6·5. G. = 7·8–8·0. Luster metallic. Color black. Opaque. Streak blackish brown to cinnamon-brown.

**Comp.**—Essentially $FeTa_2O_6$, a nearly pure iron tantalate. Cf. anal. 7, p. 734.

**Obs.**—From Härkäsaari in Tammela, Finland, associated with rose quartz and gigantolite, in albitic granite. Also with ixiolite at Skogböle in Kimito. This is the mineral ordinarily called tantalite, and regarded as isomorphous with columbite (Rose, Rg. et al.), but in fact as shown by the author having quite a different though related form. Cf. ref. [1].

A mineral from Pisek, Bohemia, referred to tantalite by Vrba (Zs. Kr., **15**, 201, 1889), is later stated to be only rutile, cf. Gdt., Index, **3**, 185, 1891.

**Ixiolite** *A. E. Nordenskiöld*, Pogg., **101**, 632, 1857. Kimito-tantalit *N. Nordenskiöld.* Ixionolit *F. J. Wiik.* Kassiterotantal *Hausm.* Cassitero-tantalite.

Orthorhombic. Axes $\acute{a} : \bar{b} : \acute{c} = 0·5508 . 1 . 1 2460$ A. E. Nordenskiöld.
$100 \wedge 110 = 28° 50\frac{3}{4}'$, $001 \wedge 101 = 66° 9\frac{1}{4}'$, $001 \wedge 011 = {}^*51° 15'$.

**Forms:** *a* (100, *i*-$\bar{i}$), *b* (010, *i*-$\breve{i}$), *c* (001, *O*); *m* (110, *I*), *s* (103, $\frac{1}{3}$-$\bar{i}$)? tw. pl.; *n* (011, 1-$\breve{i}$), *t* (031, 3-$\breve{i}$), *p* (111, 1). Angles: *mm‴* = 57° 41½′, *cs* = 37° 1′, *nn′* = 102° 30′, *tt′* = 150° 3′, *cp* = *68° 50′, *pp′* = 109° 32′, *pp‴* = 53° 28′.

Crystals rectangular prisms (*a b c*), sometimes twins with *s* (103) as tw. pl. Fracture uneven to subconchoidal. Brittle. H. = 6–6·5. G. = 7·0–7·1. Luster submetallic. Color blackish gray to steel-gray. Powder brown.

In composition a niobo-tantalate of iron and manganese, containing also a small amount of tin (anal. 11, p. 734). An analysis by Nordenskiöld gave 13 p. c. tin dioxide, but this is not confirmed by Rg. (Min. Ch., 357, 1875).

From Skogböle in Kimito, Finland. Named from *Ixion*, a mythological person related to Tantalus.

*Relation of Skogbölite and Ixiolite to Columbite-tantalite.* That there is a certain relation between the forms of columbite and the above two kinds of tantalite has been shown by various authors; it is exhibited in the following axial ratios starting from the axes of each given above:

| | | | |
|---|---|---|---|
| Columbite | | $\breve{a} : \bar{b} : \acute{c}$ | = 0·8285 : 1 : 0·8898 |
| Skogbölite | 1. | $a : b : \frac{4}{3}c$ | = 0·8170 : 1 : 0·8681 |
| | or | | |
| | 2. | $\frac{2}{3}b : a : c$ | = 0·8160 : 1 : 0·7969 |
| Ixiolite | 1. | $\frac{4}{9}b : a : \frac{1}{3}c$ | = 0·8069 : 1 : 0·7541 |
| | or | | |
| | 2. | $\frac{3}{2}a : b : \frac{2}{3}c$ | = 0·8262 : 1 : 0·8307 |

In 1 under both skogbölite and ixiolite the occurring prism (like samarskite in angle) has the symbol (490), in 2 the symbol (320) of columbite—the symbols of the other planes are in general less simple, and the value of this comparison is doubtful.

Groth proposes to retain Schrauf's position for columbite, while doubling the *ă* and *ć* axes, giving for columbite (Standish) and tantalite-skogbölite:

| | | |
|---|---|---|
| Columbite | $\breve{a} : \bar{b} : \acute{c}$ | = 0·8047 : 1 : 0·7159 |
| Tantalite-skogbölite | $\breve{a} : \bar{b} : \acute{c}$ | = 0·8170 : 1 : 0·6511 |

The similarity, however, is more apparent than real, for nearly all the prominent planes of each species are wanting on the other, and the habit is very different—moreover, true tantalite corresponds exactly with columbite in both habit and angle.

The following table shows the planes of tantalite-skogbölite common to columbite with the symbols in the positions of Dana, Schrauf and Groth; also the prominent planes of each species (those in parentheses not having been observed).

| | Dana. | Columbite Schrauf. | Groth. | | Tantalite-skogbölite N. Nd. |
|---|---|---|---|---|---|
| *a* | 100 | 010 | 010 | *b* | 010 |
| *b* | 010 | 100 | 100 | *a* | 100 |
| *h* | 203 | 021 | 011 | *μ* | 011 |
| *σ* | 213 | 163 | 133 | | |
| *β* | 233 | 121 | 111 | *p* | 111 |
| *s* | 263 | 221 | 211 | *o* | 211 |
| Also | | | | | |
| *m* | 110 | 130 | 230 | | (230) |
| *g* | 130 | 110 | 120 | | (120) |
| *k* | 103 | 011 | 012 | | (012) |
| *o* | 111 | 131 | 232 | | (232) |
| *u* | 133 | 111 | 212 | | (212) |
| *π* | 121 | 231 | 432 | | (432) |
| Also | | | | | |
| | (320) | (290) | (490) | *r* | 490 |
| | (109) | (013) | (016) | *n* | 016 |
| | (201) | (061) | (031) | *q* | 031 |
| | (496) | (342) | (322) | *v* | 322 |

**Mengite.** Ilmenite *Brooke*, Phil. Mag., **10**, 187, 1831. Mengit *G. Rose*, Reis. Ural, **2**, 83, 1842.

Occurs in short prisms terminated by a pyramid. The angles are nearly those of columbite and Des Cloizeaux states (priv. contr.) that there can be no doubt that it is really that species. The planes are then *a*, *m*, *g*, *u*; angles *gg′* = 43° 40′, *uu′* = 78° 50′, *uu‴* = 29° 28′ Brooke

G. = 5·43. Color black. Occurs in small crystals embedded in the albite of the granite veins in the Ilmen mountains. Named *mengite*, after Menge, the discoverer of the mineral. The mengite of Brooke is monazite.

HERMANNOLITE *C. U. Shepard*, Am. J. Sc., **50**, 90, 1870; **11**, 140, 1°76. A mineral from Haddam, Conn., probably identical with columbite. Cf. Hermann, who found in it "hypotantalic acid," hypoilmenic acid, etc., J. pr. Ch., **13**, 386, 1876; further Delafontaine, Am. J. Sc., **13**, 390, 1877, also Min., 5th Ed., 3d App., p. 30.

FERRO-ILMENITE *Hermann*, J. pr. Ch., **2**, 118, 1870. A kind of columbite from Haddam, Connecticut.

**527. TAPIOLITE.** Tapiolit *A. E. Nordenskiöld*, Öfv. Ak. Stockh., **20**, 445, 1863. Tantalite (fr. Sukula) *Arppe*, Act. Soc. Fenn., **6**, 590, 1861.

Tetragonal. Axis $\dot{c} = 0·6464$; 001 ∧ 101 = 32° 52¾′ Nordenskiöld.

**Forms:** *a* (100, *i-i*); *m* (110, *I*); *e* (101, 1-ĭ); *p* (111, 1), *c* (001, *O*)

Angles: *ee′* = 45° 9′, *pp′* = 56° 59½′ *pp″* = *84° 52′. The form is very near that of rutile, cassiterite, and zircon.

In square octahedrons, often monoclinic in appearance by distortion.

Cleavage not distinct. H. = 6. G. = 7·36 Nd.; 7·496 Rg. Luster strong adamantine, approaching metallic. Color pure black. Opaque.

**Comp.**—A tantalate and niobate of iron, having the same composition as tantalite, $Fe(Ta,Nb)_2O_6$ = (Ta : Nb = 4 : 1), Tantalum pentoxide 73·9, niobium pentoxide 11·1, iron protoxide 15·0 = 100.

**Anal.**—Rg., Ber. Ak. Berlin, 181, 1871. For earlier analyses see 5th Ed., p. 519.

| | $Ta_2O_5$ | $Nb_2O_5$ | $SnO_2$ | FeO | MnO |
|---|---|---|---|---|---|
| G. = 7·496 | 73·91 | 11·22 | 0·48 | 14·47 | 0·81 = 100·89 |

**Pyr.**, etc.—B.B. behaves like tantalite, but gives no reaction for manganese.

**Obs.**—Occurs near the Kulmala farm, in the village of Sukula, in the parish of Tammela, Finland, in white pegmatyte granite, with beryl, tourmaline, and arsenopyrite.

Named from an ancient Finnish divinity.

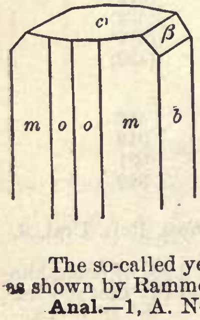
## 4. Samarskite Group. Orthorhombic.

**528. YTTROTANTALITE.** Yttrotantal *Ekeberg*, Ak. H. Stockh., **23**, 80, 1802. Tantale oxidé yttrifère *H.*, Tr., 1822. Yttroilmenit *Herm.*, J. pr. Ch., **38**, 119, 1846. Schwarzer Yttrotantalit.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·54115 : 1 : 1·1330$ A. E. Nordenskiöld[1].
100 ∧ 110 = 28° 25⅙′, 001 ∧ 101 = 64° 28⅙′, 001 ∧ 011 = 48° 34′.

**Forms:** *b* (010, *i*-ĭ), *c* (001, *O*); *o* (210, *i*-2̄), *m* (110, *I*), *p* (120, *i*-2̆), *q* (150, *i*-5̆); *s* (201, 2-ī); *β* (011, 1-ĭ).

Angles: *oo‴* = 30° 17′, *mm‴* = 56° 50′, *pp′* = 85° 28′, *bq* = *20° 17′, *ss′* = 153° 8′, *ββ′* = 97° 8′, *bβ* = *41° 26′.



Crystals prismatic, often six-sided with *m*, *b* prominent; also tabular ∥ *b*.

Cleavage: *b* very indistinct. Fracture small conchoidal. H. = 5–5·5. G. = 5·5–5·9. Luster submetallic to vitreous and greasy. Color black, brown, brownish yellow, straw-yellow. Streak gray to colorless. Opaque to subtranslucent.

**Comp.**—Essentially $\overset{\text{II}}{R}\overset{\text{III}}{R}_2(Ta,Nb)_4O_{15} + 4H_2O$, according to Rammelsberg, with $\overset{\text{II}}{R}$ = Fe,Ca, $\overset{\text{III}}{R}$ = Y,Er,Ce, etc. The water may be secondary.

The so-called yellow yttrotantalite of Ytterby and Kårarfvet belongs to fergusonite (p. 729) as shown by Rammelsberg.

**Anal.**—1, A. Nd., l. c. 2, Rg., Min. Ch., 360, 1875, also Pogg., **150**, 200, 1873.

| | | $Ta_2O_5$ | $Nb_2O_5$ | $WO_3$ | $SnO_2$ | $Y_2O_3$ | $Er_2O_3$ | $Ce_2O_3$ | $UO_2$ | FeO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | [= 100·66 |
| 1. | | 56·56 | | 3·87 | — | 19·56 | — | — | 0·82 | 8·90 | 4·27 | 6·68 |
| 2. | G. = 5·425 | $\frac{2}{3}$ 46·25 | 12·32 | 2·36 | 1·12 | 10·52 | 6·71 | 2·22 | 1·61 | 3·80 | 5·73 | 6·31 |
| | | | | | | | | | | | | [= 98·95 |

**Pyr., etc.**—In the closed tube yields water, turns yellow. On intense ignition both varieties become white. B.B. infusible. With salt of phosphorus dissolves with at first a separation of a white skeleton of tantalic acid, which with a strong heat is also dissolved; gives a glass faintly tinted rose-red from the presence of tungsten. Not decomposed by acids. Decomposed on fusion with potassium bisulphate, and when the product is boiled with hydrochloric acid metallic zinc gives a pale blue color to the solution which soon fades.

**Obs.**—Occurs in Sweden at Ytterby, near Vaxholm, in red feldspar; at Finbo and Broddbo, near Falun, embedded in quartz and albite, associated with garnet, mica, and pyrophysalite.

The name *yttrotantalite* alludes to the composition. *Yttroilmenite* was given to a variety by Hermann upon the discovery in it of his *supposed* new metal ilmenium.

**Ref.**—[1] Öfv. Ak. Stockh., **17**, p. 28, 1860, or Pogg., **111**, 280, 1860.

**529. SAMARSKITE.** Uranotantal *H. Rose*, Pogg., **48**, 555, 1839. Samarskit (Uranniobit), *H. Rose*, Pogg., **71**, 157, 1847. Yttroilmenit *Herm.*, J. pr. Ch., **42**, 129, 1847, **44**, 216, 1848. Eytlandite *Adam*, Tabl. Min., 31, 1869.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·54565 : 1 : 0·51780$ E. S. Dana[1].

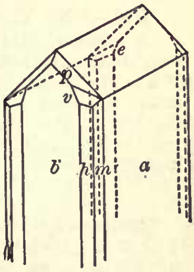
$100 \wedge 110 = 28° \ 37\frac{1}{6}'$, $001 \wedge 101 = 43° \ 30'$, $001 \wedge 011 = 27° \ 22\frac{1}{2}'$.

**Forms:** *a* (100, *i*-$\bar{i}$), *b* (010, *i*-$\breve{i}$); *m* (110, *I*), *h* (120, *i*-$\breve{2}$); *e* (101, 1-$\bar{i}$); *p* (111, 1); *v* (231, 3-$\frac{3}{2}$).

Angles: *mm'''* = 57° 14', *hh'* = *85°, *ee'* = *87°, *pp'* = 80° 14½', *pp''* = 94° 28', *pp'''* = 41° 10', *bp* = 69° 25', *vv'* = 91° 33', *bv* = 54° 5½'.

Crystals rectangular prisms (*a*, *b*), with *e* (101) prominent, also prismatic ‖ $\bar{b}$ by development of *e*, sometimes tabular ‖ *a* or ‖ $\breve{b}$. Faces rough and not allowing of exact measurement. Commonly massive, and in flattened embedded grains.

Cleavage: *b* imperfect. Fracture conchoidal. Brittle. H. = 5–6. G. = 5·6–5·8. Luster vitreous to resinous, splendent. Color velvet-black. Streak dark reddish brown. Nearly opaque.



Mitchell Co., N. C.

**Comp.**—$\overset{II}{R}_3\overset{III}{R}_2(Nb,Ta)_6O_{21}$ according to Rg., with $\overset{II}{R}$=Fe, Ca, $UO_2$, etc.; $\overset{III}{R}$ = cerium and yttrium metals chiefly.

**Anal.**—1, Miss E. H. Swallow, Proc. Nat. Hist. Bost., **17**, 424, 1875. 2, O. D. Allen, Am. J. Sc., **14**, 130, 1877. 3, J. L. Smith, Am. J. Sc., **13**, 362, 1877. 4, 5, Rg., Zs. G. Ges., **29**, 817, 1877. 6, Hoffmann, Am. J. Sc., **24**, 475, 1882. 7, Koenig, quoted by G. H. Williams, Minerals of Baltimore, 1887.

| | G. | $Ta_2O_5$ | $Nb_2O_5$ | $SnO_2,WO_3$ | $UO_3$ | $Ce_2O_3(Di_2La_2)O_3$ | $Y_2O_3$ | $Er_2O_3$ | FeO | MnO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. N. Carolina | 5·755 | 54·96 | | 0·16 | 9·91 UO | 5·17 CeO | 12·84[a] | — | 14·02 | 0·91 | 0·52[b] | 0·66 |
| | | | | | | | [insol. fr. cerium oxalate 1·25 = 100·40 | | | | | |
| 2. " | | $\frac{2}{3}$ 18·20 | 37·50 | 0·08 | 12·54 | 4·17 | 14·48 | — | 10·75 | 0·78 | 0·55 | 1·12 |
| | | | | | | | | | | | | [= 100·17 |
| 3. " | 5·72 | — | 55·13 | 0·31 | 10·96 | 4·24 | 14·49 | — | 11·74 | 1·53[b] | — | 0·72 |
| | | | | | | | | | | | | [= 99·12 |
| 4. " | 5·839 | 14·36 | 41·07 | 0·16 | 10·90 | 2·37 | 6·10 | 10·80 | 14·61 | — | — | — |
| | | | | | | | | | [$TiO_2$ 0·56 ($SiO_2$) = 100·93 | | | |
| 5. Miask | 5·672 | $\frac{2}{3}$ — | 55·34 | 0·22 | 11·94 | 4·33 | 8·80 | 3·82 | 14·30 | — | — | — |
| | | | | | | | | | | [$TiO_2$ 1·08 = 99·83 | | |
| 6. Canada | 4·95 | — | 55·41 | 0·10 | 10·75 | 4·78 | 14·34 | | 4·83 | 0·51 | 5·38 | – |
| | | | | | | [MgO 0·11, $Na_2O$ 0·23, $K_2O$ 0·39, $H_2O$ 2·21 = 99·04 | | | | | | |
| 7. Baltimore | 5·96–6·20 | — | 56·40[c] | — | 13·48 $UO_2$ | 3·85 | 11·90 | | 8·98 | — | — | 0·30 |
| | | | | | | | [$Fe_2O_3$ 1·66, $Al_2O_3$ 2·00 = 98·57 | | | | | |

[a] YO. [b] MgO. [c] Sp. grav. 5·77.

Examination of the earths contained in samarskite from North Carolina: J. L. Smith ("mosandrum"), C. R, **87**, 146, 148, 831, 1878. Delafontaine (terbium), Bibl. Univ., **61**, 273, 1878; id. (decipium, phillipium), ib., 3, 246, 250, 1880; C. R., **93**, 63. 1881. Same subject discussed by Marignac, Bibl. Univ., 3, 413, 1880; Roscoe, J. Ch. Soc., **41**, 277, 1882.

**Pyr., etc.**—In the closed tube decrepitates, glows like gadolinite, cracks open, and turns black, and is of diminished density. B.B. fuses on the edges to a black glass. With borax in O.F. gives a yellowish green to red bead, in R.F. a yellow to greenish black, which on flaming becomes opaque and yellowish brown. With salt of phosphorus in both flames an emerald-green bead. With soda yields a manganese reaction. Decomposed on fusion with potassium bisulphate, yielding a yellow mass which on treatment with dilute hydrochloric acid separates white tantalic acid, and on boiling with metallic zinc gives a fine blue color. Samarskite in powder is also sufficiently decomposed on boiling with concentrated sulphuric acid to give the blue reduction test when the acid fluid is treated with metallic zinc or tin.

**Obs.**—Occurs in reddish brown feldspar, with crystallized æschynite and columbite (and sometimes in parallel position with the latter) in the Ilmen mountains, near Miask in the Ural. The largest pieces met with were of the size of hazel-nuts.

In the United States, rather abundant and sometimes in large masses, up to 20 lbs., at the Wiseman mica mine in Mitchell Co., N. Carolina, it is intimately associated with columbite; also at the Grassy Creek mine, Mitchell Co., and in McDowell Co. Sparingly at Middletown, Conn.; also at Jones Falls, Baltimore, Md.; a related mineral in Colorado (see below). Also in Berthier Co., Quebec. Canada.

Named after the Russian, v. Samarski.

**Alt.**—An altered samarskite from Mitchell Co., N. C., called "euxenite" by Smith has yielded the following results: 1, Smith, l. c. 2, W. H. Seamon, Ch. News, **46**, 205, 1882.

| | $Nb_2O_5$ | $SnO_2,WO_3$ | $UO_3$ | $Y_2O_3$ | $Ce_2O_3$ | $(Di,La)_2O_3$ | CaO | FeO | MnO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| G. = 4·62 | 54·12 | 0·21 | 9·53 | 24·10 | | | 5·53 | 0·31 | 0·08 | 5·70 | [= 99·58 |
| G. = 4·33 | 47·09 | 0·40 | 15·15 | 13·46 | 1·40 | 4·00 | 1·53 | 7·09 | — | 9·55 | [= 99·67 |

**Ref.**—[1] No. Carolina, Am. J. Sc., **11**, 201, 1876.

A mineral related to samarskite has been found in the granitic débris of Devil's Head Mt., Douglas Co.. Colorado. In small fragments up to the size of a chestnut, with faint suggestions of a crystalline form. Fracture subconchoidal. Very brittle. H. = 5·5–6. G. = 6·18. Luster vitreous. Color pitch-black, pale brown in thin splinters. Streak dirty brown. Slightly soluble in hydrochloric acid. B.B. becomes dull but does not fuse. Composition given in 1. Another sample (anal. 2) had a salmon-colored streak; a third (3) seemed to be much altered. Analyses, W. F. Hillebrand, Proc. Col. Sc. Soc., **3**, 38, 1888.

| | $Nb_2O_5$ | $Ta_2O_5$ | $WO_3$ | $SnO_2$ | $ZrO_2$ | $UO_2$ | $ThO_2$ | $Ce_2O_3$ | $(Di,La)_2O_3$ | $Er_2O_3$ | $Y_2O_3$ | $Fe_2O_3$ | $X^b$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 27·77 | 27·03 | 2·25 | 0·95 | 2·29$^a$ | 4·02 | 3·64 | 0·54 | 1·80 | 10·71 | 6·41 | 8·77 | 2·55 | 1·58 | = 100·31 |
| 2. | 26·16 | 28·11 | 2·08 | 1·09 | 2·60$^a$ | 4·22 | 3·60 | 0·49 | 2·12 | 10·70 | 5·96 | 8·72 | 2·60 | 1·30 | = 99·75 |
| 3. | 27·56 | 19·34 | 5·51 | 0·82 | 3·10$^a$ | 6·20$^b$ | 3·19 | 0·41 | 1·44 | 9·82 | 5·64 | 8·90 | 4·31 | 3·94 | = 100·18 |

$^a$ Incl. some $TiO_2$. $^b$ $UO_2$.

| | FeO | MnO | ZnO | PbO | CaO | MgO | $K_2O$ | $(Na,Li)_2O$ |
|---|---|---|---|---|---|---|---|---|
| $^a$ In 1, X = | 0·32 | 0·78 | 0·05 | 0·72 | 0·27 | — | 0·17 | 0·24 |
| 2, X = | 0·35 | 0·75 | 0·07 | 0·80 | 0·33 | — | 0·13 | 0·17 |
| 3, X = | 0·39 | 0·77 | | 1·07 | 1·61 | 0·11 | 0·36 | |

NOHLITE *A. E. Nordenskiöld*, G. För. Förh., **1**, 7, 1872.

Massive. Fracture uneven. Brittle. H. = 4·5–5·0. G. = 5·04. Luster vitreous. Color black-brown. Streak brown. Opaque. Analysis:

$Nb_2O_5$ 50·43, $ZrO_2$ 2·96, UO 14·43, $Y_2(Er_2)O_3$ 14·36, $Ce_2O_3$ 0·25, FeO 8·09, CaO 4·67, MnO,MgO 0·28, CuO 0·11, $H_2O$ 4·62 = 100·20.

B.B. fuses quietly on the edges to a dull glass. Decrepitates slightly in giving off its water. With borax easily dissolved, giving a bead colored by uranium. Easily decomposed by warm sulphuric acid.

Found in a feldspar quarry at Nohl, near Kongelf, Sweden. One fragment, weighing 297 grams, seemed to be a portion of a mass at least 20 times as great.

VIETINGHOFITE *v. Lomonosov—Damour*, Bull. Ac. St. Pet., **23**, 463. 1877.

Essentially a ferruginous variety of samarskite. Amorphous. H. = 5·5–6. G. = 5·53. Color black, dull. Streak brown. Luster submetallic. Easily decomposed by $H_2SO_4$. An analysis by Damour gave:

$Nb_2O_5$ 51 00, $TiO_2$ 1·84, $ZrO_2$ 0·96, $U_2O_3$ 8·85, $Y_2O_3$ 6·57, $Ce_2(Di,La)_2O_3$ 1·57, FeO 23·00, MnO 2·67, MgO 0·83, ign. 1·80 = 99·09. Locality near Lake Baikal, eastern Siberia.

**530. ÅNNERÖDITE.** *W. C. Brögger*, G. För. Förh., **5**, 354, 1881. Aannerödite.

Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c} = 0{\cdot}82572 : 1 : 0{\cdot}89434$ Brögger.
$100 \wedge 110 = 39° 32\frac{5}{6}'$, $001 \wedge 101 = 47° 17'$, $001 \wedge 011 = 41° 48\frac{1}{2}'$.

**Forms:**
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)
*c* (001, *O*)
*z* (530, *i*-$\frac{5}{3}$)
*m* (110, *1*)
*g* (130, *i*-3̆)
*l* (106, $\frac{1}{6}$-ī)
*k* (103, $\frac{1}{3}$-ī)
*e* (021, 2-ĭ)
*o* (111, 1)
*β* (233, 1-$\frac{3}{2}$)
*u* (133, 1-3̆)
*s* (263, 2-3̆)
*n* (163, 2-6̆)

$zz'' = 52° 43'$ $kk' = 39° 42'$ $cn = 61° 16'$ $uu''' = 80° 8\frac{1}{2}'$
$mm''' = 79° 6'$ $ee' = 121° 35'$ $oo' = 77° 50'$ $ss''' = 110° 49'$
$gg' = 43° 58'$ $be = {*}29° 12\frac{1}{2}'$ $uu' = 30° 7\frac{1}{2}'$ $ao = 51° 5'$
$bg = {*}21° 59'$ $co = 54° 33'$ $ss' = 38° 49'$ $a\beta = 61° 42\frac{1}{2}'$
$ll' = 20° 28'$ $cu = 43° 58'$ $oo''' = 62° 29'$ $au = 74° 56'$

Twins: tw. pl. *z* (530); also *e* (021). In prismatic crystals of varied habit, often closely resembling columbite; planes sometimes developed according to monoclinic symmetry. In angles near columbite, also polycrase. Many crystals often grouped in parallel position, thus forming an apparently single crystal of considerable size.

Fracture subconchoidal. Brittle. H. = 6. G. = 5·7 of anhydrous crystals. Luster submetallic to greasy submetallic. Color black. Streak dark blackish brown to brownish or greenish gray. Opaque, or translucent in very thin splinters

**Comp.**—Essentially a pyro-niobate of uranium and yttrium; formula doubtful, the water is probably not essential.

**Anal.**—C. W. Blomstrand.

| $Cb_2O_5$ | $SnO_2$ | $ZrO_2$ | $SiO_2$ | $ThO_2$ | $Ce_2O_3$ | $Y_2O_3$ | UO | PbO | FeO | MnO | CaO | MgO | $K_2O$ | $Na_2O$ | $Al_2O_3$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 48·13 | 0·16 | 1·97 | 2·51 | 2·37 | 2·56 | 7·10 | 16·28 | 2·40 | 3·38 | 0·20 | 3·35 | 0·15 | 0·16 | 0·32 | 0·28 | 8·19 | = 99·51 |

Neglecting the silica, the formula calculated by Blomstrand is $R_2Nb_2O_7 + 2\frac{1}{2}H_2O$, which makes it nearly identical with samarskite, and also to the less certain nohlite (p. 740), except in the water; Brögger, however, shows that the water is not essential, but is due to a partial alteration which is accompanied by a lowering of the hardness (to 4·5) and specific gravity (to 4·28), and a loss of luster. A crystal with G. = 5·7 showed only a trace of water. The mineral is consequently hardly to be separated from samarskite in composition, but it is different in form.

**Pyr.**—Fuses B.B. with difficulty. Brögger remarks that ånnerödite (also euxenite and polycrase) bears much the same relation to columbite that samarskite does to tantalite (skogbölite); the two last being very near in form, as are ånnerödite and columbite.

**Obs.**—From the pegmatyte vein at Ånneröd, near Moss, Norway, where it is associated with monazite, alvite (p. 487), apatite, magnetite, beryl, topaz, and other minerals.

**531. HIELMITE.** Hjelmit *A. E. Nordenskiöld*, Öfv. Ak. Stockh., **17**, 34, 1860, Pogg., **111**, 279, 286, 1860.

Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c} = 0{\cdot}4645 : 1 : 1{\cdot}0264$ Weibull[1].
$100 \wedge 110 = 24° 54\frac{5}{6}'$, $001 \wedge 101 = 65° 39'$, $001 \wedge 011 = 45° 44\frac{3}{4}'$.

**Forms:** *m* (110, *1*), *p* (230, *i*-$\frac{3}{2}$), *r* (101, 1-ī), *q* (201, 2-ī).

Angles: $mm''' = 49° 50'$, $pp' = 69° 44'$, $rr' = 131° 18'$, $qq' = 154° 30'$, $qq'' = {*}25° 30'$. $mq = {*}27° 48'$.

Crystals usually rough and indistinct. Massive, without apparent cleavage. H. = 5. G. = 5·82. Luster metallic. Color pure black. Streak grayish black.

**Comp.**—A stanno-tantalate (and niobate) of yttrium, iron, manganese, calcium; formula doubtful.

Anal. 3 gives $4RO.3Ta_2O_5.2H_2O$, but the material was considerably altered.

**Anal.**—1, Nd., l.c. 2, Rg., Ber. Ch. Ges., 926, 1870. 3, 4, M. Weibull, G. För. Förh., **9**, 371, 1887.

| | G. | $Ta_2O_5$ | $Nb_2O_5$ | $WO_3$ | $SnO_2$ | $UO_2$ | $Y_2O_3$ | $Ce_2O_3$ | FeO | MnO | CaO | MgO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 5·82 | 62·42 | | 6·56 | | 4·87 | 5·19 | 1·07 | 8·06 | 3·32 | 4·26 | 0·26 | 3·26 |
| | | | | | | | | | | | [CuO 0·10 = 99·37 | | |
| 2. | 5·655 | 54·52 | 16·35 | 0·28 | 4·60 | 4·51 | 1·81 | 0·48 | 2·41 | 5·68 | 4·05 | 0·45 | 4·57 |
| | | | | | | | | | | | | | [= 99·71 |
| 3. | | 72·16 | 3·63 | 0·91 | 1·12 | — | 2·08 | | — | 2·21 | 6·19 | 0·60 | 2·23 |
| | | | | | | | | | | | [PbO 0·21 = 98·70 | | |
| 4. | | 75·66 | | 2·12 | | 2·34[a] | 1·65 | 0·40 | — | 2·55 | 6·79 | 0·45 | — |

[a] $UO_3$.

**Pyr., etc.**—In the closed tube decrepitates and yields water. B.B. infusible, but turns brown in O.F. With salt of phosphorus easily dissolved to a bluish green glass. With borax dissolves to a clear glass, which remains unchanged on flaming. With soda on charcoal gives metallic spangles (Nordenskiöld).

**Obs.**—From the Kårarfvet mine, near Falun, Sweden, along with garnet, pyrophysalite, gadolinite, asphaltum, in a pegmatyte granite.

Named for the Swedish chemist, P. J. Hjelm (1746–1813).

**Ref.**—[1] G. För. Förh., **9**, 371, 1887.

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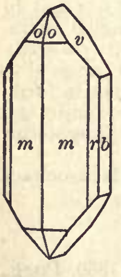
## Æschynite Group. Orthorhombic.

**532. ÆSCHYNITE.** Æschynit *Berz.*, JB., **9**, 195, 1828. Dystomes Melan-Erz *Mohs*, Min , 459, 1839.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·48665 : 1 : 0·67366$ Koksharov[1].
$100 \wedge 110 = 25° 57'$, $001 \wedge 101 = 54° 9\frac{1}{3}'$, $001 \wedge 011 = 33° 58'$.

**Forms**[1]:
*b* (010, *i*-ĭ)
*c* (001, *O*)
*m* (110, *I*)
*t* (350, *i*-$\frac{5}{3}$)[3]
*r* (120, *i*-2̆)
*n* (130, *i*-3̆)[2]
*d* (101, 1-ī)[2]
*v* (021, 2-ĭ)
*o* (111, 1)

| | | | |
|---|---|---|---|
| *mm'''* = *51° 54' | *nn'* = 68° 49' | *bv* = *36° 35' | *oo'* = 97° 53' |
| *tt'* = 101° 54½' | *dd''* = 108° 19' | *mo* = 33° 0' | *oo''* = 113° 59' |
| *rr'* = 91° 33' | *vv'* = 106° 50' | *vo* = 51° 44' | *oo'''* = 43° 3½' |



Miask. Kk.

Crystals prismatic, vertically striated; also tabular ‖ *b* with *c*, *n* prominent, *b* striated horizontally.

Cleavage: *a* in traces(?). Fracture small conchoidal. Brittle. H. = 5–6. G. = 4·93 Hitterö, Bgr.; 5·118 Miask, Kk.; 5·168 Rg. Luster submetallic to resinous, nearly dull. Color nearly black, inclining to brownish yellow when translucent. Streak gray or yellowish brown, almost black. Subtranslucent to opaque.

**Comp.**—A niobate and titanate (thorate) of the cerium metals chiefly, also in small amount iron, calcium, etc. Rammelsberg calculates $\overset{\text{iii}}{R}_2Nb_4O_{13}.\overset{\text{iii}}{R}_2(Ti,Th)_5O_{13}$.

**Anal.**—1, Mgc., Bibl. Univ., **29**, 282, 1867. 2, Rg., Zs. G. Ges., **29**, 815, 1877, Min. Ch. Erg., 2, 1886. Earlier analyses see 5th Ed., p. 522.

| | | $Nb_2O_5$ | $TiO_2$ | $ThO_2$ | $SnO_2$ | $Ce_2O_3$ | $La_2(Di_2)O_3$ | $Y_2O_3,(Er_2O_3)$ | FeO | CaO |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | G. = 5·23 | $\frac{4}{4}$ 51·45[a] | | 15·75 | 0·18 | 18·49 | 5·60 | 1·12 | 3·17 | 2·75 |
| | | | | | | | | | [ign. 1·07 = 99·58 | |
| 2. | G. = 5·168 | 32·51 | 21·20 | 17·55 | — | 19·41 | | 3·10 | 3·34 | 2·50 |
| | | | | | | | | | | [= 99·61 |

[a] Also $\frac{4}{4}$ $Nb_2O_5$ 57·6, $TiO_2$ 42·4 = 100, or $Nb_2O_5$ 29·64, $TiO_2$ 21·81 = 51·45.

**Pyr., etc.**—In the open tube yields water and traces of fluorine. B.B. in the forceps swells up and changes its color from black to a rusty brown. In borax dissolves easily in O.F., giving a yellow bead while hot, and on cooling becomes colorless; in R.F. with tin gives a blood-red bead. More difficultly soluble in salt of phosphorus; with a small amount of the assay gives a colorless bead, while with a larger quantity there separates a white substance which clouds the bead; in R.F., with tin on charcoal, yields an amethystine glass (Berzelius). Decomposed on fusion with potash; yields reactions similar to those mentioned under euxenite (Kobell). It is also sufficiently decomposed by sulphuric acid to show the reduction test with zinc.

**Obs.**—From Miask in the Ilmen Mts., in feldspar with mica and zircon; also with euclase in the gold sands of the Orenburg District, Southern Ural. From Hitterö, Norway (Bgr., l. c.) in a pegmatyte vein. In the granite of Königshain, Silesia.

Named from *αἰσχυνη*, *shame*, by Berzelius, in allusion to the inability of chemical science, at the time of its discovery, to separate some of its constituents.

**Ref.**—[1] Min. Russl., 3, 384, 1858; see also earlier, Brooke, Phil. Mag., 10, 188, 1831; Rose, Reis. Ural, 2, 70, 1842; Dx., Ann. Mines, 2, 349, 1842; and later, Bgr., Zs. Kr., 3, 481, 1879. Bgr. obtained for Hitterö crystals, $\breve{a} : \bar{b} : \grave{c} = 0·4816 : 1 : 0·6725$.

[2] Bgr., Hitterö, l. c. [3] Woitschach, Königshain, Abh. Ges. Görlitz, **17**, 182, 1881.

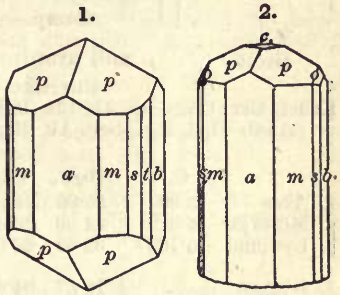
## 533. POLYMIGNITE. *Berzelius*, Ak. H. Stockh., 338, 1824.

Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c} = 0·71213 : 1 : 0·51207$ Brögger[1].
$100 \wedge 110 = 35° 27\frac{1}{3}'$, $001 \wedge 101 = 35° 43\frac{1}{6}'$, $001 \wedge 011 = 27° 7'$.

**Forms**[1]: *c* (001, *O*) *s* (120, *i*-$\breve{2}$) *v* (232, $\frac{3}{2}$-$\breve{\frac{3}{2}}$)
*a* (100, *i*-$\bar{i}$) *l* (210, *i*-$\bar{2}$) *t* (140, *i*-$\breve{4}$) *o* (131, 3-$\breve{3}$)
*b* (010, *i*-$\breve{i}$) *m* (110, *I*) *p* (111, 1)

The pyramid *p* (111) corresponds nearly in angle to *u* (133) of columbite.

*ll‴* = 39° 12′ *pp″* = *45° 9′ *vv‴* = 63° 54′
*mm‴* = 70° 55′ *pp‴* = 82° $52\frac{1}{2}'$ *oo′* = 42° 50′
*ss′* = 70° 9′ *vv′* = 59° 23′ *oo″* = 102° $33\frac{1}{2}'$
*tt′* = 38° 41′ *vv″* = 92° 55′ *oo‴* = 118° 57′
*pp′* = *65° $14\frac{1}{2}'$



Figs. 1, 2, Norway; 1, Rose; 2, Bgr.

Crystals slender prisms, vertically striated.

Cleavage: *a*, *b* in traces. Fracture perfect conchoidal. H. = 6·5. G. = 4·77–4·85. Luster submetallic, brilliant. Color black. Streak dark brown. Opaque.

**Comp.**—A niobate and titanate (zirconate) of the cerium metals, iron, calcium. Brögger calculates $5RTiO_3.5RZrO_3.R(Nb,Ta)_2O_6$.

**Anal.**—Blomstrand, quoted by Brögger:

| $Nb_2O_5$ | $Ta_2O_5$ | $ZrO_2$ | $TiO_2$ | $ThO_2$ | $SnO_2$ | $(Y,Er)_2O_3$ | $Ce_2O_3$ | $(La,Di)_2O_3$ | $Fe_2O_3$ | FeO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11·99 | 1·35 | 29·71 | 18·90 | 3·92 | 0·15 | 2·26 | 5·91 | 5·13 | 7·85[a] | 3·40[b] | 7·14[c] | 0·28 |

[PbO 0·39, Alk. 1·36 = 100·91

[a] Incl. 0·19 $Al_2O_3$. [b] Incl. 1·32 MnO. [c] Incl. MgO 0·16.

An early incomplete analysis was made by Berzelius, Ak. H. Stockh., 339, 1824 (5th Ed., p. 524).

**Pyr., etc.**—B.B. infusible, and unchanged in color. With borax dissolves readily, giving an iron bead; with more of the assay becomes brownish yellow on flaming, and opaque on cooling; with tin in R.F. turns reddish yellow. With salt of phosphorus not easily acted upon, gives a reddish tinge in R.F., which is unchanged by tin. With soda shows traces of manganese (Berzelius). The powdered Fredriksvärn mineral, heated with concentrated sulphuric acid, gives a whitish residue, which, treated with hydrochloric acid and tin-foil, gives a beautiful azure-blue color, indicating, as under polycrase, the presence of some other metallic acid in addition to titanic, which of itself gives only a violet color. The dilute acid solution gives with turmeric paper the orange color characteristic of zirconia.

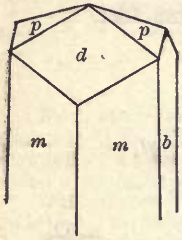
**Obs.**—Occurs at Fredriksvärn and on the island of Svenör, in Norway, with feldspar, zircon-elæolite, pyrochlore, magnetite. Its crystals sometimes exceed an inch in length. Reported from Moravia; also by Shepard as occurring at Beverly, Mass.

**Ref.**—[1] Zs. Kr., 16, 387, 1890. Earlier Rose, Pogg., 6, 506, 1826. If the axes $\breve{a}$ and $\grave{c}$ are interchanged the axial ratios of polymignite and æschynite are closely similar, the pyramid *p* corresponding to *o*; the forms are hence very near and the two may be the same species, as suggested by Frankenheim, Pogg., 91, 372, 1855, and later Rammelsberg.

**534. EUXENITE.** Euxenit *Scheerer*, Pogg., **50**, 149, 1840, **72**, 566, 1847.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·364 : 1 : 0·303$ Groth[1].
$100 \wedge 110 = 20° 0'$, $001 \wedge 101 = 39° 46'$, $001 \wedge 011 = 16° 51'$.

**Forms**[1]: *a* (100, *i*-$\bar{i}$), *b* (010, *i*-$\breve{i}$); *m* (110, *I*); *d* (201, 2-$\bar{i}$); *p* (111, 1).
Angles: $mm''' = {*}40° 0'$, $dd' = {*}118° 0'$, $pp' = 77° 4'$, $pp''' = 26° 12'$.



Groth.

Crystals rare. Commonly massive.

Cleavage none. Fracture subconchoidal. Brittle. H.=6·5. G. = 4·60 Jölster, Scheerer; 4·73–4·76 Tvedestrand, id.; 4·94–4·99, ib., Breith.; 4·89–4·99 Alve, Forbes; 4·96, Chydenius. Luster brilliant, metallic-vitreous, or somewhat greasy. Color brownish black; in thin splinters a reddish brown translucence lighter than the streak. Streak-powder yellowish to reddish brown.

**Comp.**—A niobate and titanate of yttrium, erbium, cerium, and uranium; formula (Rg.) probably $\overset{\text{III}}{\text{R}}(\text{NbO}_3)_3.\overset{\text{III}}{\text{R}}_2(\text{TiO}_3)_3.\tfrac{3}{2}\text{H}_2\text{O}$.

Euxenite contaius the rare element germanium in small amount, cf. Krüss, Ber. Ch. Ges., **21**, 131, 1888.

**Anal.**—1–3, Rg., Ber. Ak. Berlin, 428, 1871. 4, Jehn, Inaug. Diss., Jena, 1871.

| | G. | $Nb_2O_5$ | $TiO_2$ | $Y_2O_3$ | $Er_2O_3$ | $Ce_2O_3$ | $UO_2$ | FeO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Alve | 5·00 | 35·09 | 21·16 | 27·48 | 3·40 | 3·17 | 4·78 | 1·38 | — | 2·63 | = 99·09 |
| 2. Mörefjär | 4·672 | 34·59 | 23·49 | 16·63 | 9·06 | 2·26 | 8·55 | 3·49 | — | 3·47 | = 101·54 |
| 3. Eydland | 5·103 | 33·39 | 20·03 | 14·60 | 7·30 | 3·50 | 12·12 | 3·25 | 1·36 | 2·40 | $K_2O,Na_2O$ 0·82 = 98·77 |
| 4. Hitterö | | $\tfrac{3}{8}$ 18·37 | 34·96 | 13·20 | — | 8·43 | 7·75[a] | 2·54 | 1·63 | 2·87 | $Al_2O_3$ 5·41, MgO 3·92 = 99·08 |

[a] UO.

On the absorption-spectra of rare earths in euxenite see Krüss and Nilson, Öfv. Ak. Stockh., **44**, 378, 1887.

**Pyr., etc.**—B.B. infusible. Dissolves in borax and salt of phosphorus, giving a yellow bead while hot; with salt of phosphorus shows a yellowish green (uranium reaction) on cooling, if sufficiently saturated (Scheerer). When decomposed by fusion with caustic potash, and subsequently treated with water, and this solution neutralized with hydrochloric acid, it gives a precipitate, which, boiled with concentrated hydrochloric acid and tin-foil, gives a clear sapphire-blue fluid, which changes to an olive-green, and finally bleaches. If the residue of the fusion after leaching is treated with hydrochloric acid and boiled with tin-foil it yields on dilution a pale rose-red color (Kobell). The mineral is sufficiently attacked, on evaporation with sulphuric acid, to give a whitish residue, which, treated with metallic zinc or tin, affords the characteristic blue reduction test.

**Obs.**—Occurs at Jölster in Norway, embedded in feldspar and sometimes in scaly mica, the largest crystals 2 in. long and ½ in. wide, but usually much smaller; also near Tvedestrand; at Alve, Tromö, near Arendal; at Mörefjär, near Näskilen; also Hitterö.

Named by Scheerer from εὔξενος, *friendly to strangers, hospitable,* in allusion to the rare elements it contains.

**Ref.**—[1] Arendal, Min.-Samml. Strassburg, 255, 1878; the measurements are approximate only, but agree fairly well with Breith. and Kjerulf (see Zs. Kr., 3, 483, 1879); not, however, with Dahll (Ed. N. Phil. J., 1, 63, 1855) who gives a prism of 54°, a macrodome (*r*) of 129° ($ar = 25° 30'$) and a pyramid $\alpha$, $b\alpha = 73°$.

**535. POLYCRASE.** Polykras *Scheerer*, Pogg., **62**, 430 1844.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·3462 : 1 : 0·3124$ Brögger[1].
$100 \wedge 110 = 19° 5\tfrac{3}{4}'$, $001 \wedge 101 = 42° 3\tfrac{3}{4}'$, $001 \wedge 011 = 17° 21'$.

**Forms**[1]: *c* (001, *O*)[2] *d* (201, 2-$\bar{i}$) *l* (011, 1-$\breve{i}$)[2] *z* (121, 2-$\breve{2}$)[2]
*a* (100, *i*-$\bar{i}$) *m* (110, *I*) *q* (301, 3-$\bar{i}$) *s* (111, 1) *r* (131, 3-$\breve{3}$)
*b* (010, *i*-$\breve{i}$) *u* (101, 1-$\bar{i}$)[2]

$mm''' = 38° 11\tfrac{1}{2}'$ $qq' = 139° 27'$ $ss''' = 26° 7'$ $zz'' = 95° 19\tfrac{1}{2}'$
$ll' = 34° 42'$ $ss' = {*}81° 29'$ $sb = {*}76° 56\tfrac{1}{2}'$ $zz''' = 49° 46'$
$dd' = 122° 1'$ $ss'' = 87° 21\tfrac{1}{2}'$ $zz' = 74° 51'$ $rr'' =$ [illegible]

Crystals thin prismatic, tabular ‖ *b*.

Cleavage none. Fracture conchoidal. Brittle. H. = 5–6. G. = 4·97–5·04. Luster vitreous to resinous. Color black, brownish in splinters. Streak grayish brown.

**Comp.**—A niobate and titanate of yttrium, erbium, cerium, uranium, like euxenite. Formula (Rg.) $\overset{\text{III}}{R}(NbO_3)_3.2\overset{\text{III}}{R}(TiO_3)_3.3H_2O$.

Hidden and Mackintosh deduce from anal. 4, 5: $Nb_2O_5 : TiO_2 : RO : H_2O = 1 : 2 : 1\frac{1}{3} : \frac{2}{3}$ or (uniting $H_2O$ and RO) $10RO.Nb_2O_5.5TiO_2$.

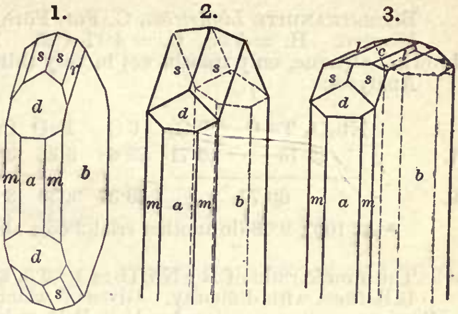


Fig. 1, Norway, Scheerer 2, 3, Marietta, H.

Scandium is prominent in the spectrum of the American polycrase (Rowland).

**Anal.**—1, 2, Rg., Ber. Ak. Berlin, 425, 1871. 3, Blomstrand, Minnesskrift Sällsk. Lund, No. 3, p. 19. 1878. 4, 5, Hidden & Mackintosh, Am. J. Sc., **41**, 423, 1891. Also earlier anals., ib., **39**, 302, 1890.

| | G. | $Nb_2O_5$ | $Ta_2O_5$ | $TiO_2$ | $Y_2O_3$ | $Er_2O_3$ | $Ce_2O_3$ | $UO_2$ | FeO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Hitterö *cryst.* | | 20·35 | 4·00 | 26·59 | 23·32 | 7·53 | 2·61 | 7·70 | 2·72 | 4·02 | =98·84 |
| 2. " *mass.* | 4·972 | 25·16 | — | 29·09 | 23·62 | 8·84 | 2·94 | 5·62 | 0·45 | 3·00 | =98·72 |
| 3. Slättåkra | 4·98 | $\frac{6}{6}$ 22·82 | — | 25·24 | 13·06 | 6·45 | 3·07 | 8·45 | 2·76 | 4·71 | $ThO_2$ [3·51, $SnO_2$ 0·55, X[a] 10·01 = 100·63 |
| 4. Henderson Co., N. C. | | 19·48 | — | 29·31 | 27·55[b] | — | — | 13·77[d] | 2·87 | 5·18 | =98·16 |
| 5. Greenville Co., S. C. | | 19·37 | — | 28·51 | 21·23[c] | — | — | 19·47[d] | 2·47 | 4·46 | X[e] 2·45 [= 97·96 |

[a] X = $SiO_2$ 3·33, $Al_2O_3$ 0·60, MnO 0·60, PbO 0·92, CaO 3·53, MgO 0·22, $K_2O$ 0·52, $Na_2O$ 0·29.
[b] At. wght. 112. [c] Do. 114·1. [d] $UO_3$. [e] X=PbO 0·46, CaO 0·68, $SiO_2$ 1·01, $Fe_2O_3$ 0·18, insol. 0·12.

**Pyr., etc.**—In the closed tube decrepitates, and gives traces of water. B.B. in the forceps glows, and turns to a light grayish brown color, but is infusible. Soluble in borax, giving in O.F. a clear yellow bead, which in R.F. with tin turns brown. In salt of phosphorus gives a clear yellow glass, which on cooling is greenish; in R.F. the color becomes darker. With soda no reaction for manganese, and on charcoal no metallic particles. Decomposed by evaporation with concentrated sulphuric acid; the product, treated with hydrochloric acid, gives on boiling with metallic zinc or tin a deep azure-blue solution which does not fade. The dilute solution gives a deep orange to turmeric paper (zirconia).

**Obs.**—From Hitterö, Norway, in crystals ½ to 1½ in. long, in granite with gadolinite and orthite; at Slättåkra, parish of Alsheda, Småland, Sweden; also near Dresden.

In the U. States, occurs in well-formed prismatic crystals (G. = 4·724–4·78) in N. Carolina, in the gold-washings on Davis land, Henderson Co., with zircon, monazite, xenotime, magnetite; the crystals are altered on the exterior to a yellow substance resembling gummite. Also in S. Carolina, four miles from Marietta in Greenville Co. (G. = 4·925–5·038), about twenty miles from the N. Carolina locality.

Named from πολὺς, *many*, and κρᾶσις, *mixture*.

N. B. Möller makes the so-called polycrase of Brevik certainly, and that of Hitterö probably, identical with polymignite (J. pr. Ch., **69**, 318, 1856).

**Ref.**—[1] Zs. Kr., **3**, 484, 1879, the angles make no great claim to accuracy; Scheerer, l. c., obtained earlier *pp'''* = 28°, *mm'''* = 40°. [2] Hidden & Mackintosh, Am. J. Sc., **39**, 302, 1890, and **41**, 423, 1891; the crystals described showed some irregularity in the distribution of the planes, suggesting hemimorphism; apparent twins are mentioned with *d* (201) and *l* (011), also *u* (101) as twinning-planes.

## APPENDIX TO NIOBATES, TANTALATES.

Arrhenite *Nordenskiöld; Engström*, Inaug. Diss., Upsala, 1877.

A heterogeneous decomposition-product looking like red feldspar; occurs with fergusonite and cyrtolite at Ytterby, Sweden. G. = 3·68. Analysis:

| $Ta_2O_5$ | $Nb_2O_5$ | $SiO_2$ | $ZrO_2$ | $Fe_2O_3$ | $Al_2O_3$ | $Ce_2(Di_2,La_2)O_3$ | $Y_2O_3$ | $Er_2O_3$ | CaO | BeO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21·28 | 2·67 | 17·65 | 3·42 | 1·87 | 3·88 | 2·59 | 22·06 | 11·10 | 5·22 | 0·74 | 6·87 | = 100·35 |

**Blomstrandite** *Lindström*, G. För. Förh., 2, 162, 1874.

Massive. H. = 5·5. G. = 4·17–4·25. Luster vitreous. Color black. Powder coffee-brown. Opaque, only translucent in very thin splinters.

Analyses:

| | $Nb_2O_5$ $Ta_2O_5$ | $TiO_2$ | UO | FeO | CaO | $H_2O$ | MgO | MnO | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 49·76 | 10·71 | 23·68 | 3·33 | 3·45 | 7·96 | 0·16 | 0·04 | $Al_2O_3$ 0·11, X[b] 0·12 = 99·32 |
| 2. | 60·77 | | 23·37 | 3·39 | 3·04 | 8·17[a] | *tr.* | 0·06 | X[b] 0·20 = 99·00 |

[a] At 100°, 2·78 (in another trial 2·65); above 100°, 5·39.

[b] Precip. by $H_2S$.

The atomic ratio of R : Nb,Ti = 1 : 2·5, and for Ti : Nb = 1 : 2·75.

B.B. fuses with difficulty. Gives off water in the closed tube. With borax in O.F. a reddish yellow, on cooling a yellow bead; in R.F. reddish brown. With salt of phosphorus in O.F. a red brown bead when hot, and yellow when cold; in R.F. reddish yellow hot, and green cold.

Found very sparingly with nohlite in a feldspar quarry at Nohl, Sweden. Named for Prof. C. W. Blomstrand of Lund.

**Rogersite** *J. L. Smith*, Am. J. Sc., 13, 367, 1877.

Massive. As a thin mammillary crust on samarskite. H. = 3·5. G. = 3·313. Color white. Analyses (approximate):

| | $Nb_2O_5$ | $Y_2O_3$, etc. | $H_2O$ | |
|---|---|---|---|---|
| 1. | 18·10 | 60·12 | 17·41 | = 95·63 |
| 2. | 20·21 | *und.* | 16·34 | |

Considered as a decomposition-product of samarskite, with which, and with hatchettolite, it occurs in Mitchell Co., N. C. Named after Prof. Wm. B. Rogers (1805–1882).

## Oxygen Salts.

## 4. PHOSPHATES, ARSENATES, VANADATES, ANTIMONATES.

A. Anhydrous Phosphates, etc.

B. Acid and Basic Phosphates, etc. C. Hydrous Phosphates, etc.

### A. Anhydrous Phosphates, Arsenates, Vanadates, Antimonates.

1. **Introductory Subdivision.**
2. **Triphylite Group.** Orthorhombic.
3. **Apatite Group.** Hexagonal.
4. **Wagnerite Group.** Monoclinic.
5. **Amblygonite Group.** Monoclinic, Triclinic.

### 1. Introductory Subdivision.

| | | | | | |
|---|---|---|---|---|---|
| | | | | ċ | |
| 536. | **Xenotime** | $YPO_4$<br>$(Y,Ce,Er)PO_4$ | Tetragonal | 0·6187 | |
| | | | | ă : b̄ : ċ | β |
| 537. | **Monazite** | $(Ce,La,Di)PO_4$ | Monoclinic | 0·9693 : 1 : 0·9256 | 76° 20′ |

Most varieties contain also thorium and silicon.

| | | | |
|---|---|---|---|
| 538. | **Berzeliite** | $(Ca,Mg,Mn)_3As_2O_8$ | Isometric |
| | Pseudoberzeliite | | |
| 539. | **Monimolite** | $(Pb,Fe,Ca)_3Sb_2O_8$ | Isometric |

| | | | |
|---|---|---|---|
| 540. | **Caryinite** | $(Pb,Mn,Ca,Mg)_3As_2O_8$ ? | Monoclinic |
| 541. | **Carminite** | $Pb_3Fe_{10}(AsO_4)_{12}$? | Orthorhombic |

| | | | | |
|---|---|---|---|---|
| | | | | ă : b̄ : ċ |
| 542. | **Pucherite** | $BiVO_4$ | Orthorhombic | 0·5327 : 1 : 2·3357 |

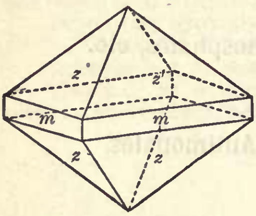
**536. XENOTIME.** Phosphorsyrad Ytterjord *Berz.*, Ak. H. Stockh., **2**, 334, 1824. Phosphorsaure Yttererde *Germ.* Phosphate of Yttria. Xenotime *Beud.*, Tr., **2**, 552, 1832. Ytterspath *Glocker*, Handb., 959, 1831. Castelnaudite *Damour*, L'Institut, 78, 1853.

Tetragonal. Axis $\dot{c}$ = 0·61867; 001 ∧ 101 = 31° 44⅔′ Rath-Klein[1].

**Forms**[2]: *c* (001, *O*)[4]; *a* (100, *i-i*), *m* (110, *I*); *e* (101, 1-*i*)[3], *f* (201, 2-*i*)[5], *z* (111, 1), *u* (331, 3)[4]; *τ* (311, 3-3)[2].

*ee′* = 46° 19′
*ee″* = 63° 29′
*ff′* = 66° 44′
*ff″* = 102° 7′
*zz′* = *55° 30′
*zz″* = 82° 22′
$zz^{iv}$ = 97° 38′
*uu′* = 82° 43′
*uu″* = 138° 17′
*ττ′* = 46° 56′
$\tau\tau^{vii}$ = 32° 42½′
$\tau\tau^{viii}$ = 54° 9′
*mτ* = 37° 13′
*zτ* = 29° 53½′

1.



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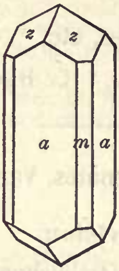

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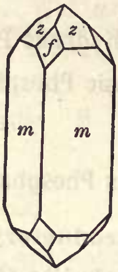

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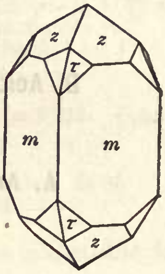

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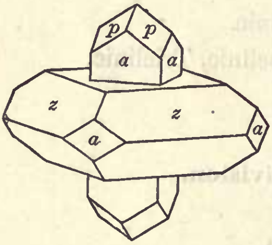

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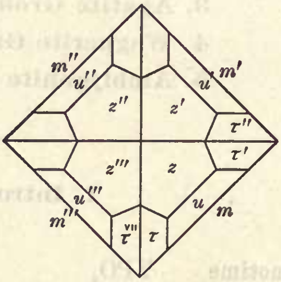


Fig. 1, Clarksville, Ga. 2, Binnenthal, Klein. 3, Alexander Co., N. C., Hidden. 4, Fibia, Klein. 5, Xenotime, enclosing zircon in parallel position, Henderson Co., N. C., Hidden. 6, Hitterö, after Flink

In crystals, usually pyramidal or prismatic, resembling zircon in habit; sometimes compounded with zircon in parallel position, f. 5. In rolled grains.

Cleavage: *m* perfect. Fracture uneven and splintery. Brittle. H. = 4–5. G. = 4·45–4·56; 4·557 Berz.; 4·54 Georgia, Smith. Luster resinous to vitreous. Color yellowish brown, reddish brown, hair-brown, flesh-red, grayish white, wine-yellow, pale yellow; streak pale brown, yellowish, or reddish. Opaque. Optically +.

**Comp.**—Essentially yttrium phosphate $YPO_4$ or $Y_2O_3.P_2O_5$ = Phosphorus pentoxide 38·6, yttria 61·4 = 100. The yttrium metals may include erbium in large amount; cerium is sometimes present; also silicon and thorium as in monazite.

**Anal.**—1, Schiötz, Jb. Min., 306, 1876. 2, J. L. Smith, Am. J. Sc., **18**, 378, 1854. 3, Wartha, Pogg. Ann., **128**, 166, 1866 (6·59 p. c. hematite deducted). 4, Gorceix, C. R., **102**, 1024, 1886. 5, 6, Blomstrand, G. För. Förh., **9**, 185, 1887. 7, Id., quoted by Brögger, Zs. Kr., **16**, 68, 1890.

| | G. | $P_2O_5$ | $Y_2O_3$ | $Ce_2O_3$ | $Fe_2O_3$ | |
|---|---|---|---|---|---|---|
| 1. Hitterö | | 31·88 | 54·88 | 8·24[a] | 2·93 | $Mn_2O_3$ 0·13, FeO 0·87, CaO 0·13, $H_2O$ 1·56 [= 100·62 |
| 2. Georgia | 4·54 | 32·45 | 54·13 | 11·03[b] | 2·06 | = 99·67 |
| 3. St. Gothard | | 37·51 | 62·49 | — | — | = 100 |
| 4. Minas Geraes | 4·6 | 35·64 | 63·75[c] | — | — | insol. 0·40 = 99·79 |

[a] Incl. $Al_2O_3$. [b] Incl. $La_2O_3$,$Di_2O_3$. [c] About one-sixth $Er_2O_3$.

| | G. | $P_2O_5$ | $Y_2O_3$ | $Er_2O_3$ | $Ce_2O_3$ | $UO_3$ | $SiO_2$ | $SnO_2$ | $ZrO_2$ | $ThO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MnO | CaO | MgO | PbO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5. Hvalö | 4·49 | 32·45 | 38·91 | 17·47 | 1·22 | — | 1·77 | 0·19 | 0·76 | 3·33 | 0·36 | 1·88 | 0·13 | 0·34 | — | 0·21 | 1·03<br>[= 100·05 |
| 6 Narestö | 4·492 | 29·23 | 30·23 | 24·34 | 0·96 | 3·48 | 2·36 | 0·08 | 1·11 | 2·43 | 0·28 | 2·01 | — | 1·09 | 0·26 | 0·68 | 1·77<br>[= 100·31 |
| 7. Arö | 4·62 | 35·66 | 62·63[a] | | 0·32 | — | 0·24 | 0·11 | — | 0·49 | — | 0·38[b] | — | 0·35 | — | — | 0·23<br>[= 100·41 |

[a] Molec. wght. 254·5. [b] FeO.

**Pyr., etc.**—B.B. infusible. When moistened with sulphuric acid colors the flame bluish green. Difficultly soluble in salt of phosphorus. Insoluble in acids.

**Obs.**—Occurs as an accessory mineral in granite veins; sometimes in minute embedded crystals generally distributed in granitic and gneissoid rocks. From a granite vein at Hitterö, with polycrase, malacon, and orthite, where the crystals are sometimes symmetrically compounded with crystals of zircon (E. Zschau, l. c.[2]), the two species being closely homœomorphous; also at Moss, Kragerö, and from pegmatyte veins at other points in Norway, as Narestö near Arendal; rare in the Langesund fiord region, as on the Arö reefs; at Ytterby, Sweden; the Fibia Berg, S.W. from St. Gothard; the Binnenthal in Upper Valais, Switzerland; from the granite of the Schwalbenberg near Görlitz, Silesia; Pisek, Bohemia (G. = 4·308, Vrba). Kenngott's *wiserine*, from the Binnenthal, formerly referred here, is in fact octahedrite (see p. 241).

An accessory constituent in considerable quantity of the muscovite granites of Brazil as detected by washing the decomposed or crushed rock; the localities noted are chiefly in the states Rio de Janeiro, São Paulo, Minas Geraes (cf. O. A. Derby, Am. J. Sc., **41**, 308, 1891). Observed in grayish white or pale yellow crystals in the diamond sands of Diamantinos and of Bahia (*castelnaudite*).

In the United States, in the gold washings of Clarksville, Georgia, associated with zircon, rutile, and cyanite; in McDowell Co., N. C., near Dysortville, sometimes in twisted crystals; at Mill's Gold mine, Burke Co., N. C. (in crystals compounded), also near Green River P. O., Henderson Co., and in Mitchell Co. with zircon (cyrtolite); further in brilliant crystals in Alexander Co. with rutile, etc., with tysonite near Pike's Peak, Colorado; rare on New York Island (Hidden, l. c.).

Beudant named the species *xenotime* (apparently from ξενός, *stranger to*, and τιμή, *honor*), but in the next line gives the derivation " κενός, *vain*, et τιμή, honneur," as if the word were *kenotime*, and adds afterward that his name is intended to recall the fact that the mineral was erroneously supposed by Berzelius (in 1815) to contain a new metal (the metal which he named thorium, before the later thorium was discovered). There is a sneer at the great Swedish chemist in the name, which should have occasioned its immediate rejection. Fortunately the word was misspelt from the first; and in its accepted form may be regarded as referring to the fact that the crystals are small, rare, not showy, and were long unnoticed.

**Ref.**—[1] Rath. Fibia, Pogg., **123**, 187, 1864, Klein, Binnenthal, Jb. Min., 536, 1879. Hbg. obtained $\dot{c}$ = 0·61631 Tavetsch, Min. Not., **12**, 1, 1875; Bgr., 0·62596, Kragerö, G. För. Förh., **6**, 750, 1883; Washington, $\dot{c}$ = 0·61943, New York Island, Am. J. Sc., **36**, 380, 1888. Cf. Scharizer on vicinal planes, Zs. Kr., **13**, 15, 1887.

[2] Zschau, Jb. Min., 513, 1855; Brezina, Min. Mitth., 15, 1872. [3] Lsx., Königshain, Jb. Min., 175, 1877. [4] Bgr., Kragerö, Hitterö, l. c.; also Flink, Ak. H. Stockh., **12** (2), 2, 41, 1886. [5] Hidden, Alex. Co., N. C., Am. J. Sc., **36**, 381, 1888.

**537. MONAZITE.** Monazit *Breith.*, Schw. J., **55**, 301, 1829. Monacite *bad orthogr.* Mengite *Brooke*, Phil. Mag., **10**, 139, 1831. Edwardsite *Shep.*, Am. J. Sc., **32**, 162, 1837. Eremite *Shep.*, ib., 341, 1837. Monazitoid *Herm.*, J. pr. Ch., **40**, 21, 1847. Urdit *Forbes & Dahll*, Nyt. Mag., **8**, 227, 1855. Turnerite *Levy*, Ann. Phil., **5**, 241, 1823.

Kryptolith *Wöhler*, Gel. Anz. Gött., 19, 1846, Pogg., **67**, 424, 1846. Cryptolite. Phosphocerite *H. Watts*, J. Ch. Soc., **2**, 131, 1849.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 0·96933 : 1 : 0·92558$; $\beta = 76° 20' 10'' = 001 \wedge 100$ E. S. Dana[1].

$100 \wedge 110 = {}^*43° 17' 10''$, $001 \wedge 101 = 37° 7' 40''$, $001 \wedge 011 = 41° 58' 5''$.

**Forms**[2]:
*a* (100, *i*-*ī*)
*b* (010, *i*-*ì*)
*c* (001, *O*) rare
*y* (310, *i*-$\bar{3}$)

*l* (210, *i*-$\bar{2}$)
*m* (110, *I*)
*n* (120, *i*-$\grave{2}$)
*h* (305, − $\frac{3}{5}$-*ī*)[3]
*w* (101, − 1-*ī*)

*q* (701, − 7-*ī*)[4]
*x* ($\bar{1}$01, 1-*ī*)
*g* (012, $\frac{1}{2}$-*ì*)
*e* (011, 1-*ì*)
*u* (021, 2-*ì*)

*f* (112, − $\frac{1}{2}$)[4]
*r* (111, − 1)
*d* ($\bar{1}$12, $\frac{1}{2}$)
*v* ($\bar{1}$11, 1)
*s* (121, − 2-$\grave{2}$)

*z* ($\bar{3}$11, 3-$\bar{3}$)
*t* ($\bar{2}$12, 1-$\bar{2}$)
*i* ($\bar{2}$11, 2-$\bar{2}$)[8]
*o* ($\bar{1}$21, 2-$\grave{2}$)

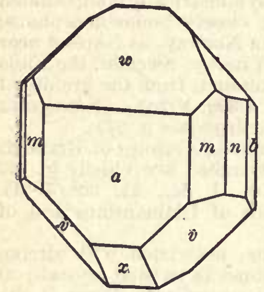
*yy'''* = 34° 52′
*ll'''* = 50° 26′
*mm'''* = 86° 34′
*nn'''* = 124° 4′
*ah* = 50° 13′
*aw* = *39° 12′ 30″
*a'x* = 53° 31′
*gg'* = 48° 26′
*ee'* = 83° 56′
*uu'* = 121° 51′
*cm* = 80° 6′

*mr* = 33° 35′
*m'd* = 53° 56′
*m'v* = 30° 56′
*cy'* = 103° 2′
*y'z* = 19° 20′
*cl'* = 102° 20½′
*li* = 27° 15′
*cn* = 83° 38′
*ns* = 24° 50′
*n'o* = 27° 18′

*ar* = 48° 1½′
*ae* = *79° 53′ 3″
*as* = 59° 47′
*au* = 83° 25′
*a'z* = 26° 44′
*a'i* = 38° 21′
*a'v* = 61° 31′
*a't* = 56° 8′
*ag* = 77° 33½′
*rr'* = 60° 40′

*ss'* = 98° 58′
*dd'* = 48° 22½′
*vv'* = 73° 19′
*zz'* = 35° 35′
*tt'* = 40° 49′
*ii'* = 49° 51′
*oo'* = 112° 12′
*xz* = 37° 12′
*xi* = 33° 39′

1.



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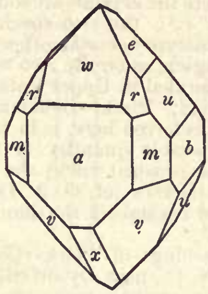

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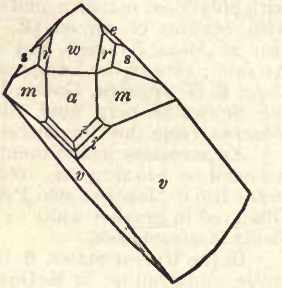

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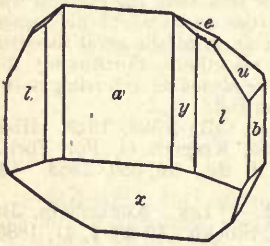

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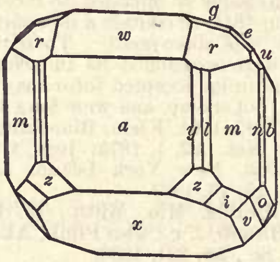

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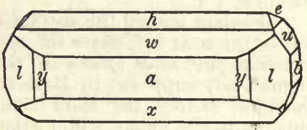

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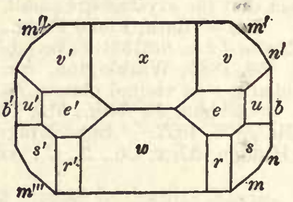


Fig. 1, Norwich, Conn. 2, Watertown, Conn. 3, Alexander Co., N. C. 4, 6, Binnenthal, Trechmann. 5, *Turnerite*, Rath Trechmann. 7, Watertown.

Twins: tw. pl. *a* not uncommon, in part cruciform twins. Crystals commonly small, often flattened ∥ *a* or elongated ∥ axis *b*; sometimes prismatic by extension of *v* $(\bar{1}11)$, f. 3; also large and coarse. In masses yielding angular fragments; in rolled grains.

Cleavage: *c* sometimes perfect (parting?); also, *a* distinct; *b* difficult; sometimes showing parting ∥ *c*, *m*. Fracture conchoidal to uneven. Brittle. H. = 5–5·5. G. = 4·9–5·3; mostly 5·0 to 5·2. Luster inclining to resinous. Color hyacinth-red, clove-brown, reddish or yellowish brown. Subtransparent to subtranslucent.

Optically +. Ax. pl. ⊥ *b* and nearly ∥ *a*. $Bx_a \wedge \dot{c} = +1°$ to 4°. Dispersion $\rho < v$ weak; horizontal weak.

*Turnerite* $Bx_a \wedge \dot{c} = +1° 4'$ $2H_{a.r} = 23° 5'$ $2H_{a.gr} = 23° 24'$ ∴ $2E_r = 34° 12'$
$2E_{gr} = 34° 48'$ Tr.

*Monazite*, Conn. $Bx_a \wedge \dot{c} = +3° 46'$ $2E_r = 29° 4'$ $2E_{bl} = 28° 48'$ Dx.[6]
Siberia $2E_r = 31° 8\frac{1}{2}'$ $2E_{bl} = 31° 43\frac{1}{3}'$
Schüttenhofen $Bx_a \wedge \dot{c} = +5° 54'$ $2E_r = 25° 22'$ $2E_y = 24° 56'$ $\beta = 1·9465$ $\gamma = 1·9285$
$\therefore$ $2V = 12° 44'$ Scharizer
Pisek $2E_r = 29° 7'$ Sr $2E_y = 28° 25'$ $[\beta = 1·9465]$ $2V_r = 14° 50'$
$2V_y = 14° 29'$ Vrba.

**Comp.**—Phosphate of the cerium metals, essentially $(Ce,La,Di)PO_4$.

Most analyses show the presence of $ThO_2$ and $SiO_2$, usually, but not always, in the proper amount to form thorium silicate; that this is mechanically present is not certain but possible (cf. Penfield, Blomstrand).

**Anal.**—1, Rg., Zs. G. Ges., **29**, 79, 1877. 2, Pisani (on ·013 gr.), C. R., **84**, 462, 1877. 3, Fontaine, Am. Ch. J., **4**, 140, 1882. 4–6, Penfield, Am. J. Sc., **24**, 250, 1882. 7, Penfield and Sperry, ibid., **36**, 322, 1888. 8, W. A. Dixon, Min. N. S. W., 114, 1888. 9, Genth, Am. J. Sc., **38**, 203, 1889. 10–19, Blomstrand, G. För. Förh., **11**, 379, 1889, and Lund. Univ. Årsskrift, **25**, 1888–89 (also in J. pr. Ch., **41**, 265, 1890).

| | G. | $P_2O_5$ | $Ce_2O_3$ | $La_2O_3$ | $Di_2O_3$ | $(Y,Er)_2O_3$ | $SiO_2$ | $ThO_2$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Arendal | 5·174 | 29·92 | 28·82 | 40·79 | | — | — | — | = 99·53 |
| 2. *Turnerite* | | 28·4 | 68·0 | | | — | — | — | = 96·4 |
| 3. Amelia Co., Va. | | 24·04 | 16·30 | 10·30 | 24·40 | 1·10 | 2·70 | 18·60[a] | $Fe_2O_3$ 0·90, $Al_2O_3$ 0·04 = 98·38 |
| 4. " " | 5·30 | $\frac{2}{2}$ 26·12 | 29·89 | 26·66 | | — | 2·85 | 14·23 | ign. 0·67 = 100·42 |
| 5. Portland, Conn. | 5·22 | $\frac{2}{2}$ 28·18 | 33·54 | 28·33 | | — | 1·67 | 8·25 | ign. 0·37 = 100·34 |
| 6. Burke Co., N. C. | 5·10 | $\frac{3}{3}$ 29·28 | 31·38 | 30·88 | | — | 1·40 | 6·49 | ign. 0·20 = 99·63 |
| 7. Alex Co., " | 5·203 | $\frac{2}{2}$ 29·32 | 37·26 | 31·60 | | — | 0·32 | 1·48 | ign. 0·17 = 100·15 |
| 8. Gough Co., N. S. W. | 5·001 | 25·09 | 36·64 | 30·21 | | — | 3·21 | 1·23 | $Al_2O_3$ 3·11, MnO,MgO *tr.* = 99·49 |
| 9. Ottawa Co., Q. | 5·233 | 26·86 | 24·80 | 26·41 | | 4·76 | 0·91 | 12·60 | $Fe_2O_3$ 1·07, CaO 1·54, MgO 0·04, $H_2O$ 0·78 = 99·77 |

[a] Not pure.

| | G. | $P_2O_5$ | $Ce_2O_3$ | $La_2O_3$ | $Y_2O_3$ | $SnO_2$ | $SiO_2$ | $ThO_2$ | $Fe_2O_3$ | $Al_2O_3$ | MnO | CaO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10. Moss | 4·89 | 28·62 | 32·52 | 29·41 | 2·04 | 0·22 | 1·51 | 4·54 | 0·36 | 0·22 | — | 0·84 | — | 0·27 | = 100·55 |
| 11. " | 4·64 | 26·37 | 31·23 | 24·51 | 1·83 | 0·21 | 2·10 | 9·20 | 1·97 | — | 0·28 | 0·93 | 0·16 | 1·53 | = 100·32 |
| 12. Dillingsö | 5·19 | 29·41 | 36·63 | 26·78 | 1·81 | 0·09 | 0·93 | 3·81 | 0·33 | 0·12 | — | 0·34 | — | 0·18 | = 100·43 |
| 13. " | 5·18 | 27·07 | 25·82 | 30·62 | 2·03 | 0·18[a] | 1·85 | 9·60 | 1·01 | 0·15 | 0·08 | 0·91 | 0·03 | 0·35 | PbO 0·58 = 100·28 |
| 14. Lönneby | | 28·27 | 28·06 | 29·60 | 1·82 | — | 1·65 | 9·34 | 0·66 | 0·16 | — | 0·53 | — | 0·21 | = 100·30 |
| 15. " | 4·77 | 27·99 | 30·98 | 25·88 | 2·76 | — | 1·58 | 9·03 | 1·25 | — | — | 0·55 | — | 0·20 | = 100·22 |
| 16. Arendal | 5·15 | 27·55 | 29·20 | 26·26 | 3·82 | — | 1·86 | 9·57 | 1·13 | — | — | 0·69 | — | 0·52 | = 100·60 |
| 17. Narestö | 5·117 | 28·94 | 30·58 | 29·21 | 0·78 | — | 1·32 | 7·14 | 0·42 | 0·18 | — | 1·19 | — | 0·09 | PbO 0·33 = 100·18 |
| 18. Hvalö | | 23·85 | 27·73 | 21·96 | 2·86 | 0·66[b] | 5·95 | 9·05 | 4·63 | — | — | 1·83 | — | 1·61 | = 100·13 |
| 19. " | 5·08 | 27·28 | 30·46 | 24·37 | 1·58 | 0·08 | 2·02 | 11·57 | 1·10 | — | 0·24 | 1·05 | — | 0·38 | PbO 0·26 = 100·39 |

[a] Metallic acids. [b] $ZrO_2$.

**Pyr., etc.**—B.B. infusible, turns gray, and when moistened with sulphuric acid colors the flame bluish green. With borax gives a bead yellow while hot and colorless on cooling; a saturated bead becomes enamel-white on flaming. Difficultly soluble in hydrochloric acid.

**Obs.**—Monazite is rather abundantly distributed as an accessory constituent of gneissoid rocks in certain regions, thus in North Carolina and Brazil (cf. Derby, Am. J. Sc., **37**, 109, 1889.

It occurs near Zlatoust in the Ilmen Mts., in granite, along with flesh-red feldspar; also near the river Sanarka, in the Ural; with zircon in gold sands of Ivalo, Finnish Lapmark. In Norway near Nöterö (*urdite*), in crystals sometimes 1 in. across; at various points near Arendal, and in pegmatyte at Ånneröd near Moss. In granite at Schreiberhau, Silesia, with gadolinite; at Schüttenhofen and Pisek, Bohemia; near the Laacher See. At Nil St. Vincent, Belgium (cf. Franck., Bull. Soc. Belg., **21**, 40, 1891). In Cornwall, England.

Found also in the gold-washings of Rio Chico, in Antioquia, in the diamond gravels of Minas Geraes, Caravellas, and Bahia, Brazil.

In the United States it is found in small crystals from $\frac{1}{16}$ to $\frac{3}{4}$ in. long, with the sillimanite of Norwich, and sparingly with the same mineral at Chester, Ct. A few minute crystals (*eremite* of Shepard) were found in a boulder of albitic granite, containing also a few minute zircons and tourmalines, in the northeastern part of Watertown, Ct.; sparingly at Portland, Ct. Good crystals have been obtained with the sillimanite of Yorktown, Westchester Co., N. Y. In large coarse crystals and masses in albitic granite with microlite, etc. (see p. 728); at Amelia Court House, Virginia. In Alexander Co., N. Carolina, in splendent crystals at Milholland's Mill; also at Stony Point in large cruciform twins with rutile, hiddenite, etc. In considerable quantities in Madison Co., N. C., yielding angular fragments due to parting ‖ *c*, *m* (with twinning striations?), probably *d* and perhaps other planes. Also in Mitchell Co., Yancey Co. In rolled grains in the gold-washings, sometimes abundant, in Burke, Polk, McDowell, and Rutherford counties; large quantities have been mined from this source for technical purposes; some 15 tons of monazite sand, containing from 60 to 92 p. c. of small crystals, have been obtained (Genth, 1891). In the mica veins of Villeneuve, Ottawa Co., Quebec.

The original *turnerite*, whose crystallographic identity with monazite was established by J. D. Dana in 1866, was from Dauphiné, probably from Le Puys, near St. Cristophe (not "Mt. Sorel," cf. Miers, Min. Mag., 8, 207, 1889); it occurs in small yellow or brown crystals with quartz, albite, octahedrite, crichtonite (ilmenite); also similarly from Santa Brigritta, Tavetsch, the Binnenthal, Laacher See, etc.

*Cryptolite* occurs in wine-yellow prisms and grains in the green and red apatite of Arendal, Norway, and is discovered on putting the apatite in dilute nitric acid; constitutes 2 or 3 p. c. of the mass; it was found especially in the red apatite, or in reddish points of the green, and associated with particles of magnetic iron, hornblende, and another cerium ore of a hyacinth-red color, supposed to be monazite. Occurs also in the apatite of the Sliudianka river in Siberia. Phosphocerite, according to Watts and Chapman, may be present in the cobalt ore of Tunaberg. The crystalline forms described as most common in the powder are an octahedron and a square or rectangular prism, terminating in a four-sided pyramid parallel with the lateral planes, resembling zircon. Genth has observed a mineral, probably cryptolite, in the Hurdstown apatite. Named from *κρυπτός, concealed.* The relations of phosphocerite are uncertain.

Mallard has shown that minute crystals inclosed in the apatite from Midbö, near Tvedestrand, are monazite, and it seems probable that all the cryptolite is of the same nature. Bull. Soc. Min., **10**, 236, 1887.

Monazite is named from *μονάζειν, to be solitary*, in allusion to its rare occurrence. *Turnerite* is named after the English chemist, E. H. Turner.

**Ref.**—[1] Milholland's Mill, Alexander Co., N. C., Am. J. Sc., **24**, 247, 1882; the axial ratios vary rather widely for different localities. Some other values of the axial ratio, in addition to that here adopted, are as follows:

| | $\grave{a} : \bar{b} : \grave{c}$ | $\beta$ | |
|---|---|---|---|
| Norwich, Conn. | 0·9742 : 1 : 0·9227 | 76° 14′ | J. D. Dana. |
| Sanarka | 0·9705 : 1 : 0·9221 | 76° 14′ | Koksharov. |
| Laach | 0·9659 : 1 : 0·9217 | 76° 32′ | Rath. |
| Alex. Co., N. C. | 0·9609 : 1 : 0·9081 | 76° 33½′ | " |
| Schüttenhofen | 0·9735 : 1 : 0·9254 | 76° 23′ | Scharizer. |
| Nil St. Vincent | 0·9718 : 1 : 0·9233 | 76° 18′ | Franck. |

[2] See J. D. D., monazite, Conn., Am. J. Sc., **33**, 70, 1838; Kk., Ural, Min. Russl., **4**, 5, 1862; **6**, 387, 1870, 9, 10, 1884. On turnerite Lévy, l. c. and Min. Heuland, **3**, 423, 1837; Dx., Min., **1**, 533, 1862; Rath, Pogg., **119**, 247, 1863; further J. D. D., Am. J. Sc., **42**, 420, 1866, who first suggested its identity with monazite, later Rath, Pogg., Erg.-Bd., **5**, 413, 1871.

[3] Trechmann, Binnenthal, Jb. Min., 593, 1876. [4] Miers, Cornwall, Min. Mag., **6**, 164, 1885. [5] Kk., Min Russl., 4. 5; Rath, Jb. Min., 393, 1876; Hidden, Alex. Co., N. C., Am. J. Sc., **32**, 207, 1886; Rath, do., Ber. nied. Ges., May 3, 1886. [6] Dx., N. R, 150, 1867; Bull. Soc. Min., **4**, 57, 1881; Trechmann, l. c.; Scharizer, Zs. Kr., **12**, 255, 1886; Vrba, Zs. Kr., **15**, 203, 1888.

KÅRARFVEITE. Korarfveite *F. Radominski*, C. R., **78**, p. 764, 1874. Occurs in albite with gadolinite, hielmite, and beryl at Kårarfet near Falun, Sweden (there called monazite). In imperfect crystals, or crystalline masses often very large; one cleavage perfect. Luster vitreous. Double refracting. G. = 4·93. Color yellow passing into brown. Translucent. Streak grayish yellow. Analysis upon impure material:

$P_2O_5$ 27·38 $(Ce,La,Di)_2O_3$ 67·40 CaO 1·24 MgO *tr.* $Fe_2O_3$ 0·32 F 4·35 $H_2O$ *tr.* = 100·69

B.B. infusible. Partially attacked by hydrochloric acid with evolution of chlorine. Blomstrand shows it to be impure monazite, G. För. Förh., **11**, 379, 1889.

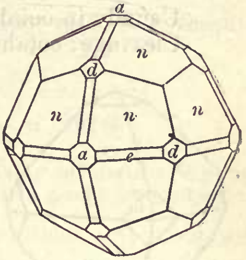
**538. BERZELIITE.** Berzeliit *Kühn*, Lieb. Ann., **34**, 211, 1840. Magnesian Pharmacolite *Dana*, Min., 239, 1844. Chaux arseniatée anhydre *Dufr.* Berzelit *Haid.*, Handb., 495, 1845. Kühnite *B. & M.*, Min., 481, 1852. Pyrrhoarsenite *L. J. Igelström*, Bull. Soc. Min., **9**, 218, 1886. Pyrrharsenite.

Isometric, rarely in trapezohedrons[1] *n* (211, 2-2) with also *a* (100, *i-i*), *d* (110, *i*), and *e* (210, *i*-2). Usually massive.

Cleavage none. Fracture subconchoidal. Brittle. H. = 5. G. = 4·07–4·09 Flink. Luster resinous. Color honey-, sulphur-, and orange-yellow; yellowish red. Streak nearly white to orange-yellow. Transparent to translucent. Optically isotropic.

**Comp.**—An orthoarsenate, $R_3As_2O_8$ with R = Ca, Mg, Mn. The relative amounts of manganese and magnesium vary widely.

In *pyrrharsenite* a little antimony takes the place of part of the arsenic.



Långban, Flink.

**Anal.**—1, Flink, l. c. 2, Hogböm, G. För. Förh., **9**, 397, 1887. 3, Igelström, Bull. Soc. Min., **9**, 28, 1886. 4, Id., Jb. Min., **1**, 48, 1889. 5–7, Hogböm, l. c.

| | | | G. | $As_2O_5$ | $Sb_2O_5$ | MnO | CaO | MgO | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | Långban | | 4·08 | 60·00 | — | 8·40 | 20·73 | 10·10 | $Na_2O$ 0·73 = 99·96 |
| 2. | " | | | 57·59 | — | 5·68 | 19·97 | 16·12 | insol. 0·49 = 99 85 |
| 3. | *Pyrrharsenite* | | | 58·06 | | 17·96 | 18·68 | 3·58 | ign. 0·85, insol. 1·02 = 100·15 |
| 4. | " | *straw-yw.* | | 53·23 | 6·54 | 10·82 | 20·21 | 9·20 | = 100 |
| 5. | " | *red yw.* | | 50·92 | 2·60 | 19·18 | 18·35 | 3·50 | $CO_2$ 1·27, insol. 3·96 = 99·78 |
| 6. | " | " | | *undet.* | | 17·12 | 18·50 | 3·55 | |
| 7. | " | *yellow* | 4·01 | 53·39 | 2·90 | 14·12 | 18·54 | 7·53 | $CO_2$ 1·58, insol. 1·36 = 99·42 |

Kühn's original analyses (5th Ed., p. 544) led to the formula $R_{10}As_6O_{25}$. He gives also G. = 2·52(!). B.B. infusible. His observations, which can hardly be entirely correct, may have been made on pseudoberzeliite.

**Pyr., etc.**—B.B. fuses easily to a black bead if rich in manganese, less readily to a gray or brown bead in other kinds. With soda on charcoal gives an arsenical odor; with soda on platinum foil fuses with effervescence, and gives a manganese reaction. Soluble in nitric acid.

*Pyrrharsenite* fuses easily to a black bead; with soda on charcoal a strong arsenical odor and some antimony fumes; with soda also a manganese reaction. Dissolves readily in acids; with sulphuric acid gives a precipitate of calcium sulphate.

**Obs.**—Occurs at Långban in Sweden, with iron ore and granular limestone, braunite, hausmannite; also the Moss mine, Nordmark, with hausmannite in crystalline limestone. Sometimes encloses a nucleus of caryinite. Named after the Swedish chemist, Berzelius (1799–1848).

*Pyrrharsenite* occurs in deep yellowish red embedded grains, with hausmannite, tephroite, also barite, calcite, at the Sjö manganese mines of Grythytte, Örebro, Sweden.

Named from πυρρός, *fire*, and *arsenic*, in allusion to its brilliant fire-red color.

**Ref.**—[1] Flink, Nyt Mag., **29**, 300, 1885. Ak. Handl. Stockh. Bihang, **12** (2), No. 2, 27, 1886; see earlier H. Sj., G. För. Förh., **2**, 533, 1875. Wichmann, Zs. Kr., **5**, 105, 1880.

PSEUDOBERZELIITE. Dubbelbrytande Berzeliit *W. Lindgren*, G. För. Förh., **5**, 552, 1881. Pseudoberzeliit *Id.*, ibid., **7**, 291, 1884. Associated with the isometric berzeliite there occurs at Långban also a doubly refracting arsenate similar in appearance and probably also having the composition $R_3As_2O_8$. If, as appears probable, it proves to be a distinct species, the above name may be retained for it.

Massive; anisotropic. No distinct cleavage. H. = 5. G. = 4·03–4·04. Color dirty yellowish white or light sulphur-yellow. Composition $R_3As_2O_8$. Anal.—L. W. McCay, G. För. Förh., **5**, 554, 1881.

| $As_2O_5$ | MnO | CaO | MgO | |
|---|---|---|---|---|
| 62·00 | 4·18 | 20·00 | 12·81 | PbO,$Fe_2O_3$ *tr.*, insol. 0·68 = 99·67 |

Occurs in a light brown fine granular mixture of calcite and manganiferous mica, often penetrated by hausmannite.

Here also seems to belong the berzeliite from the Moss mine, Nordmark, described by Igelström, G. För. Förh., **7**, 101, 1884. It occurs in veins and rounded grains. Color yellow. Optically biaxial, positive (orthorhombic?). 2E = 140°, $\rho < v$ Btd. (Bull. Soc. Min., **7**, 31, 1884). Comp. probably $R_3As_2O_8$. Analysis, Igelström, l. c.:

$As_2O_5$ 57·80  CaO 25·25  MgO(MnO *tr.*) 16·95 = 100

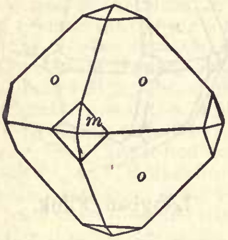
**539. MONIMOLITE.** Monimolit *L. J. Igelström*, Öfv. Ak. Stockh., **22**, 227, 1865.

Isometric. Observed forms[1]:

*a* (100, *i-i*), *d* (110, *i*), *o* (111, 1), *m* (311, 3-3).

Usually in octahedrons, also cubic. Also massive and incrusting.

Cleavage: octahedral, indistinct. Fracture small conchoidal, splintery. Brittle. H. = 5–6. G. = 6·58; also 7·29 (cf. below). Luster greasy to submetallic. Color yellowish or brownish green, dark brown to black. Streak straw-yellow, cinnamon-brown. Translucent to nearly opaque. Isotropic, or sometimes showing slight double refraction.



Pajsberg, Flink.

**Comp., Var.**—An antimonate of lead, iron, and sometimes calcium, in part, $R_3Sb_2O_8$, with R = Pb : Fe = 3 : 1, hence: Antimony pentoxide 36·6, lead protoxide 57·2, iron protoxide 6·2 = 100. Manganese is present in small amount.

**Var.**—1. *Contains calcium* (anal. 1, 2). Octahedral with *m* (311). H. = 6. G. = 6·579. Luster greasy. Color brownish green; by transmitted light yellow-green. Not attacked by fusion with alkaline carbonates. Anal. 1 gives $4RO.Sb_2O_5$; anal. 2, $15RO.4Sb_2O_5$, with R = Pb : Fe : Ca = 5 : 2 : 5 nearly.

2. *Without calcium.* Cubic, with *o*, *d*. H. = 5. G. = 7·287. Luster submetallic. Color dark brown to black, nearly opaque. Readily decomposed by fusion with alkaline carbonates. Agrees with the formula $R_3Sb_2O_8$ given above.

These varieties are distinguished by Flink, their relation is uncertain.

**Anal.**—1, Igelström, l. c. 2, 3, Flink, l. c.

| | G. | $Sb_2O_5$ | PbO | FeO | MnO | CaO | MgO | $Na_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Pajsberg | 5·94 | 40·29 | 42·40 | 6·20 | | 7·59 | 3·25 | — | = | 99·73 |
| 2. " | 6·58 | 40·51 | 42·74 | 5·38 | 0·41 | 9·70 | 0·56 | 0·54 | = | 99·84 |
| 3. " | 7·29 | 38·18 | 55·33 | 5·57 | 1·16 | — | — | — | = | 100·24 |

Nordenskiöld[2] made the species tetragonal, with $\dot{c} = 0·9950$, $oo' = {}^*70° \ 23·6'$, $oo'' = 109° \ 12'$.

**Pyr., etc.**—B.B. fuses to a black slag; on charcoal gives a malleable lead-colored globule, which in O.F. gives a white coating of antimony trioxide, and nearer the assay the yellow of lead oxide. Insoluble in strong acids, or with carbonated or caustic alkalies, even on fusion, except var. 2 (cf. above). Reduced by hydrogen gas at a red heat; becomes soluble in acids.

**Obs.**—Occurs with tephroite, magnetite, and hedyphane at the Harstig mine, Pajsberg, in Wermland, Sweden. Also at Långban with tephroite and rhodonite.

Named from *μόνιμος, permanent, stable.*

**Ref.**—[1] Flink, Ak. Stockh., Bihang, **12** (2), No. 2, 35, 1887. [2] Nd., Öfv. Ak. Stockh., **27**, 550, 1870.

**540. CARYINITE.** Koryinit, Karyinit *C. H. Lundström*, G. För. Förh., **2**, 178, 223, 1874.

Massive, probably monoclinic. Cleavage in two directions at 90° (at 50° Dx.).

Fracture splintery. H. = 3–3·5. G. = 4·25. Luster greasy. Color brown to yellowish brown. Streak yellowish white. Biaxial, 2E = 41° 58′ to 47°. Dispersion $\rho > v$, also horizontal, Dx.[1]

**Comp.**—Perhaps $R_3As_2O_8$ with R = Pb, Mn, Ca, Mg.

**Anal.**—Lundström, l. c.

| $As_2O_5$ | PbO | MnO | FeO | CaO | MgO | $CO_2$ | Cl | insol. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 47·17 | 10·52 | 15·82 | 0·54 | 16·40 | 4·25 | 3·86 | 0·07 | 0·65 | = | 99·28 |

**Pyr., etc.**—B.B. fuses easily to a black slag, giving reactions for arsenic, lead, and manganese. Dissolves readily, with slight effervescence in nitric acid.

**Obs.**—Occurs intimately mixed with calcite and hausmannite and berzeliite (isotropic, A. Sj., G. För. Förh., **2**, 533, 1875; cf. Lindgren, ib., **5**, 556, 1881) at Långban, Wermland, Sweden.

Named from *καρύϊνος, nut-brown.*

**541. CARMINITE.** Carminspath *Sandberger*, Pogg., 80, 391, 1859. Karminspath. Carmine Spar. Carminite *Dana*, Min., 410, 1854.

Orthorhombic. In clusters of fine needles. Also in spheroidal forms with a columnar structure. Cleavage parallel to the faces of a rhombic prism.

H. = 2·5. G. = 4·105. Luster vitreous, but cleavage pearly. Color carmine to tile-red; powder reddish yellow. Translucent. Brittle.

**Comp.**—Perhaps $Pb_3As_2O_8.10FeAsO_4$ = Arsenic pentoxide 48·5, iron sesquioxide 28·1, lead oxide 23·4 = 100.

**Anal.**—R. Müller, on 0·068 gr., Pogg., 103, 345, 1858.

$As_2O_5$ 49·11 $Fe_2O_3$ 30·29 PbO 24·55 = 103·95

**Pyr., etc.**—B.B. on charcoal fuses easily to a steel-gray globule, giving out arsenical vapors; with soda a globule of lead, and with borax an iron reaction. Heated in a glass tube no change. Soluble in nitric acid.

**Obs.**—From the Luise mine at Horhausen, N. of Neuwied on the Rhine, with beudantite and quartz in a mine of limonite.

**542. PUCHERITE.** *A. Frenzel*, J. pr. Ch., 4, 227, 361, 1871.

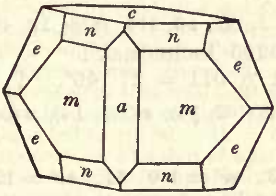
Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·5327 : 1 : 2·3357 Websky[1].

100 ∧ 110 = 28° 2⅔′, 001 ∧ 101 = 77° 9⅙′, 001 ∧ 011 = 66° 49⅓′.

**Forms**[1]: *a* (100, $i$-$\bar{i}$), *c* (001, *O*); *m* (110, *I*); *w* (012, $\frac{1}{2}$-$\breve{i}$), *x* (011, 1-$\breve{i}$); *n* (112, $\frac{1}{2}$); *ψ* (544, $\frac{5}{4}$-$\frac{5}{4}$); *e* (122, 1-$\breve{2}$).

*mm‴* = 56° 5′ *cn* = 68° 4′ *nn′* = 109° 55′ *nn‴* = 51° 43′
*ww′* = 98° 51′ *cψ* = 80° 28′ *ψψ′* = 130° 16′ *ψψ‴* = 45° 29′
*xx′* = 133° 39′ *ce* = 72° 40′ *ee′* = 81° 35′ *ee‴* = 88° 13′

1.



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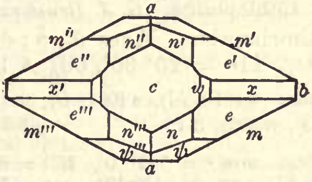

Schneeberg, after Websky.

Crystals small, usually tabular ∥ *c*; also acicular. Faces *e* striated ∥ edge *c/e*.

Cleavage: *c* perfect. Fracture subconchoidal. Brittle. H. = 4. G. = 6·249. Luster vitreous to adamantine. Color reddish brown. Streak yellow. Translucent to opaque.

**Comp.**—Bismuth vanadate, $BiVO_4$ or $Bi_2O_3.V_2O_5$ = Vanadium pentoxide 28·2, bismuth trioxide 71·8 = 100.

**Anal.**—1, 2, Frenzel, l. c. 3, Id., Jb. Min., 514, 1872.

| | $V_2O_5$ | $As_2O_5$ | $P_2O_5$ | $Bi_2O_3$ | | |
|---|---|---|---|---|---|---|
| 1. | 27·31 | — | — | 73·39 | = | 100·70 |
| 2. | 27·07 | — | — | 72·93 | = | 100 |
| 3. | 22·19 | 3·66 | 1·34 | 73·16 | = | 100·35 |

**Pyr., etc.**—In the closed tube decrepitates. B.B. on charcoal fuses and gives a coating of bismuth oxide, with soda yields a globule of metallic bismuth. With salt of phosphorus a chrome-green bead in R.F., becoming light yellow in O.F. (vanadium). Soluble in hydrochloric acid with evolution of chlorine to a deep-red solution, which on dilution becomes green and deposits a yellow basic chloride.

**Obs.**—Found at the Pucher Mine, Schneeberg, Saxony, on quartz associated with bismite and asbolite. Also at the Arme Hilfe mine, at Ullersreuth, near Hirschberg, Voigtland, on ocherous limonite with bismuthinite, native bismuth, etc.; at the mine Sosaer Glück, at Sosa, near Eibenstock.

**Artif.**—Obtained by Frenzel by the desiccation (over $H_2SO_4$) of a solution containing bismuth nitrate and vanadium chloride. Jb. Min., 680, 1875.

**Ref.**—[1] Min. Mitth., 245, 1872.

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## 2. Triphylite Group. Orthorhombic.

Orthophosphates of an alkali metal, lithium or sodium, with iron and manganese.

| | | | ă : b̄ : ċ |
|---|---|---|---|
| **543.** | **Triphylite** | $Li(Fe,Mn)PO_4$ | 0·4348 : 1 : 0·5265 |
| **544.** | **Lithiophilite** | $Li(Mn,Fe)PO_4$ | |
| **545.** | **Natrophilite** | $NaMnPO_4$ | |
| **546.** | **Beryllonite** | $NaBePO_4$ | 0·5724 : 1 : 0·5490 |
| **547.** | **Herderite** | $\left\{\begin{array}{l}(CaF)BePO_4\\(CaOH)BePO_4\end{array}\right.$ | 0·6206 : 1 : 0·4235 |
| **548.** | **Hamlinite** | Rhombohedral | ċ = 1·1353 |

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### 543, 544. TRIPHYLITE—LITHIOPHILITE:

**543. Triphylite.** Triphylin *Fuchs*, J. pr. Ch., **3**, 98, 1834, **5**, 319, 1835. Tetraphylin *Berz.*, Årsb., **15**, 1835. Perowskyn *N. Nordenskiöld.*

**544. Lithiophilite.** *G. J. Brush* and *E. S. Dana*, Am. J. Sc., **16**, 118, 1878; **18**, 45, 1879.

Orthorhombic. Axes ă : b̄ : ċ = 0·4348 : 1 : 0·5265 Tschermak[1].
100 ∧ 110 = 23° 30′, 001 ∧ 101 = 50° 27′, 001 ∧ 011 = 27° 46′.

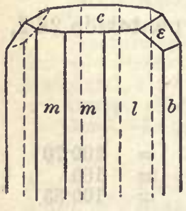
**Forms:** *b* (010, *i*-ĭ), *c* (001, *O*); *m* (110, *I*), *l* (120, *i*-2̆); *w* (102, ½-ī), *e* (101, 1-ī), *v* (302, $\frac{3}{2}$-ī); *ϵ* (021, 2-ĭ), *n* (031, 3-ĭ).

Angles: *mm‴* = *47° 0′, *ll‴* = 82° 1′, *ww′* = 62° 23′, *ee′* = 100° 54′, *vv′* = 122° 20′, *ϵϵ′* = 92° 57½′, *nn′* = 115° 19½′, *me* = *45° 0′, *mϵ* = 73° 12′.

Crystals rare, usually coarse and faces uneven. Commonly massive, cleavable to compact.

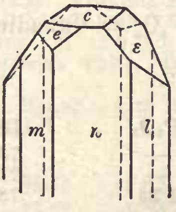
Cleavage: *c* perfect; *b* nearly perfect; *m* interrupted. Fracture uneven to subconchoidal. H. = 4·5–5. G. = 3·42–3·56. Luster vitreous to resinous. Color greenish gray, bluish in triphylite; also salmon-color, honey-yellow, yellowish brown, light clove-brown in lithiophilite; often nearly black on the surface. Pleochroism distinct, for lithiophilite: ‖ ă deep pink, ‖ b̄ faint pink, ‖ ċ pale greenish yellow, E. S. D., l. c. Streak uncolored to grayish white. Transparent to translucent.

1.



Norwich.

2.



Bodenmais.

Optically +. Ax. pl. ‖ *c*. Bx ⊥ *b*. $2H_{a.r} = 74° 45′$, $2H_{a.bl} = 79° 30′$.

**Comp., Var.**—A phosphate of iron, manganese, and lithium, $Li(Fe,Mn)PO_4$, varying from the bluish gray TRIPHYLITE with little manganese to the salmon-pink or clove-brown LITHIOPHILITE with but little iron.

Typical *Triphylite* is $LiFePO_4$ or $Li_3PO_4.Fe_3P_2O_8$ = Phosphorus pentoxide 45·0, iron protoxide 45·5, lithia 9·5 = 100.

Typical *Lithiophilite* is $LiMnPO_4$ or $Li_3PO_4.Mn_3P_2O_8$ = Phosphorus pentoxide 45·3, manganese protoxide 45·1, lithia 9·6 = 100.

**Anal.**—1–4, S. L. Penfield, Am. J. Sc., **13**, 425, 1877, **17**, 226, **18**, 47, 1879. 5, H. L. Wells, ib., **16**, 118, 1878. For earlier analyses see 5th Ed., p. 542.

| *Triphylite.* | G. | $P_2O_5$ | FeO | MnO | CaO | MgO | $Li_2O$ | $Na_2O$ | $H_2O$ | $X^b$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Bodenmais, *light blue* | 3·549 | $\frac{2}{2}$ 43·18 | 36·21 | 8·96 | 0·10 | 0·83 | 8·15 | 0·26 | 0·87 | 0·83<br>[= 99·39 |
| 2. Norwich, *gr. green* | 3·534 | $\frac{2}{2}$ 44·76 | 26·40 | 17·84 | 0·24 | 0·47 | 9·36 | 0·35 | 0·42 | —<br>[= 99·84 |
| 3. Grafton, *light blue* | 3·52 | $\frac{2}{2}$ 44·03 | 26·23 | 18·21 | 0·94 | 0·59 | 8·79 | 0·44[a] | 1·47 | —<br>[= 100·70 |
| *Lithiophilite.* | | | | | | | | | | |
| 4. Branchville, *clove-brown* | 3·482 | $\frac{2}{2}$ 45·22 | 13·01 | 32·02 | — | — | 9·26 | 0·29 | 0·17 | 0·29<br>[= 100·26 |
| 5. " *salmon-pink* | 3·478 | $\frac{2}{2}$ 44·67 | 4·02 | 40·86 | — | — | 8·63 | 0·14 | 0·82 | 0·64<br>[= 99·78 |

[a] Incl. $K_2O$, 0·32. [b] X = gangue.

**Pyr., etc.**—In the closed tube sometimes decrepitates, turns to a dark color, and gives off traces of water. B.B. fuses at 1·5, coloring the flame beautiful lithia-red in streaks, with a pale bluish green on the exterior of the cone of flame. The coloration of the flame is best seen when the pulverized mineral moistened with sulphuric acid is treated on a loop of platinum wire. With the fluxes reacts for iron and manganese, the iron reaction is feeble in pure lithiophilite. Soluble in hydrochloric acid.

**Obs.**—*Triphylite* occurs at Rabenstein, near Zwiesel, in Bavaria; also at Keityö, in Finland (perowskine or tetraphyline); Norwich, Mass.; also with spodumene at Peru, Me., Grafton, N.H.

Named from *τρίς, threefold,* and *φυλή, family,* in allusion to its containing three phosphates.

*Lithiophilite* occurs at Branchville, Fairfield Co., Conn., in a vein of albitic granite, in irregular masses intimately associated with spodumene (and cymatolite, q.v.), also with eosphorite, triploidite, rhodochrosite, uraninite; the masses are sometimes very large and occasionally there are rough crystals with the forms; also at Tubbs' Farm, Norway, Me. Named from *lithium* and *φιλός, friend.*

**Alt.**—Triphylite and triplite, like other minerals containing manganese protoxide, undergo easy alteration by oxidation and hydration; and the former also by losing its alkalies. The iron shown in some analyses (cf. sarkopside, p. 778) is thus accounted for. The following have come from the alteration of one or the other of these minerals.

A. HETEROSITE. Heteposite *Alluaud*, in an Art. by *Vauquelin*, Ann. Ch. Phys., **30**, 294, 1825. Heterosite, Heterozite, *Alluaud*, Ann. Sc. Nat., **8**, 346, 1826.

Cleavable, massive and lamellar; cleavage stated to be in three directions, unequal, affording an oblique prism of 80°. H. = 5·5–6; G. = 3·52, or 3·39 after further alteration, Dufrénoy; luster resinous, or like that of apatite; color greenish and bluish gray, becoming violet and submetallic on exposure. Soluble in acids, with a slight residue of silica. B.B. fuses to a deep brown submetallic enamel. Found in pegmatyte near Limoges, Dept. of Haute Vienne, France, and especially at the quarries of Hureaux. Named *heterosite* from *ἕτερος, other* or *different*, but misspelt by Vauquelin.

B. PSEUDOTRIPLITE *Blum*, Orykt., 2 Aufl., 537, with anal. by Delffs. Resembles triplite; but occurs incrusting triphylite at Rabenstein, Bavaria, to the alteration of which its formation is owing.

C. ALLUAUDITE *Damour*, Ann. Mines, **13**, 341, 1848 [not Alluaudite *Bernhardi*]. In nodules, or massive, with three rectangular cleavages, two of these rather easy, the other less so. H. = 4–5; G. = 3·468. Color brown, brownish red at the edges by transmitted light; powder brownish yellow. B.B. fuses easily to a black magnetic globule. Dissolves in hydrochloric acid with evolution of chlorine. Supposed to be altered triplite, and comes from Chanteloube, near Limoges.

Anal.—1–4 of altered triphylite, 5, 6, altered lithiophilite. 1, Rg., Pogg., **85**, 439, 1852. 2, Fuchs, l. c. 3, Dmr., l. c. 4, J. W. Mallet, Am. J. Sc., **18**, 33, 1854. 5, F. P. Dewey, ib., **17**, 367, 1879. 6, H. L. Wells, ib., p. 368. Other analyses, 5th Ed., p. 543.

| | G. | $P_2O_5$ | $Fe_2O_3$ | $Mu_2O_3$ | MnO | CaO | $Li_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 1. Limoges, *Heterosite* | 3·41 | 32·18 | 31·46 | 30·01 | — | — | — | 6·35 = 100 |
| 2. Rabenstein, *Pseudotr.* | | 35·70 | 48·17 | 8·94 | — | — | — | 5·30 $SiO_2$ 1·40=99·51 |
| 3. Chanteloube, *Alluaud.* | | 41·25 | 25·62 | 1·06 | 23·08 | — | — | 2·65 $SiO_2$ 0·60, $Na_2O$<br>[5·47 = 99·73 |
| 4. Norwich, Mass. | | $\frac{3}{3}$ 43·04 | 29·50 | 22·59 | — | 0·09 | 1·79 | 2·05 Mg 0·73 =99·79 |
| 5. Branchville | 3·395 | $\frac{2}{2}$ 40·66 | 12·56 | 25·27 | 11·66 | 0·18 | 5·66 | 3·07 $Al_2O_3$ 0·10,<br>[$Na_2O$ 0·49 = 99·65 |
| 6. " | 3·265 | $\frac{2}{2}$ 40·38 | 15·89 | 14·71 | 18·80 | 0·72 | 4·83 | 3·37 $K_2O$ 0·26, insol.<br>[0·90 = 99·86 |

**Ref.**—[1] Ber. Ak. Wien, **47** (1), 282, 1863. Cf. J. D. D., Am. J. Sc., **11**, 100, 1851.

A phosphate near triphylite has been described by W. P. Headden (Am. J. Sc., **41**, 416, 1891) from the "Nickel Plate" tin mine, Pennington Co., S. Dakota. It occurs in nodules associated with spodumene and beryl. Cleavage in two directions, one perfect, the other imperfect. Fracture uneven to subconchoidal. H. = 5. G. = 3·612. Luster greasy to vitreous. Color dark green. Transparent to translucent in thin splinters. Anal.—

| | $P_2O_5$ | FeO | MnO | CaO | MgO | $Na_2O$ | $K_2O$ | $Li_2O$ | F | ign. | gangue |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $\frac{2}{2}$ | 38·64 | 25·05 | 15·54 | 5·53 | 1·50 | 7·46 | 2·00 | 0·28 | 0·69 | 0·73 | 2·47 = 99·89 |

Formula deduced $4\overset{\text{I}}{R}_3PO_4.9\overset{\text{II}}{R}_3P_2O_8$.

MELANCHLOR *Fuchs*, J. pr. Ch., **17**, 171, 1839. A hydrous iron phosphate from Rabenstein, occurring on triphylite and probably derived from its alteration. The name alludes to its blackish green color.

## 545. NATROPHILITE. *G. J. Brush* and *E. S. Dana*, Am. J. Sc., 39, 205, 1890.

Orthorhombic, near triphylite in form; measured angles: $mm''' = 50° 30'$, $ll''' = 87°$, $ce = 47°–49°$. Chiefly massive, cleavable.

Cleavage: *c* perfect; *b* much less so; *m* interrupted. Fracture uneven to conchoidal. Brittle. H. = 4·5–5. G. = 3·41. Luster resinous to nearly adamantine, on *c* somewhat pearly. Color deep wine-yellow. Transparent to translucent. Optically +. Ax. pl. ∥ *c*. Bx ⊥ *b*.

**Comp.**—Sodium-manganese phosphate, $NaMnPO_4$ or $Na_3PO_4.Mn_3P_2O_8$ = Phosphorus pentoxide 41·1, manganese protoxide 41·0, soda 17·9, = 100.

**Anal.**—H. L. Wells, l. c.

| | $P_2O_5$ | MnO | FeO | $Na_2O$ | $Li_2O$ |
|---|---|---|---|---|---|
| $\frac{3}{3}$ | 41·03 | 38·19 | 3·06 | 16·79 | 0·19 $H_2O$ 0·43, insol. 0·81 = 100·50 |

**Pyr., etc.**—B.B. fuses easily, coloring the flame intensely yellow. Reacts for manganese with the fluxes. Soluble in acids.

**Obs.**—Occurs rather sparingly at Branchville, Fairfield Co., Connecticut, closely associated with the corresponding lithium-manganese phosphate, lithiophilite. It may have been derived from the alteration of it, analogous to the changes which the lithium silicate, spodumene, has undergone at the same locality (cf. p. 368).

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## 546. BERYLLONITE. *E. S. Dana*, Am. J. Sc., 36, 290, 1888. *E. S. Dana* and *H. L. Wells*, ibid., 37, 23, 1889.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·57243 : 1 : 0·54901 E. S. Dana.

$100 \wedge 110 = 29° 47' 17''$, $001 \wedge 101 = 43° 48' 13''$, $001 \wedge 011 = 28° 46' 2''$.

**Forms:**
*a* (100, $i$-$\bar{i}$)
*b* (010, $i$-$\breve{i}$)
*c* (001, *O*)

*g* (410, $i$-$\bar{4}$)
*h* (310, $i$-$\bar{3}$)
*i* (210, $i$-$\bar{2}$)
*j* (320, $i$-$\bar{\frac{3}{2}}$)
*m* (110, *I*)
*k* (230, $i$-$\breve{\frac{3}{2}}$)

*l* (120, $i$-$\breve{2}$)
*n* (130, $i$-$\breve{3}$)
*o* (140, $i$-$\breve{4}$)
*π* (150, $i$-$\breve{5}$)
*p* (160, $i$-$\breve{6}$)
*q* (1·12·0, $i$-$\breve{12}$)

*d* (102, $\frac{1}{2}$-$\bar{i}$)
*e* (101, 1-$\bar{i}$)
*f* (201, 2-$\bar{i}$)

*α* (014, $\frac{1}{4}$-$\breve{i}$)

*β* (013, $\frac{1}{3}$-$\breve{i}$)
*γ* (012, $\frac{1}{2}$-$\breve{i}$)
*δ* (023, $\frac{2}{3}$-$\breve{i}$)
*ϵ* (011, 1-$\breve{i}$)
*ζ* (032, $\frac{3}{2}$-$\breve{i}$)
*η* (021, 2-$\breve{i}$)
*ϑ* (031, 3-$\breve{i}$)
*κ* (041, 4-$\breve{i}$)
*λ* (051, 5-$\breve{i}$)
*μ* (061, 6-$\breve{i}$)

*ψ* (112, $\frac{1}{2}$)
*v* (111, 1)
*s* (221, 2)
*Δ* (331, 3)

*R* (411, 4-$\bar{4}$)
*u* (212, 1-$\bar{2}$)
*r* (211, 2-$\bar{2}$)
*T* (421, 4-$\bar{2}$)

*φ* (232, 1-$\breve{\frac{3}{2}}$)
*t* (231, 3-$\breve{\frac{3}{2}}$)

*ρ* (123, $\frac{2}{3}$-$\breve{2}$)
*χ* (122, 1-$\breve{2}$)
*w* (121, 2-$\breve{2}$)
*σ* (132, $\frac{3}{2}$-$\breve{3}$)
*x* (131, 3-$\breve{3}$)
*Q* (142, 2-$\breve{4}$)
*y* (141, 4-$\breve{4}$)
*z* (151, 5-$\breve{5}$)
*τ* (163, 2-$\breve{6}$)
*ω* (161, 6-$\breve{6}$)

$gg''' = 16^\circ\ 17'$
$hh''' = 21^\circ\ 36'$
$ii''' = 31^\circ\ 57'$
$mm''' = 59^\circ\ 34\frac{1}{2}'$
$ll' = 82^\circ\ 16'$
$nn' = 60^\circ\ 26'$
$oo' = 47^\circ\ 11'$
$\pi\pi' = 38^\circ\ 31'$

$dd' = 51^\circ\ 14'$
$ee' = 87^\circ\ 36\frac{1}{2}'$
$ff' = 124^\circ\ 56'$

$\alpha\alpha' = 15^\circ\ 38'$

$\beta\beta' = 20^\circ\ 44'$
$\gamma\gamma' = 30^\circ\ 42'$
$\delta\delta' = 40^\circ\ 12'$
$\epsilon\epsilon' = 57^\circ\ 32'$
$\eta\eta' = 95^\circ\ 21'$
$\vartheta\vartheta' = 117^\circ\ 28'$
$\kappa\kappa' = 131^\circ\ 2'$

$c\psi = 28^\circ\ 55'$
$cv = {}^*47^\circ\ 51\frac{1}{2}'$
$cs = 65^\circ\ 39'$
$c\varDelta = 73^\circ\ 13'$
$c\rho = 25^\circ\ 55'$

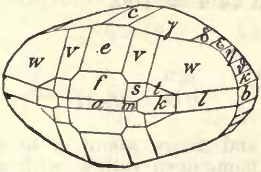
$cw = 55^\circ\ 33'$
$c\sigma = 43^\circ\ 37'$
$cx = 62^\circ\ 19'$
$cQ = 50^\circ\ 9'$
$cy = 67^\circ\ 21'$

$vv' = 80^\circ\ 6\frac{1}{2}'$
$vv''' = 43^\circ\ 14'$
$ww' = 65^\circ\ 42\frac{1}{2}'$
$ww''' = 76^\circ\ 47'$
$a\underset{\cdot}{t} = 45^\circ\ 8'$
$ax = 63^\circ\ 32'$

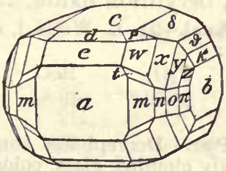
$bu = 78^\circ\ 48'$

$bv = 68^\circ\ 23'$
$bw = 51^\circ\ 36'$
$bx = 40^\circ\ 4'$
$by = 32^\circ\ 15'$
$bz = 26^\circ\ 47'$
$b\omega = 22^\circ\ 49'$
$bt = 52^\circ\ 43'$
$bs = 63^\circ\ 5'$
$br = 75^\circ\ 46'$
$b\tau = 43^\circ\ 43'$
$b\sigma = 53^\circ\ 24'$
$b\rho = 70^\circ\ 47'$

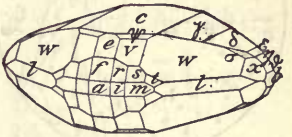
**1.**



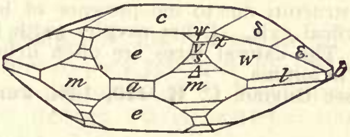
**2.**



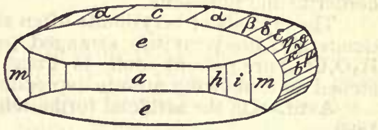
**3.**



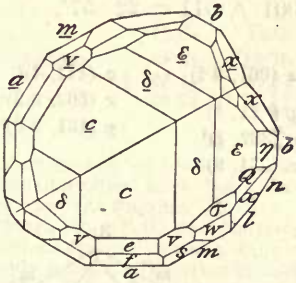
**4.**



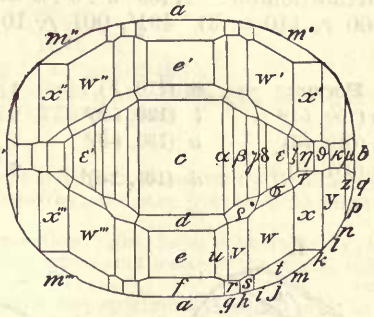
**5.**



**6.**



**7.**



Twins: tw. pl. *m*, hence $a\underline{a} = 120^\circ\ 25'$. Sometimes repeated, rarely in stellate forms. Crystals short prismatic to tabular, highly complex. Prismatic faces near *a* often united in oscillatory combination, hence showing vertical striations. Faces *v* also striated ∥ edge *v*/*f*. In crystals or broken fragments.

Cleavage: *c* highly perfect; *a* less so, interrupted; *m* still less distinct; *b* faintly indicated. Fracture conchoidal. Brittle. H. = 5·5–6. G. = 2·845. Luster vitreous, brilliant; sometimes on *c* pearly. Colorless to white or pale yellowish. Transparent.

Optically –. Ax. pl. ∥ *a*. Bx ⊥ *c*. Dispersion small $\rho < v$. Axial angles:

$2E_r = 120° 26'$ Li $\quad 2E_y = 121° 1'$ Na $\quad 2E_{gr} = 121° 24'$ Tl

Also

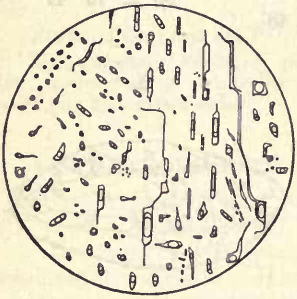
$2H_{a \cdot r} = 72° 35' \quad 2H_{a \cdot y} = 72° 47' \quad 2H_{a \cdot gr} = 73° 1'$

$2H_{o \cdot r} = 125° 13' \quad 2H_{o \cdot y} = 124° 59' \quad 2H_{o \cdot gr} = 124° 30' \quad 2V_y = 67° 34'$

Refractive indices:

| | $\alpha$ | $\beta$ | $\gamma$ |
|---|---|---|---|
| Red, Li | 1·5492 | 1·5550 | 1·5604 |
| Yellow, Na | 1·5520 | 1·5579 | 1·5608 |
| Green, Tl | 1·5544 | 1·5604 | 1·5636 |

8.



**Comp.**—A phosphate of beryllium and sodium, $NaBePO_4$ or $Na_3PO_4.Be_3P_2O_8$ = Phosphorus pentoxide 55·9, beryllium oxide, 19·7, soda 24·4 = 100.

**Anal.**—H. L. Wells, l. c.

| $P_2O_5$ | BeO | $Na_2O$ | ign. |
|---|---|---|---|
| 55·86 | 19·84 | 23·64 | 0·08 = 99·42 |

**Pyr.**—Decrepitates somewhat and fuses about 3 to a slightly clouded glass, coloring the flame deep yellow with a green streak on the lower edge. Slowly but completely soluble in hot acids.

**Obs.**—Found loose among the disintegrated material of a granitic vein, at Stoneham, Maine; associated with feldspars, smoky quartz, beryl, columbite. The same region has yielded herderite and phenacite.

The crystals of beryllonite often show a columnar structure due to the presence of hollow canals and fluid cavities arranged parallel to the vertical axis. Other cavities (with liquid $H_2O,CO_2$) are present often in great numbers (f. 8). The natural faces are often delicately etched on *c*, showing minute depressions nearly square in outline.

**Artif.**—On the artificial formation of beryllonite, see Ouvrad, C. R., **110**, 1334, June 23, 1890.

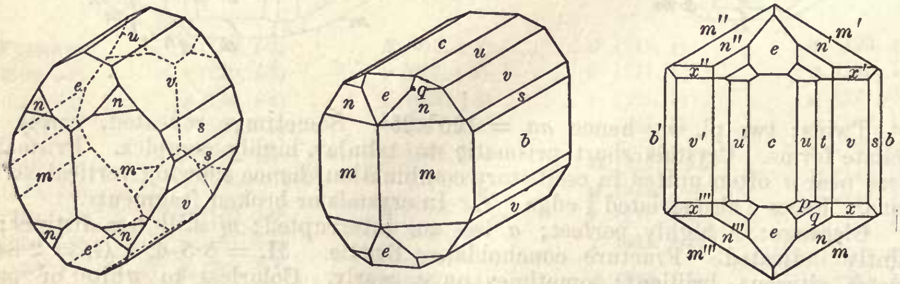
### 547. HERDERITE.

Herderite *Haid.*, Phil. Mag., **4**, 1, 1828. Allogonit *Breith.*, Uib., 23, 1830, Char., 78, 1832.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·62060 : 1 : 0·42345 E. S. Dana[1].

100 ∧ 110 = 31° 49½′, 001 ∧ 101 = 34° 18⅓′, 001 ∧ 011 = 22° 57′.

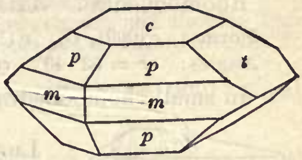
**Forms:**
*a* (100, *i*-$\bar{i}$)$^2$
*b* (010, *i*-$\breve{i}$)
*c* (001, *O*)
*m* (110, *I*)
*l* (120, *i*-$\breve{2}$)$^3$
*μ* (130, *i*-$\breve{3}$)$^3$
*d* (101, 1-$\bar{i}$)$^4$
*e* (302, $\frac{3}{2}$-$\bar{i}$)$^3$
*u* (011, 1-$\breve{i}$)$^3$
*t* (032, $\frac{3}{2}$-$\breve{i}$)
*v* (031, 3-$\breve{i}$)$^3$
*s* (061, 6-$\breve{i}$)
*p* (111, 1)
*q* (332, $\frac{3}{2}$)$^3$
*n* (331, 3)
*o* (441, 4)$^2$
*x* (362, 3-$\breve{2}$)$^3$
*y* (131, 3-$\breve{3}$)$^3$



Figs. 1–3, Stoneham.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $mm'''$ | = 63° 39′ | $cp$ | = 38° 46′ | $oo'$ | = 108° 26′ |
| $ll'$ | = 77° 43′ | $cq$ | = 50° 18′ | $xx'$ | = 64° 40′ |
| $\mu\mu'$ | = 56° 29′ | $cn$ | = 67° 27′ | $yy'$ | = 45° 46′ |
| $dd'$ | = 68° 37′ | $co$ | = 72° 42½′ | $pp'''$ | = 38° 33½′ |
| $ee'$ | = 91° 20′ | $cx$ | = 58° 29½′ | $qq'''$ | = 47° 52′ |
| $uu'$ | = *45° 54′ | $cy$ | = 55° 15½′ | $nn'''$ | = 58° 17½′ |
| $tt'$ | = 64° 51′ | $pp'$ | = 64° 17′ | $oo'''$ | = 60° 28′ |
| $vv'$ | = 103° 35′ | $qq'$ | = 81° 39′ | $nu$ | = *57° 7′ |
| $ss'$ | = 137° 2′ | $nn'$ | = 103° 24′ | | |

4.



4, Ehrenfriedersdorf.

Crystals sometimes resembling a low hexagonal pyramid (f. 4); also short prismatic in direction of axis ǎ.

Cleavage: *m* interrupted. Fracture subconchoidal. H = 5. G. = 2·99–3·01; 3·012, a perfectly transparent crystal from Stoneham, Penfield. Luster vitreous, inclining to subresinous. Color various shades of yellowish and greenish white. Translucent.

Optically –. Ax. pl. ∥ *b*. Bx ⊥ *à*. Dispersion $\rho > v$. Axial angles, Dx.[5]:

| | | | |
|---|---|---|---|
| Maine | $2E_r$ = 121° 44′ Li | $2E_y$ = 121° 22′ Na | $2E_{bl}$ = 120° 33′ $CuSO_4$ |
| " | $2H_{a.r}$ = 72° 34′ glass | $2H_{a.y}$ = 72° 12′ | $2H_{a.bl}$ = 71° 24′ |
| " | $2E_r$ = 120° 21′ | $2E_y$ = 119° 45′ | $2E_{bl}$ = 119° 11′ |

Also for yellow $\alpha = 1·592$, $\beta = 1·612$, $\gamma = 1·621$ Btd.

| | | | | |
|---|---|---|---|---|
| Saxony | $2H_{a.r}$ = 74° 18′ | $2H_{a.y}$ = 74° 4′ | $2H_{o.r}$ = 105° 11′ | ∴ $2V_r$ = 74° 29′ |
| " | $2E_r$ = 124° 35′ | $2E_y$ = 124° 18′ | $2H_{o.y}$ = 105° 23′ | ∴ $2V_y$ = 74° 16′ |

**Comp.**—A fluo-phosphate of beryllium and calcium, $(CaF)BePO_4$, with the fluorine in part replaced by hydroxyl. If F : OH = 1 : 1, this requires: Phosphorus pentoxide 43·8, beryllium oxide 15·4, lime 34·6, fluorine 5·9, water 2·8 = 102·5, deduct 2·5 (O = 2F) = 100. If fluorine alone were present the amount would be 11·7 p. c.

Groth includes herderite in the Olivenite Group, cf. Tab. Ueb., pp. 75, 76, 1889.

**Anal.**—1, Mackintosh, Am. J. Sc., **27**, 135, 1884. 2, Genth, Am. Phil. Soc., **21**, 694, 1884. 3, Penfield and Harper, Am. J. Sc., **32**, 107, 1886.

| | $P_2O_5$ | BeO | CaO | F | $H_2O$ |
|---|---|---|---|---|---|
| 1. Stoneham | 44·31 | 15·76 | 33·21 | 11·32 | — = 104·60 |
| 2. " | 43·43 | 15·04 | 33·65 | 8·93 | 0·61? $Al_2O_3,Fe_2O_3$ 0·35, MnO 0·11=102·12 |
| 3. " | 43·74 | 15·51 | 33·67 | 5·27 | 3·70 = 101·89 |

Analyses of the herderite from Ehrenfriedersdorf and from Stoneham by Winkler, made on minute quantities, have been shown to be untrustworthy; he gave considerable alumina and overlooked the fluorine, Jb. Min., 2, 134, 1884.

**Pyr., etc.**—B.B. phosphoresces with an orange-yellow light, fuses with difficulty, becomes white and opaque; takes a blue with cobalt solution; gives acid water in the closed tube when strongly heated. Dissolves in acids.

**Obs.**—The original herderite is known only from a few specimens obtained prior to 1825 at the tin mines of Ehrenfriedersdorf, Saxony; the crystals described by Haidinger resemble apatite in form (f. 4). $pp'''$ = 38° 43′ herderite, $xx'$ = 37° 44′ apatite.

Discovered in 1883 at Stoneham, Maine (see Hidden, Am. J. Sc , 27, 73, 135, 1884). It occurs in a granitic ledge in isolated crystals and in clusters implanted on quartz crystals, or embedded in them; also on muscovite and associated with albite; found sparingly with tourmaline at Auburn, Me.; also at Hebron.

Named after Baron von Herder, director of the Saxon mines. The name *glucinite* was suggested (Hidden, l. c.) for the Stoneham mineral in the idea that it might prove to differ from the Saxon in containing beryllium (glucinum) in place of aluminium, but the identity of the minerals from the two localities has been thoroughly proved.

**Ref.**—[1] Stoneham, Am. J. Sc., **27**, 229, 1884. Haidinger gives for Ehrenfriedersdorf: $pp'$ = 63° 57′, $pp'''$ = 38° 43′. [2] Ehrenfriedersdorf only, Haid., l. c. [3] Stoneham only, E. S. D., l. c. [4] Stoneham, Hidden, *ibid.*, **32**, 209, 1886. [5] Dx., Bull. Soc. Min., **7**, 130, 1884; Btd., **9**, 141, 1886.

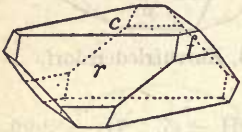
**548. HAMLINITE.** *W. E. Hidden* and *S. L. Penfield*, Am. J. Sc., **39**, 511, 1890.

Rhombohedral. Axis $\dot{c} = 1{\cdot}1353$; $0001 \wedge 10\bar{1}1 = 52° \ 39\tfrac{5}{6}'$ Penfield.

**Forms:** $c$ (0001, $O$), $r$ ($10\bar{1}1$, R), $f$ ($02\bar{2}1$, $-2$).

Angles: $cr = 52° \ 40'$, $cf = 69° \ 7\tfrac{1}{2}'$, $rr' = {}^*87° \ 2'$, $ff' = 108° \ 2'$, $rf = 54° \ 1'$.

In small rhombohedral crystals with basal plane prominent.



Cleavage: basal, perfect. H. = 4·5. G. = 3·228. Luster on $c$ pearly; on rhombohedral faces greasy to resinous. Colorless and transparent, or with a slight yellow tint. Optically +; double refraction not strong.

**Comp.**—A phosphate of aluminium or beryllium (or both) with water and fluorine; exact composition undetermined.

**Pyr., etc.**—B.B. fuses about 4 to a white porcelain-like mass coloring the flame green. In the closed tube gives off water abundantly and fluorine which etches the glass. Slowly soluble in acids, giving a solution which reacts strongly for phosphoric acid. The presence of aluminium (or beryllium) and absence of calcium were proved by qualitative test.

**Obs.**—Occurs very sparingly at Stoneham, Me., associated with the beryllium phosphate, herderite, and the beryllium silicate, bertrandite. Only a single specimen has thus far been found.

Named after Dr. A. C. Hamlin of Bangor, Me., author of a work on precious stones.

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### 3. Apatite Group. Hexagonal with pyramidal hemihedrism.

Phosphates, Arsenates, Vanadates of calcium and lead, with chlorine or fluorine.

General formula $R_5(F,Cl)[(P,As,V)O_4]_3 = (R(F,Cl))R_4[(P,As,V)O_4]_3$;

Also written $3R_3(P,As,V)_2O_8.R(F,Cl)_2$. Here R=Ca or Pb, also Mn.

| | | | | $\dot{c}$ |
|---|---|---|---|---|
| 549. | **Apatite** | $(CaF)Ca_4(PO_4)_3$ | Fluor-apatite | 0·7346 |
| | | or $(CaCl)Ca_4(PO_4)_3$ | Chlor-apatite | |
| | Manganapatite | $(CaF)Ca_4(PO_4)_3$ with $(MnF)Mn_4(PO_4)_3$ | | |
| 550. | **Pyromorphite** | $(PbCl)Pb_4(PO_4)_3$ | | 0·7362 |
| | Polysphærite | $((Pb,Ca)Cl)(Pb,Ca)_4(PO_4)_3$ | | |
| 551. | **Mimetite** | $(PbCl)Pb_4(AsO_4)_3$ | | 0·7224 |
| | Campylite | $\left\{\begin{matrix}(PbCl)Pb_4(PO_4)_3\\(PbCl)Pb_4(AsO_4)_3\end{matrix}\right.$ | | |
| 552. | **Vanadinite** | $(PbCl)Pb_4(VO_4)_3$ | | 0·7122 |
| | Endlichite | $\left\{\begin{matrix}(PbCl)Pb_4(AsO_4)_3\\(PbCl)Pb_4(VO_4)_3\end{matrix}\right.$ | | 0·7495 |

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**549. APATITE.** *Crystallized from Spain.* Chrysolite ordinaire *de Lisle* (with figs.), Crist., 1772, **2**, 271, 1783; = Spargelgrüne Steinkrystalle aus Spanien nähern Apatit *Wern.*, Bergm J., 74, 1790; = Spargelstein *Wern.;* Asparagus Stone; Pierre d'Asperge *Fr.;* Asparagolithe *Abildgaard*, Ann. Ch., **32**, 195, 1800. Chaux phosphatée *Vauq.*, Ann. Ch., **26**, 123, 1798. Phosphate of Lime.

*Cryst fr. Saxony.* Aquamarin (celandine-green, fr. Schneckenstein) *Brunnich*, his Cronst., 1770. Améthiste basaltine (mostly violet, fr. Mines d'etain de Saxe) *Sage*, Min., **1**, 231, 1777; *de Lisle*, Crist., **2**, 254, 1783; = Apatit *Wern.*, Gerhard's Grundr., 281, 1786, Bergm. J., 576, 1788, 378, 1789. Phosphorsaurer-Kalk *Klapr.*, ib., 294, 1788. Sächsischer Beryll, Agustit (with announcem. of supposed new earth, Augusterde), *Trommsdorf*, Trommsd. J. Pharm., 1800.

*Cryst. fr. Norway, etc.* Moroxit (fr. Arendal) *Abildgaard*, Moll's Jahrb. B. H., **2**, 432, 1798. Francolite (fr. Devonshire) *Brooke*, *T. H. Henry*, Phil. Mag., **36**, 1850. Lazur-Apatit *N. Nd.*, Bull. Soc. Moscou, **30**, 224, 1857.

*Massive.* La Pierre Phosphorique (fr. Lagrosan, Estremadura) *Davila*, p. 60, Madrid; = Phosphate calcaire *Proust*, J. Phos., **32**, 241, 1788; *Pelletier*, Ann. Ch., **7**, 1790; = Phosphorite

*Kirw.*, Min., **1**, 129, 1794; id., *Karst.*, Tab., 52, 1808. Eupyrchroite (fr. N. Y.) *Emmons*, Rep. G. N. Y., 1838. Osteolith *Bromeis*, Lieb. Ann., **79**, 1851 = Bone-phosphate.

Apatite (incl. the Saxon and the Spanish crystallized (Spargelstein) and massive Phosphorite, excl. Moroxite) *Karst.*, Tab., 36, 1800; id. incl. the same and also Moroxite) *H.*, Tr., **2**, 1801.

Hexagonal, with pyramidal hemihedrism. Axis $\dot{c} = 0{\cdot}734603$; $0001 \wedge 10\bar{1}1 = 40° 18' 22''$ Koksharov[1].

**Forms**[2]:
*c* (0001, *O*)
*m* (10$\bar{1}$0, *I*)
*a* (11$\bar{2}$0, *i*-2)
*h* (21$\bar{3}$0, *i*-$\frac{3}{2}$, r)
*h*, (3$\bar{1}\bar{2}$0, *i*-$\frac{3}{2}$, l)[3]
*k* (4150, *i*-$\frac{5}{4}$, r)[4]

τ (10$\bar{1}$6, $\frac{1}{6}$)[6]
σ (10$\bar{1}$3, $\frac{1}{3}$)[6]
ζ (5·0·$\bar{5}$·12, $\frac{5}{12}$)[5]
*r* (10$\bar{1}$2, $\frac{1}{2}$)
η (30$\bar{3}$5, $\frac{3}{5}$)[8]
ε (30$\bar{3}$4, $\frac{3}{4}$)[6]
*x* (10$\bar{1}$1, 1)

α (30$\bar{3}$2, $\frac{3}{2}$)
*y* (20$\bar{2}$1, 2)
*w* (70$\bar{7}$3, $\frac{7}{3}$)[9]
*z* (30$\bar{3}$1, 3)
π (40$\bar{4}$1, 4)[6]
χ (1·1·$\bar{2}$·12, $\frac{1}{6}$-2)[12]
φ (11$\bar{2}$6, $\frac{1}{3}$-2)[6]

ψ (11$\bar{2}$4, $\frac{1}{2}$-2)[10]
*v* (11$\bar{2}$2, 1-2)
*s* (11$\bar{2}$1, 2-2)
*d* (22$\bar{4}$1, 4-2)
zone *msx'*, r)
ρ (41$\bar{5}$1, 5-$\frac{5}{4}$)[5]
*n* (31$\bar{4}$1, 4-$\frac{4}{3}$)

ω (7·3·$\overline{10}$·3, $\frac{10}{3}$-$\frac{10}{7}$)[7]
μ (21$\bar{3}$1, 3-$\frac{3}{2}$)
*i* (12$\bar{3}$2, $\frac{3}{2}$-$\frac{3}{2}$)[5]
μ, (3$\bar{1}\bar{2}$1, 3-$\frac{3}{2}$, l)[3]
*o* (31$\bar{4}$2, 2-$\frac{4}{3}$, r)
*q* (43$\bar{7}$1, 7-$\frac{7}{4}$, r)[9]

Also the vicinal form[11]: δ (3·1·$\bar{4}$·280, $\frac{1}{70}$-$\frac{4}{3}$).

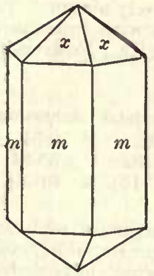
*mk* = 10° 54′
*mh* = 19° 6′
*c*τ = 8° 3′
*c*σ = 15° 47′
*c*ζ = 19° 28′
*cr* = 22° 59′
*c*η = 26° 58½′
*c*ε = 32° 28′
*c*α = 51° 50′
*cy* = 59° 29′
*cw* = 63° 12′
*cz* = 68° 33′
*c*π = 73° 35′

*c*φ = 13° 45½′
*cv* = 36° 18′
*cs* = 55° 45½′
*cd* = 71° 12′
*c*ρ = 75° 34′
*co* = 56° 49′
*cn* = 71° 54′
*ci* = 48° 18′
*c*μ = 65° 59′
*cq* = 79° 2′
ττ′ = 8° 2′
σσ′ = 45° 38′
ζζ′ = 19° 11′

*rr′* = 22° 31′
ηη′ = 26° 13′
εε′ = 31° 8′
*xx′* = *37° 44½′
αα′ = 46° 18′
*yy′* = 51° 2′
*zz′* = 55° 28′
*vv′* = 34° 26′
*ss′* = 48° 50′
*dd′* = 56° 30′
μμ′ = 54° 21′
μμ, = 19° 53′

μμ,$^{v}$ = 34° 48′
*m*ρ = 18° 7½′
*mn* = 22° 41′
*m*ψ = 27° 18′
*m*μ = 30° 20′
*ms* = 44° 17′
*mi* = 55° 38½′
*mx′* = 71° 8′
*aq* = 11° 56′
*a*μ = 26° 14′
*ao* = 36° 29′
*ax* = 55° 56′

1.



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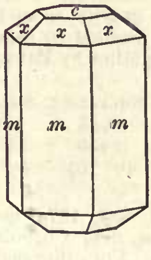

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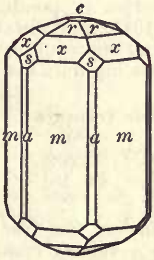

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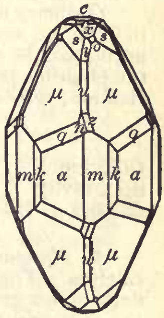

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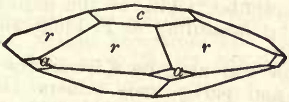

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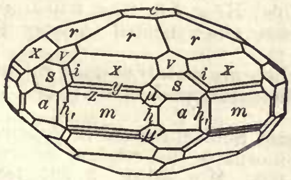

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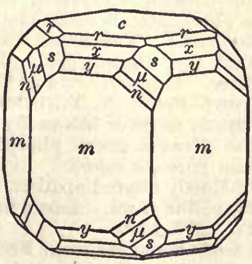

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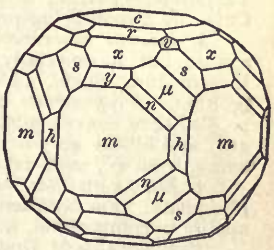
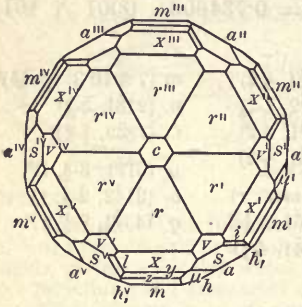


Figs. 1, 2, Common forms. St. Lawrence Co., N. Y., and Canada. 3, 6, Alexander Co., N. C., Hidden and Washington[13]. 4, Paris, Me.[9] 5, Hebron. 7, Branchville, Conn., Pirsson. 8, St. Gothard, Haidinger.

Crystals varying from long prismatic to short prismatic and tabular; in the latter cases often highly modified; also in low pyramids (f. 5); rarely terminated by a pyramid of the third series (f. 4). Also globular and reniform, with a fibrous or imperfectly columnar structure; massive, structure granular to compact.

9.



Alexander Co., N. C., basal section of f. 6.

Cleavage: *c* imperfect; *m* more so. Fracture conchoidal and uneven. Brittle. Etching-figures conform to the pyramidal hemihedrism[14]. H. = 5, sometimes 4·5 when massive. G. = 3·17–3·23 cryst. Luster vitreous, inclining to subresinous. Streak white. Color usually sea-green, bluish green; often violet-blue; sometimes white; occasionally yellow, gray, red, flesh-red, and brown. Transparent to opaque. A bluish opalescence sometimes in the direction of the vertical axis, especially in white varieties. Some colored varieties pleochroic; absorption $\epsilon > \omega$.

Optically —. Double refraction weak. Sometimes abnormally biaxial (cf. Mld.[15]). Indices, Heusser[16]:

| Fraunhofer lines | D | E | F | G |
|---|---|---|---|---|
| $\omega$ | 1·64607 | 1·64998 | 1·65332 | 1·65953 |
| $\epsilon$ | 1·64172 | 1·64543 | 1·64867 | 1·65468 |

**Var.**—1. *Ordinary.* Crystallized, or cleavable and granular massive. Colorless to green, blue, yellow, flesh-red. (*a*) The *asparagus-stone*, originally from Murcia, Spain, is yellowish green, as the name implies. *Moroxite*, from Arendal, is in greenish blue and bluish crystals. Both names have been used for apatite of the same shades from other places. (*b*) *Lasurapatite* is a sky-blue variety; it occurs in crystals with lapis-lazuli in Siberia. (*c*) *Francolite*, from Wheal Franco, near Tavistock, Devonshire, occurs in small crystalline stalactitic masses, grayish green to brown, and in minute curving crystals (anal. 11).

Ordinary apatite is *fluor-apatite*, containing fluorine often with only a trace of chlorine, up to 0·5 p. c.; rarely the chlorine preponderates, and sometimes fluorine is entirely absent. The normal angle, *cx* ($0001 \wedge 10\bar{1}1$), and also the specific gravity seem to diminish with increase of the chlorine percentage, but more observations are needed to establish this (Kk., Pusirevsky, Baumh., ref. [1]). The following data are brought together by Baumhauer:

| | Schwarzenstein | Tokovaya | Sulzbach | Rothenkopf | Sliudianka | Blagodatsk | Achmatovsk |
|---|---|---|---|---|---|---|---|
| Chlorine | *tr.* | 0·01 | 0·028 | 0·085 | 0·109 | 0·22 | 0·51 |
| Sp. gravity | 3·215 | 3·202 | 3·153 | 3·149 | 3·178 | 3·132 | 3·091 |
| *cx* ($0001 \wedge 10\bar{1}1$) | 40° 17′ | 40° 18⅛′ | 40° 15½′ | 40° 10¾′ | — | 40° 16⅙′ | 40° 6⅛′ |

2. *Manganapatite* (Siewert, Zs. Nat. Halle, **10**, 339, 1874) contains manganese replacing calcium. The original is a variety from San Roque, near Córdoba, Argentine Republic, color dark bluish green, containing 6·7 p. c. MnO, anal. 26. For other occurrences, which have proved to be not uncommon, see anals. 27–33. The dark green apatite from Dixon's quarry, Wilmington, Del., also contains considerable manganese (Genth, priv. contr.).

*Cupro-apatite* Adam, Tabl. Min., 45, 1869. From near Coquimbo, Chili, at the mines of Tambillos, occurring in clear turquoise-blue crystals, containing, according to F. Field, 20·93 CuO, the copper being present as phosphate; it needs confirmation.

3. *Fibrous, concretionary, stalactitic.* The name *Phosphorite* was used by Kirwan for all apatite, but it especially included the fibrous concretionary and partly scaly mineral from Estremadura, Spain, and elsewhere. It has H. = 4·5; G. = 2·92–3 Forbes, but 2·98–3·12 after ignition. *Eupyrchroite*, from Crown Point, N. Y., belongs here; it is concentric in structure, consisting of convex subfibrous layers, more or less easily separable; H. = 4·5; G. = 3·053; ash-gray and bluish gray in color, and gives a green phosphorescence when heated (whence the name, from *εὖ, well, πῦρ, fire*, and *χρόα, a color*).

4. *Earthy apatite; Osteolite.* Mostly altered apatite. Coprolites are mainly impure calcium phosphate. For both see beyond, p. 768 *et seq.* Lasne finds sedimentary phosphates to be fluor-apatite in composition, C. R., **110**, 1376, 1890.

*Pseudoapatite* of Breithaupt from Kurprinz, near Freiberg, and Schlackenwald in Bohemia, has been called pseudomorphous apatite. Frenzel makes pyromorphite the original mineral, analysis: $P_2O_5$ 39·28, CaO 56·66, $SO_3$ 1·42, $CO_2$ [2·64], Cl *tr.* = 100. Min. Mitth., 3, 364, 1880.

*Staffelite* of Stein (Jb. Min., 716, 1866) occurs incrusting the phosphorite of Staffel, in botryoidal, reniform, or stalactitic masses, fibrous and radiating. H. = 4. G. = 3·128. Color leek to dark green, greenish yellow. See anal. 37. Stein regards it as a result of the action of carbonated waters on phosphorite.

**Comp.**—For *Fluor-apatite* $(CaF)Ca_4P_3O_{12}$; for *Chlor-apatite* $(CaCl)Ca_4P_3O_{12}$; also written $3Ca_3P_2O_8 + CaF_2$ and $3Ca_3P_2O_8 + CaCl_2$. There are also intermediate compounds containing both fluorine and chlorine. The percentage composition for these normal varieties is as follows:

| | | | | | | |
|---|---|---|---|---|---|---|
| *Fluor-apatite* | $P_2O_5$ 42·3 | CaO 55·5 | F 3·8 = 101·6 | or $Ca_3P_2O_8$ 92·25 | $CaF_2$ 7·75 | = 100 |
| *Chlor-apatite* | $P_2O_5$ 41·0 | CaO 53·8 | Cl 6·8 = 101·6 | or $Ca_3P_2O_8$ 89·4 | $CaCl_2$ 10·6 | = 100 |

In the formula as first (and more correctly) written the univalent group (CaF) or (CaCl) takes the place of one hydrogen atom in the acid $3H_3PO_4 = H_9P_3O_{12}$.

Some analyses give results at variance with this normal composition, showing a deficiency in the fluorine and chlorine: thus Voelcker proposes to write the formula $3Ca_3P_2O_8.\left\{\begin{matrix} CaF_2 \\ CaCl_2, \\ CaO \end{matrix}\right.$ and Hoskyns-Abrahall gives $Ca_{10}(PO_4)_6(O,F_2,Cl_2)$. Cf. Groth, Tab. Ueb., 74, 1889.

Fluor-apatite is much more common than the other variety; here belongs the apatite of the Alps, Spain, St. Lawrence Co., N. Y., Canada. Apatites in which chlorine is prominent are rare; this is true of some Norwegian kinds. An apatite from Kragerö contained 4·10 chlorine and no fluorine, Voelcker, J. pr. Ch., **75**, 384, 1858, while others gave 1·38 and 1·03. See also analyses below. Varieties also occur in which the calcium is largely replaced by manganese, as in *manganapatite*. Further Cossa (Trans. Acc. Linc., **3**, 17, 1878) has noted the presence of didymium (also Ce,La) in many apatites as proved by absorption bands in the spectrum; these elements have been found before by chemical means, but usually referred to enclosed cryptolite. Scheerer found 5 p. c. cerium oxide in the apatite of the augite-syenite of southern Norway, which is *not* due to enclosed cryptolite—cf. Bgr., Zs. Kr., **16**, 70, 1890.

**Anal.**—G. Rose first detected the fluorine and chlorine, and published the following as the composition of different specimens (Pogg., **9**, 185, 1827):

| | 1. Snarum | 2. Murcia | 3. Arendal | 4. Greiner | 5. St. Gothard |
|---|---|---|---|---|---|
| | G. = 3·174 | G. = 3·235 | G. = 3·222 | G. = 3·175 | G. = 3·197 |
| Calcium phosphate | 91·13 | 92·066 | 92·189 | 92·16 | 92·31 |
| Calcium chloride | 4·28 | 0·885 | 0·801 | 0·15 | *tr.* |
| Calcium fluoride | 4·59 | 7·049 | 7·01 | 7·69 | 7·69 |

The following are other typical analyses; some earlier ones are given in 5th Ed., p. 532.

1–7, Hoffmann, Rep. G. Surv. Canada, 1 H., 1879. 8, 9, Voelcker, Inaug. Diss., Giessen, 1883. 10, Rowan, Ch. News, **50**, 208, 1884. 11, Maskelyne and Flight, J. Ch. Soc., **24**, 3, 1871. 12, Klement, Bull. Mus. Belg., **5**, 159, 1888. 13–15, Hoskyns-Abrahall, Inaug. Diss., Munich, 1889. 16, Sachsse, after deducting impurities, quoted by Stelzner, Jb. Min., **1**, 265, 1889. 17, Schertel, ibid. 18, Nikolayev, Zs. Kr., **11**, 391, 1886; also other anals. of massive varieties with 3·05 to 1·87 p. c. Cl. 19–24, Voelcker, l. c. 25, Waage, quoted by Brögger and Reusch, Zs. G. Ges., **27**, 674, 1875; also another anal. with 3·5 p. c. Cl.

26. Siewert, l.c. 27, 29, 30, Penfield, Am. J. Sc., **19**, 367, 1880. 28, Dewey, ibid. 31. Hilger, quoted by Sandberger, Jb. Min., **1**, 171, 1885. 32, Weibull, G. För. Förh., **8**, 492, 1886. 33, Igelström, Bull. Soc. Min., **5**, 303, 1882.

34, Garzo and Penuelas, Bull. Soc. G., **17**, 157, 1860. 35, Mayer, Lieb. Ann., **101**, 281, 1857. 36, 37, Forster, quoted by Stein, Jb. Min., 716, 1866. 38, Jackson, Am. J. Sc., **12**, 73, 1851.

For many other analyses of phosphorite see: Wicke, Nassau, Jb. Min., 88, 1869. Schwackhöfer, Jb. G. Reichs., **21**, 211, 1871. De Reydellet, Belmez, Bull. Soc. G., **1**, 350, 1873. Niederstadt, Estremadura, Ber. Ch. Ges., 107, 1874. Nivoit, Ciply C. R., **79**, 256, 1874. Möller, Nizhni Novgorod, Vh. Min. Ges., **12**, 61, 187 . Gunn, Russia, Min. Mag., **1**, 209, 1876. Guyot, Vosges, C. R., **87**, 333, 1878. Vernadsky, Zmolensk, Zs. Kr., **17**, 628, 1890.

| | G. | $P_2O_5$ | CaO | F | Cl | $Al_2O_3$ | $Fe_2O_3$ | MgO | insol. | $CO_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Storrington | 3·139 | 40·37 | 53·05 | 3·31 | 0·44 | 0·61 | 0·15 | 0·15 | 3·89 | 0·03 | = 102·04 |
| 2. Buckingham | 3·149 | 41·08 | 54·49 | 3·47 | 0·26 | 0·71 | 0·13 | 0·16 | 0·37 | 0·37 | = 101·04 |
| 3. N. Burgess | 3·160 | 39·05 | 52·29 | 3·79 | 0·48 | 1·19 | 1·29 | 0·55 | 3·49 | 0·10 | = 102·23 |
| 4. Portland | 3·188 | 41·14 | 55·21 | 3·86 | 0·23 | 0·57 | 0·09 | 0·18 | 0·06 | 0·22 | = 101·56 |
| 5. Loughborough | 3·164 | 40·87 | 54·31 | 3·73 | 0·43 | 0·84 | 0·91 | 0·16 | 1·15 | 0·11 | = 102·51 |
| 6. Portland | 3·168 | 40·52 | 54·09 | 3·38 | 0·09 | 0·27 | 0·08 | 0·21 | 1·63 | 0·86 | = 101·13 |
| 7. Templeton | 3·175 | 40·81 | 54·37 | 3·55 | 0·04 | 0·57 | 0·13 | 0·62 | 0·63 | 0·52 | = 101·24 |
| 8. Canada | | 40·93 | 54·80 | 2·20 | 0·09 | 0·86 | 0·41 | 0·19 | 0·15 | 0·86 | $SO_3$ 0·32, ign. 0·25 = 101·10 |
| 9. " | | 41·37 | 55·19 | 2·45 | 0·48 | 0·99 | 0·24 | — | 0·99 | — | = 101·71 |
| 10 Amelia Co., Va. | 3·161 | 41·06 | 53·94 | 3·30 | *tr.* | 0·19 | 0·81 | — | 0·63 | — | ign. 0·81 = 100·74 |

| | G. | $P_2O_5$ | CaO | F | Cl | $Al_2O_3$ | $Fe_2O_3$ | MgO | insol. | $CO_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11. Tavistock, *Francolite* | | 38·14 | 54·09 | 3·34 | — | — | 0·91[a] | 0·69[c] | — | 2·25 | $H_2O$ 1·59 [= 101·01 |
| 12. Ciply | | 43·49 | 54·49 | 1·31 | 0·57 | 1·46 | 0·33 | 0·42 | *tr.* | — | = 102·07 |
| 13. Zillerthal | | $\frac{4}{4}$ 42·86 | 56·22 | 1·54 | — | — | — | — | — | — | = 100·62 |
| 14. Jumilla | | 41·12 | 55·45 | 1·98 | 0·24 | — | 1·07 | 0·44[c] | — | — | ign. 0·25 [= 100·55 |
| 15. Ehrenfriedersdorf | | 42·07 | 55·83 | 2·27 | — | — | 0·56[d] | — | — | — | ign. 0·57 [= 100·90 |
| 16. Freiberg | | 42·60 | 55·43 | 3·41 | — | — | — | — | — | — | = 101·44 |
| 17. Kinzigthal | | 42·51 | 55·46 | 3·51 | — | — | — | — | — | — | = 101·58 |
| 18. Turkestan | 3·199 | 41·93 | 55·29 | 3·64 | *tr.* | — | — | 0·18[e] | 0·12 | — | = 101·16 |
| 19. Norway *cryst.* | | 41·65 | 54·25 | — | 1·52 | 0·92 | 0·40 | — | 0·64 | 0·09 | $SO_3$ 0·14, [ign. 0·22 = 99·83 |
| 20. " A. " | | 41·29 | 54·57 | — | 0·81 | 1·85 | 1·62 | — | 0·34 | — | $SO_3$ 0·15, [ign. 0·44 = 101·07 |
| 21. " B. " | | $\frac{2}{3}$ 41·17 | 53·91 | — | 0·91 | 1·04 | 1·57 | — | 0·32 | — | $SO_3$ 0·13, [ign. 0·30 = 99·35 |
| 22. " " | | 40·29 | 53·23 | — | 2·26 | 0·39 | 0·64 | — | 1·89 | — | $SO_3$ 0·15, [ign. 0·14 = 98·99 |
| 23. " *mass.* | | 40·48 | 51·97 | — | 5·06 | 0·91 | 0·24 | — | 1·77 | — | $SO_3$ 0·18, [ign. 0·14 = 100·75 |
| 24. Arendal, *Moroxite* | | 41·58 | 53·92 | — | 0·50 | | [3·61][b] | | 0·31 | — | ign. 0·08 [= 100 |
| 25. Ödegaard, *red* | | 41·15 | 51·0 | — | 5·8 | — | — | — | 0·8 | — | ign. 0·6 [= 99·35 |

[a] Incl. moisture, in 8, 0·04; in 9, 0·18. [b] Incl. $CO_2$,$SO_3$. [c] $Na_2O$. [d] FeO + MnO. [e] MnO.

*Manganapatite.*

| | G. | $P_2O_5$ | CaO | MnO | F | Cl | $Al_2O_3$ | $Fe_2O_3$ | insol. | |
|---|---|---|---|---|---|---|---|---|---|---|
| 26. Córdoba | | $\frac{3}{3}$ 42·54 | 48·01 | 6·59 | 2·75 | — | — | 0·92[a] | — | MgO 0·48 [= 101·29 |
| 27. Branchville, *dark green* | 3·39 | 41·63 | 44·92 | 10·59 | 3·12 | 0·03 | — | 0·77 | — | = 101·06 |
| 28. " *green* | | 40·96 | 53·53 | 2·48 | 3·84 | — | 0·50 | 0·08 | 0·06 | = 101·45 |
| 29. " *white* | 3·144 | 41·47 | 53·15 | 1·96 | 2·68 | 0·10 | — | 0·22 | 1·50 | = 101·08 |
| 30. Franklin Furn., *cryst.* | 3·22 | 39·59 | 51·64 | 1·35 | 3·37 | 0·04 | 0·56 | 0·77 | — | ZnO 0·03, [$CaCO_3$ 2·82, $H_2O$ 0·52 = 99·69 |
| 31. Zwiesel | 3·169 | 43·95 | 52·78 | 3·04 | 2·15 | — | — | — | — | = 101·92 |
| 32. Westanå | | 42·04 | 50·12 | 5·95 | 3·74 | *tr.* | — | — | — | = 101·85 |
| 33. Horrsjöberg | | 36·42 | 45·17 | 8·80[b] | | *und.* | — | — | — | = |

[a] FeO. [b] Incl. some FeO.

*Phosphorite.*

| | G. | $P_2O_5$ | CaO | F | Cl | $Al_2O_3$ | $Fe_2O_3$ | MgO | insol. | $CO_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 34. Estremadura | | 40·12 | 53·50 | 2·16 | 0·06 | 3·10[a] | 0·61 | — | — | — | = 100·21 |
| 35. Amberg | | 39·57 | 52·21 | 1·90 | — | — | 0·90 | 0·09 | 1·96 | 2·78 | Alk. 0·66 [= 100·07 |
| 36. Staffel | | 34·48 | 45·79 | 3·45 | — | 1·08 | 6·42 | 0·16 | 4·83[b] | 1·51 | Alk. 1·00, [$H_2O$ 2·45 = 101·17 |
| 37. " *Staffelite* | 3·128 | 39·05 | 54·67 | 3·05 | — | 0·03 | 0·04 | — | — | 3·19 | $H_2O$ 1 40 [= 101·43 |
| 38. *Eupyrchroite* | 3·053 | 45·71 | 48·71 | 0·60 | 0·13 | — | 2·00[c] | — | — | 2·77[d] | $H_2O$ 0·50 [= 100·42 |

[a] Incl. $SiO_2$. [b] $SiO_2$ [c] FeO. [d] $CaCO_3$.

For further analyses of phosphorite see references above.

The oxygen equivalent of the fluorine (chlorine) is to be deducted from the above analyses. Anal. 20, 21 are from different parts of the same crystal. From 16, 17, impurities have been deducted.

**Pyr., etc.**—B.B. in the forceps fuses with difficulty on the edges (F. = 4·5–5), coloring the flame reddish yellow; moistened with sulphuric acid and heated colors the flame pale bluish green (phosphoric acid); some varieties react for chlorine with salt of phosphorus, when the bead has been previously saturated with copper oxide, while others give fluorine when fused with this salt in an open glass tube. Gives a phosphide with the sodium test.

Dissolves in hydrochloric and nitric acid, yielding with sulphuric acid a copious precipitate of calcium sulphate; the dilute nitric acid solution gives with lead acetate a white precipitate, which B.B. on charcoal fuses, giving a globule with crystalline facets on cooling. Some varieties of apatite phosphoresce on heating.

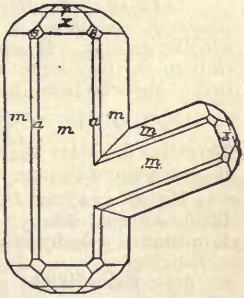
**Obs.**—Apatite occurs in rocks of various kinds and ages, but is most common in metamorphic crystalline rocks, especially in granular limestone, granitic and many metalliferous veins, particularly those of tin, in gneiss, syenite, hornblendic gneiss, mica schist, beds of iron ore; occasionally in serpentine; common in igneous or volcanic rocks in the form of microscopic acicular crystals which have been early formed in the crystallization from the magma; sometimes in ordinary stratified limestone, beds of sandstone or shale of the Silurian, Carboniferous, Jurassic, Cretaceous, or Tertiary. It has been observed as the petrifying material of wood.

Among its localities are Ehrenfriedersdorf in Saxony; Schwarzenstein, Rothenkopf, Pfitsch in the Tyrol; with epidote on the Knappenwand, Untersulzbachthal; St. Gothard, Tavetsch, etc., in Switzerland; Mussa-Alp in Piedmont, white or colorless, and of like form and color on the Mittaghorn in Upper Valais; Zinnwald and Schlackenwald in Bohemia; in England, in Cornwall, with tin ores; in Cumberland, at Carrock Fells, in celandine-green crystals in gilbertite; in Devonshire, cream-colored at Bovey Tracey, and at Wheal Franco (*francolite*); in Ireland, in a basaltic dike near Kilroot in Antrim, also in Down, Dublin, and Killiney Hill. The greenish blue variety, called *moroxite*, occurs at Arendal, Snarum, and Kragerö in Norway, at the latter place in part flesh-red, and looking much like feldspar; with magnetic iron of a greenish yellow color at Mt. Blagodatsk in the Ural; with black tourmaline on the Shaitanka in Ekaterinburg; on the Sliudianka (*lasurapatite*); at the emerald mine of the Takovaja, 85 versts N.E. of Ekaterinburg; on the Kiräba, 70 versts S.W. of Miask, containing *no* chlorine (Pusirevsky), with G. = 3·126; in Pargas, Finland. The *asparagus-stone* or *spargelstein* of Jumilla, in Murcia (not C. de Gata), Spain, is pale yellowish green in color; a variety from Zillerthal is wine-yellow; a similar variety is obtained from the Cerro de Mercado, Durango, Mexico. The *phosphorite*, or massive radiated variety, is obtained abundantly near the junction of granite and argillyte, in Estremadura, Spain; at Schlackenwald in Bohemia; at Amberg, Bavaria, in Jurassic limestone, nodular and stalactitic; Nassau, etc.

Large quantities of apatite are mined in Norway at Kragerö, where it was worked as early as 1854; also at Ödegaard, near Bamle, Norway, with enstatite and wagnerite (kjerulfine) in large crystals; further in veins at many points along the southern coast from Langesund fiord to Arendal, in part in connection with the so-called "geflecter gabbro" mentioned on pp. 467, 472, in which a triclinic feldspar has been largely altered to scapolite.

In *Maine*, on Long Island, Blue-hill Bay, in veins 10 in. wide, intersecting granite. In *N. Hamp.*, crystals, often large, are abundant, 4 m. S. of the N. village meeting-house, Westmoreland, in a vein of feldspar and quartz, in mica slate, along with molybdenite; fine crystals at Piermont, in white limestone, on the land of Mr. Thomas Cross. In *Mass.*, crystals occasionally 6 in. long, at Norwich (N.E. part), in gray quartz; at Bolton abundant, the forms seldom interesting; sparingly at Chesterfield, Chester, Sturbridge, Hinsdale, and Williamsburgh. In *Conn.*, at Branchville, dark greenish blue (*manganapatite*), also in greenish white and colorless crystals, highly modified and resembling the Swiss, in short pearly white prisms with rough basal planes; at Leete's quarry, near Stony Creek. In *New York*, large crystals of apatite are found in St. Lawrence Co., in granular limestone, with scapolite, titanite, etc., at Hammond, Gouverneur; in Rossie, with titanite and pyroxene, 2 m. N. of the village of Oxbow; also on the bank of Vrooman Lake, Jefferson Co., in white limestone; Sanford mine, East Moriah, Essex Co., in magnetite, which is often thickly studded with six-sided prisms; at the iron mine, Brewster, Putnam Co.; near Edenville, Orange Co., asparagus-green, in white limestone; in the same region, blue, grayish green, and grayish white crystals; 2 m. S. of Amity, emerald- and bluish green crystals; at Long Pond, Essex Co., with garnet and vesuvianite; fibrous mammillated (*eupyrchroite*) at Crown Point, Essex Co., about a mile south of Hammondsville, in large quantities, quarried for agricultural purposes. In *New Jersey*, on the Morris Canal, near Suckasunny, of a brown color, in massive pyrrhotite; with the magnetite of Bryam mine; Mt. Pleasant mine near Mt. Teabo, in a low hill near the junction of Rockaway R. and Burnt Meadow Cr., ¾ m. from the canal, in masses sometimes 6 in. through; at Hurdstown, Sussex Co., where a shaft has been sunk and the apatite mined; masses brought out weigh occasionally 200 lbs., and some cleavage prisms have the planes 3 in. wide. In *Penn.*, at Leiperville, Delaware Co.; in Chester Co., at New Garden; in Bucks Co., at Southampton, manganesian, Genth. In *Maryland*, near Baltimore. In *Delaware*, at Dixon's quarry, Wilmington, of a rich blue color. In *N. Carolina*, in highly modified clear yellow crystals (f. 6, p. 763), also in slender greenish prisms with hiddenite, rutile, emerald, dolomite, muscovite, etc.; at Stony Point, N. Carolina, one of the latter habit seemed to be a cruciform-twin with tw. pl. *s* (f. 10).

10.



Alex. Co., N. C., H. & W.

In *Canada*, in North Elmsley, and passing into South Burgess, in an extensive bed 10 ft. broad, 3 ft. of which are pure sea-green apatite, and outside of this mixed with limestone, and sometimes occurring in prisms a foot long and 4 in. through, with pyroxene and phlogopite—a *fluor-apatite* containing only 0·5 chlorine (Hunt); similar in Ross; at the foot of Calumet Falls, in blue crystals; also near Blaisdell's mill on the Gatineau; at St. Roch, on the Achigan, clear rose-red, amethystine, and colorless crystals, with augite.

In extensive beds in the Laurentian gneiss of Canada, usually associated with limestone, and accompanied by pyroxene, amphibole, titanite, zircon, garnet, vesuvianite, and many other species. Prominent mines are in Ottawa county, Quebec, along the Lièvre river in the townships of Buckingham, Templeton, Portland, Hull, and Wakefield. Also in Renfrew county, Ontario, and in Lanark, Leeds, and Frontenac counties. The yield in 1889 was 30,500 tons. The crystals of apatite are sometimes of enormous size, one crystal from Buckingham, Ottawa Co., Quebec, weighed 550 lbs. and measured 72½ inches in circumference.

Apatite was named by Werner from ἀπατάειν, *to deceive*, older mineralogists having referred it to aquamarine, chrysolite, amethyst, fluor, schorl, etc.

For a comprehensive review of the occurrence of apatite, phosphorite, and calcium phosphate in general, see R. A. Penrose, U. S. G. Surv., Bull. **49**, 1888, who also gives an extended bibliography. On the Canadian deposits, see Harrington, G. Surv. Canada, 1–50 G, 1877–78; Vennor, Rep. G. Surv. Canada, 1870 *et seq.*; also Hoffmann, l. c., ref. on p. 765. On the apatite of Norway, see Brögger & Reusch, Zs. G. Ges., **27**, 646, 1875; Nyt Mag., **25**, 255, 1880; H. Sjögren, G. För. Förh., **6**, 447, 1883; G. Löfstrand, ibid., **12**, 145, 207, 1890; G. Torell, ibid., p. 365. On the phosphorite of various localities, see ref. on p. 765. See also Phosphatic Nodules below.

**Alt.**—See osteolite, etc., below. Moore and Zepharovich have described apatite altered to tallaite from Fresno Co., California. Zs. Kr., **10**, 240, 1885.

**Artif.**—Early obtained by Deville & Caron (C. R., **47**, 985, 1858, and Ann. Ch. Phys., **67**, 443, 1863). Lechartier has shown (C. R., **65**, 172, 1867) that an arsenic apatite may be made by fusion together of calcium arsenate and calcium chloride; and that from the same at a lower temperature an arsenical wagnerite is obtained in crystals. See also Fouqué-Lévy, Synth. Min., 262, 1882, Bourgeois, Reprod. Min., 178, 1884.

**Ref.**—[1] Ekaterinburg, Min. Russl., **2**, 39, 1854; see also ib., **5**, 86, 1866, where the rather widely varying angles for different localities are compared. A review of the angles for apatite from different localities is given by Baumhauer, Zs. Kr., **18**, 31, 1890, in part quoted on p. 764.

[2] Cf. Schrauf, Ber. Ak. Wien, **62** (1), 745 *et seq.*, 1870, also Atlas XVIII–XX; earlier Haid., Isis, 1824, Kk., l. c. [3] Cf. Klein, Jb. Min., 485, 1871. [4] Questioned by Schrauf, but noted by E. S. D., see [9] below. [5] Strüver, Att. Acc. Torino, **3**, 125, 1867, **6**, 363, 1871. [6] Schrauf, l. c. [7] Klein, Untersulzbach, Jb. Min., 121, 1872. [8] Schmidt, Tavetsch, Zs. Kr., **7**, 551, 1883. [9] E. S. D., Paris, Me., Am. J. Sc., **27**, 480, 1884. [10] Flink, Nordmark, Ak. H. Stockh., Bih., **12** (2), No. 2, 42, 1886. [11] Weisbach, Ehrenfriedersdorf, Jb. Min., **2**, 249, 1882. [12] Vrba, Pisek, Zs. Kr., **15**, 464, 1889. [13] Hidden and Washington, Am. J. Sc., **33**, 503, 1887.

[14] *Etching-figures*, Baumhauer, Ber. Ak. München, **5**, 169, 1875; Ber. Ak. Berlin, 863, 1887, 447, 1890. [15] Pusirevsky, quoted by Kk.; also Baumh., Zs. Kr., **18**, 41, 1891; Mld., Ann. Mines, **10**, 147, 1876. [16] *Refractive indices*, Heusser, Pogg., **87**, 467, 1852. *Elasticity*, Vater, Zs. Kr., **11**, 581, 1886. *Pyroelectricity*, Hankel, Wied. Ann., **6**, 52, 1879.

OSTEOLITE is a massive impure form of calcium phosphate, and according to A. H. Church (Ch. News, **16**, 150, 1867), after analyses of specimens from various localities, it is to be regarded as an altered apatite. The ordinary compact variety looks like lithographic stone of white to gray color. It also occurs earthy. H. = 1–2; G. = 2·8–3·1, fr. Ostheim near Hanau, Bromeis; 2·86, ibid., Church; luster feeble or wanting. Excepting impurities, it has the composition of apatite, although most analyses, excepting those of Church, do not show fluorine or chlorine. Analyses: 5th Ed., p. 533, 534. Named from ὀστέον, *bone*, and λίθος, since bones consist largely of the same phosphate.

EPIPHOSPHORITE *Breithaupt*, B. H. Ztg. **25**, 194, 1866. Occurs reniform, of scaly-granular structure, inclining to fibrous, vitreous luster, leek- to celandine-green color, with H. = 4·5–5, G. = 3·125. According to Richter it fuses with much difficulty, and affords indications of phosphoric acid, lime, iron protoxide, alumina, and a very little silica; not tested for fluorine or chlorine, because of too little material. Occurs with garnets and graphite in a crystalline rock, but locality unknown.

TALC-APATITE *Hermann*, J. pr. Ch., **31**, 101, 1844. An apatite from chlorite slate near Zlatoust, containing a large percentage of magnesia in place of part of the lime, and low in specific gravity. It occurs in 6-sided prisms, grouped or single; H. = 5; G. = 2·7–2·75; luster dull to earthy; color milk-white, yellowish externally; feebly translucent. Anal., Hermann, deducting 9·50 insoluble material as impurities:

$P_2O_5$ 43·11  CaO 41·44  MgO 8·55  $Fe_2O_3$ 1·10  Cl 0·92  $SO_3$ 2·32 F *undet.*

Berzelius suggests that the magnesia may have come from the gangue. According to Volger it is an altered impure apatite. Some magnesia is present in many apatites (Bischof).

HYDROAPATITE *Damour*, Ann. Mines, **10**, 65, 1856. In mammillary concretions, looking a little like chalcedony. H. = 5·5. G. = 3·10. Color milk-white. Subtransparent. Composition that of a *hydrous apatite*. Analysis by Damour:

$P_2O_5$ 40·00  CaO 47·31  F 3·36  Ca 3·60  $H_2O$ 5·30 = 99·57

Heated in a tube it decrepitates and gives out ammoniacal water. Found near St. Girons in the Pyrenees, in the fissures of a brownish, ferruginous, argillaceous schist, a rock which not far distant affords wavellite.

Besides the definite *mineral phosphates*, including normal apatite, phosphorite, etc., there are also extensive deposits of amorphous phosphates, consisting largely of "bone phosphate" ($Ca_3P_2O_8$), of great economic importance, though not having a definite chemical composition and hence not strictly belonging to pure mineralogy. Here belong the phosphatic nodules, coprolites, bone beds, guano, etc.

PHOSPHATIC NODULES. COPROLITES. Phosphatic nodules occur in many fossiliferous rocks of different ages, and are probably in all cases of organic origin. They sometimes present a spiral or other interior structure, derived from the animal organization that afforded them, and in such cases their coprolitic origin is unquestionable. In other cases there is no definite or only a concretionary structure. Phosphatic nodules, from the Lower Silurian rocks of Canada, contain sometimes fragments of shells of Lingula and Orbicula, which shells, unlike most others, consist largely of phosphates. They are found in the Chazy formation at Allumette Id., Hawkesbury. R. Ouelle, and elsewhere. They have been investigated by T. S. Hunt (Logan's Rep. Can., 1851–52, 1863, and Am. J. Sc., **17**, 235, 1854).

The nodular phosphatic deposits are most abundantly developed in the Tertiary of South Carolina, where they have been extensively mined since 1868. There are three principal regions: first, near Charleston, north and east of the city, from Wando river and the east branch of the Cooper river on the northeast to Rantowles creek and Stone river on the southwest. Again, west of the above from the Edisto river to Horseshoe creek, and finally between Bull and Broad rivers with the deposits of Coosaw and Beaufort rivers and those of Chisholm island. There are also other points where the nodules have been obtained. They are, in general, most abundant in river bottoms, where they have been washed together from their original beds.

The nodules are irregular in form and range from the size of a pea or larger up to a ton; the larger masses often formed by the union of many small nodules. They vary in hardness from 2 to 4 and in specific gravity from 2·2 to 2·5. They have no crystalline structure, but sometimes are distinctly concretionary. In color they vary from light gray to brown and rarely jet black. Chemically they usually consist of from 50 to 60 p. c. or more of bone phosphate, with 6 to 8 p. c. calcium carbonate, 4 to 5 p. c. organic matter and moisture, and a variable amount of sand. The nodules are accompanied by the remains of marine life of various forms, sharks' teeth, etc.

Phosphatic deposits also occur in North Carolina, Alabama, and Florida. Those of Florida have come into prominence recently (since 1889), and have already assumed considerable economic importance. The beds have been traced from near Tallahassee and Gainesville through Madison and Alachua counties, along a line nearly 250 miles long, running a little east of south to the mouth of Peace R. into Charlotte Harbor. The beds are chiefly in Madison, Alachua, Levy, Marion, Citrus, Hernando, Pasco, Hillsboro, Polk, and De Soto counties. The main point of interest is at Dunnellon between Marion and Citrus Cos. The Florida phosphate has been called *Floridite* by Cox (Proc. Amer. Assoc., p. 260, 1890). Much of it is a hard phosphate rock (*rock phosphate*), sometime a "pea-like phosphorite"; there is also a conglomerate, and again it is soft and plastic; it is stated to average about 80 p. c. or more of bone phosphate.

Other phosphate deposits occur in the greensand of England, in N. Wales (L. Silurian), in Belgium, France, Russia, etc. See further C. U. Shepard, South Carolina Phosphates (Charleston, 1880); Penrose, U. S. G. Surv., Bull. **46**, 1888, referred to above and here quoted from; also on the Florida deposits, Cox, l. c., Darton, Am. J. Sc., **41**, 102, 1891; also, in general, the authors quoted above (p. 768).

GUANO. Guano is bone phosphate of lime, mixed with the hydrous phosphates, and generally with some calcium carbonate, and often a little magnesia, alumina, iron, silica, gypsum, and other impurities. It often contains 9 or 10 p. c. of water. It is often granular or oolitic; also compact through consolidation produced by infiltrating waters, in which case it is frequently lamellar in structure, and also occasionally stalagmitic and stalactitic. Its colors are usually grayish white, yellowish and dark brown, and sometimes reddish, and the luster of a surface of fracture earthy to resinous. Shepard's *Pyroclasite* (Am. J. Sc., **22**, 97, 1856) is nothing but the hard guano from Monk's island, Caribbean sea, the mass of which he named *Pyroguanite*, under the wrong idea of its having undergone the action of heat; in a later notice (ibid.. **23**, 404. 1882) Shepard suggests that pyroclasite may be a "uniform compound of monetite and monite" or "a mechanical mixture of the two." Phipson's *Sombrerite* (J. Ch. Soc., **15**, 277, 1862) is similar to pyroclasite from Sombrero, as shown by A. A. Julien (Am. J. Sc., **36**, 423, 1863). The waters which have filtrated through the guano at Sombrero have altered the coral rock adjoining, turning it more or less completely into phosphate of lime of a yellowish or brownish color; and phosphatic stalagmites and stalactites resinous in fracture are common.

Shepard's massive *Glaubapatite*, yellowish brown to chocolate-brown in color, and in fibrous stalactites, from Monk's island (l. c.), is also in all probability merely the guano rock above described. He says the mineral contains 15·1 p. c. of sodium sulphate, with 74·0 of calcium phosphate, and 10·3 of water; but such a compound is hardly a possibility, and the fact of its existence needs confirmation. The name, from glauber and apatite, alludes to the composition The mineral includes also "tabular crystals," which may possibly be *brushite*, although the composition is against it. For analyses of the guano of Mexillones see Domeyko, C. R., **90**, 544, 1880.

For various guano minerals see monetite, struvite, brushite, metabrushite, martinite, etc., p. 784, etc.; also stercorite, p. 826

**550. PYROMORPHITE.** Grön Blyspat, Minera plumbi viridis pt., *Wall.*, Min., 296, 1748. Mine de Plomb verte *Fr. Trl.* Wall., **1**, 536, 1853. Grünbleierz, Braunbleierz, *Schültze*, Dresden Mag., **2**, 70, 1761, **2**, 467, 1765 (with obs. on identity). Grün Bleyerz, PHOSPHORSAUREHALTIG (fr. Zschopau), *Klapr.*, Crell's Ann., **1**, 394, 1784. Green Lead Ore, Brown Lead Ore; Phosphate of Lead. Phosphorsaures Blei, Phosphorblei, Buntbleierz, *Germ.* Plomb phosphaté *Fr.* Polychrom, Pyromorphit, *Hausm.*, Handb., 1089, 1090, 1813. Traubenblei *id.*, ib., 1093. Polysphærit *Breith.*, Char., 54, 1832. Nussierite *Danhauser*, Barruel, Ann. Ch. Phys., **62**, 217, 1836. Miesit *Breith.*, Handb., 285, 1841. Cherokine *Shep.*, Rep. Canton Mine, 1856, Min., 407, 1857, Am. J. Sc., **24**, 38, 1857.

Hexagonal, with pyramidal hemihedrism[1]. Axis $\dot{c} = 0{\cdot}7362$; $0001 \wedge 10\bar{1}1 =$ *40° 22′ Haidinger[2].

**Forms**[3]: *c* (0001, *O*); *m* ($10\bar{1}0$, *I*), *a* ($11\bar{2}0$, *i*-2); *x* ($10\bar{1}1$, 1), *y* ($20\bar{2}1$, 2), *π* ($40\bar{4}1$, 4); *s* ($11\bar{2}1$, 2-2).

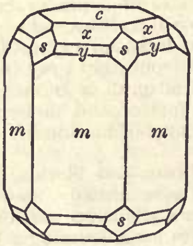
Angles: *cx* = 40° 22′, *cy* = 59° 32′, *cπ* = 73° 37′, *cs* = 55° 49′, *xx′* = 37° 47½′, *yy′* = 51° 3½′, *ππ′* = 57° 20′, *ss′* = 48° 52′, *xs* = 26° 52′, *ax* = 55° 53′.

Crystals prismatic, with faces *m* striated vertically, and often in rounded barrel-shaped forms; also in branching groups of prismatic crystals in nearly parallel position, tapering down to a slender point. Often globular, reniform, and botryoidal or verruciform, with usually a subcolumnar structure; also fibrous, and granular.

Cleavage: *m*, *x* (1011) in traces. Fracture subconchoidal, uneven. Brittle. H. = 3·5–4. G. $\doteq$ 6·5–7·1 mostly, when pure; 5·9–6·5, when containing lime. Luster resinous. Color green, yellow, and brown, of different shades; sometimes wax-yellow and fine orange-yellow; also grayish white to milk-white. Streak white, sometimes yellowish. Subtransparent to subtranslucent. Optically —. Sometimes biaxial, and increasingly so as the amount of arsenic increases. Cf. mimetite, p. 772.

1.

2.



Nerchinsk, Erem.

**Var.**—1. *Ordinary.* (*a*) *In crystals* as described; sometimes yellow and in rounded forms resembling campylite (*pseudo-campylite*). (*b*) In *acicular* and *moss-like* aggregations. (*c*) *Concretionary* groups or masses of crystals, having the surface angular. (*d*) *Fibrous.* (*e*) *Granular massive.* (*f*) *Earthy;* incrusting.

2. *Polysphærite.* Containing lime; color brown of different shades, yellowish gray, pale yellow to nearly white; streak white; G. = 5·89–6·44. Rarely in separate crystals; usually in groups, globular, mammillary, verruciform. *Miesite*, from Mies in Bohemia, is a brown variety. *Nussierite* is similar and impure, from Nussière, near Beaujeu, France; color yellow, greenish, or grayish; G. = 5·042. *Cherokine* is milk-white or pinkish white in color, and occurs in slightly acuminated prisms, and also botryoidal and massive; G. = 4·8 (?); from the Canton mine, Cherokee Co., Georgia. 3. *Chromiferous;* color brilliant red and orange. 4. *Arseniferous;* color green to white; G. = 5·5–6·6. 5. *Pseudomorphous;* (*a*) after galena; (*b*) cerussite.

Both the green and brown colors occur with the pure phosphate of lead, as well as that containing calcium.

**Comp.**—$(PbCl)Pb_4P_3O_{12}$ or also written $3Pb_3P_2O_8.PbCl_2$ = Phosphorus pentoxide 15·7, lead protoxide 82·2, chlorine 2·6 = 100·5, or Lead phosphate 89·7, lead chloride 10·3 = 100.

The phosphorus is often replaced by arsenic, and as the amount increases the species passes into mimetite. Calcium also replaces the lead to a considerable extent.

**Anal.**—1, Hilger, Jb. Min., 129, 1879. 2–5, Jannettaz and Michel, Bull. Soc. Min., **4**, 196, 1881. 6, Rivot, quoted by Jannettaz and Michel. 7, Hidegh, Zs. Kr., **8**, 535, 1883. 8, Heddle, Min. Mag., **5**, 21, 1882. 9–11, Collie, J. Ch. Soc., **55**, 93, 1889. 12, Petersen, Jb. Min., 393, 1871. 13, 14, Seidel, quoted by Sandberger, Jb. Min., 222, 1864. 15, 16, Kersten, Schw. J., **62**, 1 *et seq.*, 1831, also other anals. of the normal variety. 17, G. Barruel, Ann. Ch. Phys., **62**, 217, 1837. 18–22, Jannettaz and Michel, l. c.

1. *Ordinary.*

| | $P_2O_5$ | $As_2O_5$ | PbO | CaO | Cl | |
|---|---|---|---|---|---|---|
| 1. Dernbach, *colorless* | 15·90 | — | 80·89 | 0·42 | 2·13 | insol. 0·31 = 99·65 |
| 2. Ems | 15·73 | — | 82·12 | — | 2·62 | = 100·57 |
| 3. Emmendingen | 15·57 | — | 81·72 | — | 2·73 | = 100·02 |

| | B. | | $P_2O_5$ | $As_2O_5$ | PbO | CaO | Cl | |
|---|---|---|---|---|---|---|---|---|
| 4. | Joachimsthal | | 16·59 | — | 76·86 | — | 2·45 | FeO 3·00 = 98·90 |
| 5. | Hofsgrund | | 17·12 | — | 79·90 | — | 2·47 | FeO 0·87 = 100·36 |
| 6. | Huelgoet | | 18·10 | — | 77·87 | 1·25 | 2·43 | FeO 0·15, $CaF_2$ 1·20 = 101 |
| 7. | Schemnitz | | 15·94 | — | 80·97 | 0·25 | 2·54 | = 99·70 |
| 8. | Leadhills | | 15·63 | — | 81·81 | — | 2·68 | iron phosphate 0·45=100·57 |
| 9. | " *orange* | | 15·7 | — | 81·4 | — | 2·6 | = 99·7 |
| 10. | " *green* | | 15·9 | — | — | — | 2·6 | |
| 11. | " *yellow* | | 15·9 | — | 81·6 | — | 2·8 | |
| | 2. *Containing Calcium.* | | | | | | | |
| 12. | Schapbach, *green* | | 16·25 | 0·61 | 77·17 | 3·28 | 2·62 | F,$Cu_2O$ *tr.* = 99·93 |
| 13 | Badenweiler, *wax-yellow* | | 16·11 | 0·66 | 77·46 | 2·40 | 2·64 | = 99·27 |
| 14 | " *dark orange* | | 15·88 | 0·69 | 77·45 | 2·45 | *und.* | |
| 15. | Freiberg | G. = 6·092 | [19·36] | — | 72·17 | 6·47 | 1·94 | = 99·94 |
| 16. | Mies | G. = 6·444 | [18·35] | — | 75·83 | 3·71 | 2·05 | = 99·94 |
| 17. | *Nussierite* | | 19·80 | 4·06 | 52·64 | 12·30 | 1·95 | FeO 2·44, $SiO_2$ 7·20=100·39 |
| | 3. *Containing Arsenic.* | | | | | | | |
| 18. | Marienberg | | 14·56 | 2·72 | 80·72 | — | 2·45 | = 100·45 |
| 19. | Zschopau | | 15·56 | 2·34 | 79·28 | — | 2·85 | = 100·03 |
| 20. | " | | 13·92 | 3·54 | 78·38 | — | 2·35 | FeO 1·75 = 99·94 |
| 21. | Roughten Gill | | 11·31 | 8·98 | 77·29 | — | 2·31 | = 99·89 |
| 22. | Cornwall | | 5·20 | 9·28 | 83·02 | — | 2·52 | = 100·02 |

A calcium vanado-pyromorphite, with G. = 6·9–7·0, from Leadhills gave Collie: Lead phosphate 52·0, lead vanadate 19·2, calcium phosphate 15·8, lead chloride 11·4. J. Ch. Soc., **55**, 94, 1889.

**Pyr., etc.**—In the closed tube gives a white sublimate of lead chloride. B.B. in the forceps fuses easily (F. = 1·5), coloring the flame bluish green; on charcoal fuses without reduction to a globule, which on cooling assumes a crystalline polyhedral form, while the coal is coated white from chloride and, nearer the assay, yellow from lead oxide. With soda on charcoal yields metallic lead; some varieties contain arsenic, and give the odor of garlic in R.F. on charcoal. With salt of phosphorus, previously saturated with copper oxide, gives an azure-blue color to the flame when treated in O.F. (chlorine). Soluble in nitric acid.

**Obs.**—Pyromorphite occurs principally in veins, and accompanies other ores of lead.

Occurs at Poullaouen and Huelgoet in Brittany; at Zschopau and other places in Saxony; at Přibram, Mies, and Bleistadt, in Bohemia; at Sonnenwirbel near Freiberg; Clausthal in the Harz; in fine crystals at Ems, Braubach, in Nassau; also at Dernbach near Montabaur in Nassau; Kranzberg near Usingen; Berezov in Siberia; in the Nerchinsk mining district, in fine crystals; Cornwall, green and brown; Devon, gray; Derbyshire, green and yellow; Cumberland, golden yellow, in England; Leadhills, red and orange, in Scotland; Wicklow, clove-brown and yellowish green, and elsewhere, Ireland.

Pyromorphite has been found in good specimens at the Perkiomen lead mine near Philadelphia, and very fine at Phenixville; also in Maine, at Lubec and Lenox; in New York, a mile south of Sing Sing; sparingly at Southampton, Massachusetts, and Bristol, Conn.; in good crystallizations of bright green and gray colors in Davidson Co., N. C., also in Cabarrus and Caldwell Cos.

Named from *πῦρ*, *fire*, *μορφή*, *form*, alluding to the crystalline form the globule assumes on cooling. This species passes into mimetite.

**Alt.**—Occurs altered to galena, cerussite, calamine, calcite, and limonite.

Pseudoapatite (p. 764) is according to Frenzel a pseudomorph after pyromorphite.

**Artif.**—See mimetite.

**Ref.**—[1] Baumh., as shown by etching-figures, Jb. Min., 411, 1876. [2] Haid., Breisgau, Min. Mohs, **2**, 134, 1825; Rose obtained $xx' = 37° 53'$, Pogg., **9**, 209, 1827. Sbs. gives green cryst., Zschopau, $xx' = 37° 46'$, Pogg., **100**, 300, 1857; Erem., green, Nerchinsk, $xx' = 37° 43\frac{1}{2}'$ and 37° 41′, Vh. Min. Ges., **22**, 179, 1886, and Zs. Kr., **13**, 191, 1887. [3] Haid, l.c., Erem, l. c.

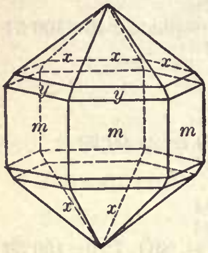
**551. MIMETITE.** Minera plumbi Viridis pt., Plumbum arsenico mineralisatum, *Wall.*, Min., 296, 1748. Plomb vert arsenical (fr. Andalusia) *Proust.*, J. de Phys., **30**, 394, 1787. Idem (fr. Roziers, with anal.) *Fourcroy*, Mem. Ac. Sc. Paris, 1789. Arsenikalisches Bleyerz *Lenz*, Min., **2**, 224, 1794. Grünbleierz pt., Buntbleierz pt., Flockenerz, Traubenblei pt., Arsensaures Blei, *Germ.* Arsenate of Lead, Green Lead Ore pt. Plomb arseniaté *Fr.* Pyromorphite pt. *Mohs.* Mimetèse *Beud.*, Tr., **2**, 594, 1832; Mimetene *Shep.*, Min., 1835; Mimetesit *Breith.*, Handb., 289, 1841; Mimetit *Haid.*, Handb., 1845, *Glocker*, Syn., 1847. Kampylit *Breith.*, Handb., **2**, 291, 1841.

Hexagonal, with pyramidal hemihedrism[1]. Axis $\dot{c} = 0·7224$; $0001 \wedge 10\bar{1}1 = {}^{*}39° 50'$ Haidinger.[2] Observed forms as in pyromorphite. Also [3]:

$h$ ($21\bar{3}0$, $i\frac{3}{2}$), $\mu$ ($21\bar{3}1$, $3\text{-}\frac{3}{2}$). Angles: $xx' = 37° 21\frac{1}{2}'$, $cs = 55° 19'$, $ss' = 48° 33'$.

Habit of crystals like pyromorphite; sometimes rounded to globular forms. Also in mammillary crusts.

Cleavage: *x* imperfect. Fracture uneven. Brittle. H. = 3·5. G. = 7·0–7·25. Luster resinous. Color pale yellow, passing into brown; orange-yellow; white or colorless. Streak white or nearly so. Subtransparent to translucent.



Optically often biaxial. Bertrand[4] has shown that while the phosphate, pyromorphite, is normally uniaxial, the arsenate, mimetite, is biaxial and sometimes with an angle (2E) of 64°, Johanngeorgenstadt. A basal section shows a division into six triangular sectors with ax. pl. parallel to the sides of the hexagon and $Bx_a$ (–) ⊥ *c*. Jannettaz and Michel have extended these observations with analyses and shown the increase in biaxial character with increase of arsenic in passing from pure pyromorphite through its arsenical varieties to pure mimetite.

**Var.**—1. *Ordinary.* (*a*) *In crystals*, usually in rounded aggregates. (*b*) *Capillary* or filamentous, especially marked in a variety from St. Prix-sous-Beuvray, France; somewhat like asbestus, and straw-yellow in color. (*c*) *Concretionary.*

2. *Calciferous.* Here belongs a variety from Villevieille near Pontgibaud, Puy-de-Dôme. Hedyphane (p. 775) formerly was placed here, but seems to be distinct optically.

3. *Containing much phosphoric acid. Campylite*, from Drygill in Cumberland, has G. = 7·218, and is in barrel-shaped crystals (whence the name, from *καμπυλος, curved*), yellowish to brown and brownish red.

**Comp.**—$(PbCl)Pb_4As_3O_{12}$, also written $3Pb_3As_2O_8.PbCl_2$ = Arsenic pentoxide 23·2, lead protoxide 74·9, chlorine 2·4 = 100·5, or Lead arsenate 90·7, lead chloride 9·3 = 100. Phosphorus replaces the arsenic in part, and calcium the lead. *Endlichite* (p. 774) is intermediate between mimetite and vanadinite.

**Anal.**—1, Rivot, quoted by Jannettaz and Michel. 2, 3, Jannettaz and Michel, Bull. Soc. Min., **4**, 200, 1881. 4, Wöhler, Pogg., **4**, 167, 1825; Dufrénoy, Min., **3**, 269, 1856. 5, Damour, Bull. Soc. Min., **6**, 84, 1883. 6, J. L. Smith, Am. J. Sc., **20**, 248, 1855. 7, Massie, Ch. News, **46**, 215, 1882. 8, Genth, Am. Phil. Soc., **24**, 33, 1887, also other anals. 9, Rg., Pogg., **91**, 316, 1854. Also Långban, Kiutaro Iwaya, G. För. Förh., **5**, 272, 1880.

| | G. | $As_2O_5$ | $P_2O_5$ | PbO | CaO | Cl | |
|---|---|---|---|---|---|---|---|
| 1. Zacatecas | | 23·06 | — | 75·47 | — | 2·50 | = 101·03 |
| 2. Johanngeorgenstadt | | 23·41 | *tr.* | 75·10 | — | 1·91 | = 100·42 |
| 3. " | | 21·16 | 1·03 | 75·02 | — | 2·31 | = 99·52 |
| 4. " | | 22·10 | 0·62 | 76·02 | — | 2·50 | = 101·24 |
| 5. Pontgibaud | | 19·65 | 3·44 | 71·32 | 3·46 | 2·57 | = 100·44 |
| 6. Phenixville, *lemon-yellow* | 7·32 | 23·17 | 0·14 | 74·58 | — | 2·39 | = 101·28 |
| 7. Eureka, *colorless* | 6·92 | 23·41 | *tr.* | 75·18 | — | 2·22 | = 100·81 |
| 8. Durango, *pseudomorphs* | 6·636 | 24·97 | 0·05 | 71·40 | 0·57 | 2·47 | clay 0·65, ign. 0·37 = 100·48 |
| 9. Cumberland, *Campylite* | 7·218 | 18·47 | 3·34 | 76·47 | 0·50 | 2·41 | = 101·19 |

**Pyr., etc.**—In the closed tube like pyromorphite. B.B. fuses at 1, and on charcoal gives in R.F. an arsenical odor, and is easily reduced to metallic lead, coating the coal at first with lead chloride, and later with arsenic trioxide and lead oxide. Gives the chlorine reaction as under pyromorphite. Soluble in nitric acid.

**Obs.**—Occurs at Wheal Unity, near Redruth in Cornwall, and at several other of the Cornish mines; also at Beer Alston in Devonshire; Roughten Gill, Drygill, etc., in Cumberland; formerly at Leadhills and Wanlockhead in Scotland. At St. Prix in the Department of the Saone, in France, in capillary crystals; at Villevieille, near Pontgibaud, Puy-de Dôme; at Johanngeorgenstadt, in fine yellow crystals; at Nerchinsk, Siberia, in reniform masses, brownish red, also in fine crystals, also at Zinnwald, and Badenweiler; Långban, Sweden; Mine grande, Marqueza, Chili; Peru. At the Brookdale mine, Phenixville, Pa., crystals of pyromorphite capped with mimetite; at the Cerro Gordo mines, California.

Pseudomorphs (anal. 8) in reticulated crystalline groups, perhaps after anglesite, have been described by Genth and Rath from the Mina del Diablo, Durango, Mexico. Am. Phil. Soc., **24**, 33, 1887.

Named from *μιμητής, imitator*, it closely resembling pyromorphite. Beudant's word *mimetese* is inadmissible, because wrongly formed. Shepard's modification of it, *mimetene*, he has rejected for *mimetite* in his last edition. *Mimetite* is the correct form in view of the derivation. Mohs united this species with pyromorphite.

**Artif.**—Formed by fusing together arsenate and chloride of lead, and dissolving out afterward the excess of chloride, Lechartier, C. R., **65** 172, 1867. Michel has described the formation of crystals varying like the natural mineral from the phosphate to the arsenate and showing like optical characters. Bull. Soc. Min., **10**, 133, 1887.

**Ref.**—[1] Baumhauer, as shown by etching-figures, Jb. Min., 411, 1876. [2] Johanngeorgenstadt, Haid., Min. Mohs, **2**, 135, 1825; Schabus gives same. Eremeyev gives $\dot{c}$ = 0·7242, 0·7251, 0·7285, 0·7315 for four varieties from the Nerchinsk mining district, Vh. Min. Ges., **22**, 179 *et séq.*, 1886, and Zs. Kr., **13**, 191, 1888 (full abstract). [3] Mlr. (quoting Haid., l. c., who does not separate pyromorphite and mimetite) gives the same list as for pyromorphite, p. 481. Erem. (ref. above) adds $h$, $\mu$. [4] Btd., Bull. Soc. Min., **4**, 36, 1881, **5**, 254, 1882; also Jannettaz, ib., **4**, p. 39; Jannettaz and Michel, ib., **4**, p. 196; Michel, ib., **10**, 133, 1887.

**552. VANADINITE.** Plomb brun, Braunbleierz of Zimapan, *early authors.* Chromate de plomb brun (from Descotil's anal.) *Brongn.*, Min., **2**, 204, 1807. Vanadinbleierz *G. Rose*, Pogg., **29**, 455, 1833. Vanadinit *v. Kobell*, Grundz., 283, 1838. Vanadate of Lead. Vanadinspath, Vanadinbleispath, Vanadinsaures Blei, *Germ.* Plomo pardo *Domeyko.* Endlichite *Genth*, Am. Phil. Soc., **22**, 367, April 17, 1885.

Hexagonal, with pyramidal hemihedrism. Axis $\dot{c}$ = 0·71218; $0001 \wedge 10\bar{1}1$ = *39° 25′ 56″ Vrba.[1]

**Forms**[2]:
$c$ $(0001, O)$
$m$ $(10\bar{1}0, I)$

$a$ $(11\bar{2}0, i\text{-}2)$
$h$ $(21\bar{3}0, i\text{-}\frac{3}{2})^5$
$\sigma$ $(10\bar{1}3, \frac{1}{3})^7$

$r$ $(10\bar{1}2, \frac{1}{2})^5$
$x$ $(10\bar{1}1, 1)$
$y$ $(20\bar{2}1, 2)$

$q$ $(50\bar{5}2, \frac{5}{2})?^4$
$z$ $(30\bar{3}1, 3)^5$
$v$ $(11\bar{2}2, 1\text{-}2)^3$

$s$ $(11\bar{2}1, 2\text{-}2)$
$u$ $(21\bar{3}1, 3\text{-}\frac{3}{2})^6$

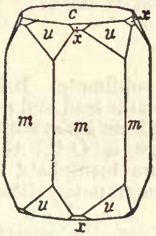
$c\sigma$ = 15° 20′
$cr$ = 22° 21′
$cy$ = 58° 42′
$cq$ = 64° 4′
$cz$ = 67° 56′

$cv$ = 35° 27½′
$cs$ = 54° 56′
$cu$ = 65° 19′
$rr'$ = 21° 55′
$xx'$ = 37° 2′

$yy'$ = 50° 35′
$qq'$ = 53° 26′
$zz'$ = 55° 13′
$vv'$ = 33° 43′
$ss'$ = 48° 19′

$mu$ = 30° 51′
$ms$ = 44° 52′
$mx'$ = 71° 29′
$au$ = 26° 50½′
$ax$ = 56° 38′

1.



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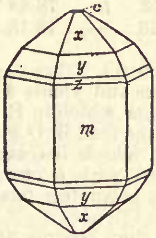

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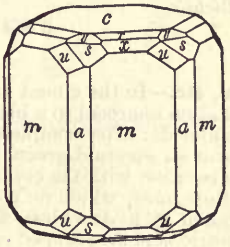

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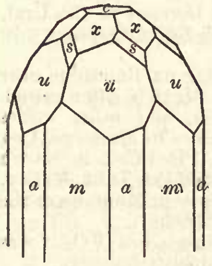

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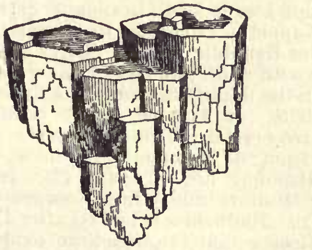

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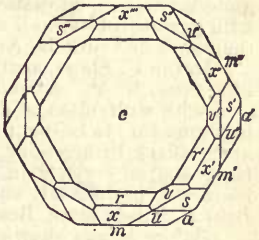


Figs. 1, 3, Pinal Co., Arizona, Pfd. 2, *Endlichite*, Lake Valley, Sierra Co., N. M., Id. 4, Córdoba, Websky. 5, Yuma Co., Arizona. 6, Basal projection of 3.

Crystals prismatic, with smooth faces and sharp edges; sometimes cavernous, the crystals hollow prisms; also in rounded forms and in parallel groupings like pyromorphite. In implanted globules or incrustations.

Fracture uneven, or flat conchoidal. Brittle. H. = 2·75–3. G. = 6·66–7·23; 6·886 Carinthia, Rg.; 6·863 Berezov, Struve. Luster of surface of fracture resinous. Color deep ruby-red, light brownish yellow, straw-yellow, reddish brown. Streak white or yellowish. Subtranslucent to opaque.

**Comp.**—$(PbCl)Pb_4V_3O_{12}$, also written $3Pb_3V_2O_8.PbCl_2$ = Vanadium pentoxide 19·4, lead protoxide 78·7, chlorine 2·5 = 100·6, or Lead vanadate 90·2, lead chloride 9·8 = 100.

Phosphorus is sparingly present, also sometimes arsenic, both replacing vanadium. In *endlichite* the ratio of V : As = 1 : 1 nearly. A pyromorphite, from Leadhills, carrying a large amount of vanadium is mentioned on p. 771.

**Anal.**—1, Flight, J. Ch. Soc., **25**, 1053, 1872. 2, Frenzel, Min. Mitth., 3, 504, 1880 (Jb. Min., 673, 1875). 3, Genth, Am. Phil. Soc., Oct. 2, 1885. 4, 5, Rg., Ber. Ak. Berlin, 661, 1880; 4, G. = 6·635, 5, G. = 6·373, both containing some quartz. 6, Doering, Bol. Acad. Cienc., Córdoba, **5**, 498, 1883. 7, Nordström, G. För. Förh., **4**, 267, 1879. 8, Rg., Min. Ch. Erg., 252, 1880. 9–11, Genth, Am. Phil. Soc., **22**, 365, 1885. 12, H. F. Keller, ibid.; from 12 nearly 80 p. c. gangue (quartz, etc.) has been deducted. 13–15, Genth, l. c. Also Leadhills, Collie, J. Ch. Soc., **55**, 94, 1889.

| | G. | $V_2O_5$ | $As_2O_5$ | $P_2O_5$ | PbO | Cl |
|---|---|---|---|---|---|---|
| 1. S. Africa | 6·661 | 19·24 | — | — | 78·42 | 2·56 = 100·22 |
| 2. Wanlockhead | | 17·92 | — | 2·75 | 73·97 | 2·34 CaO 3·02 = 100 |
| 3. " | | 18·04 | 0·34 | 0·27 | 78·39 | 2·53 = 99·57 |
| 4. Córdoba, *brown* | | 18·40 | — | 0·76 | 76·73 | 2·36 ZnO 0·94 = 99·19 |
| 5. " *yellow* | | 20·88 | — | 1·05 | 74·22 | 2·19 ZnO 2·48 = 100·82 |
| 6. " | | 19·49 | — | — | 74·58 | 2·44 Zn(Mn)O 2·91, $H_2O$, etc. 0·52 |
| 7. Bölet | | 17·61 | — | *tr.* | 79·18 | 2·34 $Fe_2O_3$ 1·39 = 100·52 [=99·24 |
| 8. Arizona | 6·847 | 19·62 | — | 1·41 | 77·28 | 2·40 = 100·71 |
| 9. Lake Valley, N. M. | | 17·37 | 0 24 | 0·57 | 79·43 | 2·39 = 100 |
| 10. " " " | 6·862 | 17·74 | 1·33 | 0·39 | 78·31 | 2·49 = 100·26 |
| 11. Oracle, Arizona | 6·572 | 16·98 | 3·06 | 0·29 | 77·49 | 2·41 $Fe_2O_3$ 0·48 = 100·71 |
| 12. " " | | 17·16 | 4·30 | *tr.* | 77·47 | 2·46 = 101·39 |
| 13. Yavapai Co., " | 7·109 | 18·64 | *tr.* | 0·72 | 77·96 | 2·69 CuO 0·18, $Fe_2O_3$ 0·04=100·23 |
| 14. *Endlichite* | | 10·98 | 13 52 | *tr.* | 73·48 | 2·45 CaO 0·34 = 100·77 |
| 15. " | 6·864 | 7·94 | 10·73 | — | 79·15 | 2·18 = 100 |

**Pyr., etc.**—In the closed tube decrepitates and yields a faint white sublimate. B.B. fuses easily, and on charcoal to a black lustrous mass, which in R. F. yields metallic lead and a coating of lead chloride; after completely oxidizing the lead in O.F. the black residue gives with salt of phosphorus an emerald-green bead in R.F., which becomes light yellow in O.F. Gives the chlorine reaction with the copper test. Fused with 3 parts of potassium bisulphate forms a clear yellow mass, which on cooling reddens, becoming finally of a pomegranate-yellow color. Decomposed by hydrochloric acid.

If nitric acid be dropped on the crystals they become first deep red from the separation of vanadic oxide, and then yellow upon its solution.

**Obs.**—This mineral was first discovered at Zimapan in Mexico, by Del Rio. Later obtained among some of the old workings at Wanlockhead in Dumfriesshire, where it occurs in small globular masses, on calamine, and also in small hexagonal crystals; also at Berezov in the Ural, with pyromorphite; and near Kappel in Carinthia, in crystals; at Undenäs, Bölet, Sweden. In the Sierra de Córdoba, Argentine Republic. South Africa (anal. 1).

In the U. States, sparingly with wulfenite and pyromorphite as a coating on limestone near Sing Sing, N. Y. Abundant in the mining regions of Arizona and New Mexico, often associated with wulfenite and descloizite. In Arizona, at the Hamburg, Melissa, and other mines in Yuma Co., in brilliant deep red crystals; Vulture, Phœnix, and other mines in Maricopa Co.; at the Black Prince mine, also from the Mammoth gold mine, near Oracle, Pinal Co.; in brown barrel-shaped crystals in the Humbug dist., Yavapai Co. In New Mexico, at Lake Valley, Sierra Co. (*endlichite*); and the Mimbres mines near Georgetown. Sparingly in Montana at the Bald Mountain mine, Beaver Co. Endlichite is named after Dr. F. M. Endlich.

Before it was shown by Roscoe that the vanadium oxide was $V_2O_5$ instead of $VO_3$ it was supposed that vanadinite crystals might be pseudomorphs after pyromorphite.

Del Rio discovered this species at Zimapan, and obtained from it, in 1801, 80·72 of lead oxide, and 14·8 of a new metallic acid, the basis of which he called *Erythronium*. This result was later (1804) set aside by himself, and also by Descotils, both of whom made the acid the chromic, and the mineral a *brown* chromate of lead. The metal vanadium was not discovered by Sefstrom until 1830, and then in iron made of ore from Taberg, Sweden; and in the same year Wöhler showed that Del Rio's lead ore was a vanadate.

**Ref.**—[1] From Kappel, Carinthia, Zs. Kr., 4, 353, 1880. Other determinations are: Rg., 0·72699, Pogg., **98**, 249, 1856; Sbs., 0·71157, ib., **100**, 297, 1857; Pfd., Pinal Co., Arizona, $\dot{c}$ = 0·71121, and Lake Valley, New Mexico (endlichite), $\dot{c}$ = 0·7495, $xx'$ = 38° 12', Am. J. Sc., **32**, 441, 1886.

[2] See Vrba, l. c. [3] Kenng., Ueb. Min., 48, 1854. [4] Sbs., l. c. [5] Vrba, l. c. [6] Websky, Córdoba, Zs. Kr., **5**, 553, 1881. [7] Zeph., Yuma Co., Arizona, Lotos, 1889.

**Hedyphane** *Breithaupt*, Schw. J., **60**, 310, 1830.

Massive, perhaps monoclinic. Two cleavages at 84°. H. = 4·5. G. = 5·404 Br.; 5·82 Lindström. Luster resinous. Color white or yellowish white. Optically biaxial with small divergence, one axis visible in cleavage section.

Comp.—Apparently analogous to mimetite, but with calcium (and barium).

Anal.—1, Kersten, Schw. J., **62**, 22, 1831, as recalc. by Rg., Min. Ch., 337, 1875. 2, Michaelson, ibid. 3, Lindström, G. För. Förh., **4**, 266, 1879, after deducting some $CaCO_3$. 4, Igelström, Öfv. Ak. Stockh., **22**, 229, 1865.

| | G. | $As_2O_5$ | $P_2O_5$ | PbO | CaO | BaO | MgO | Cl | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Långban | | 22·78 | *und.* | 51·03 | 14·09 | — | — | 2·66 | = |
| 2. " | | 28·51 | 3·19 | 57·45 | 10·50 | — | — | 3·06 | = 102·71 |
| 3. " | 5·82 | 29·01 | 0·55 | 50·89 | 7·85 | 8·27 | 0·25 | 3·14 | $Fe_2O_3$ 0·08, $(Na_2,K_2)O$ 0·24 [= 100·28 |
| 4. Pajsberg | | 31·34 | — | 58·64[a] | 7·64 | — | 0·06 | 3·00 | = 100·68 |

[a] Pb 49·20, $PbCl_2$ 11·76.

From Långban, Sweden; also from Pajsberg, but containing no barium. Named ἡδυφανης, *of attractive aspect.*

Hedyphane has ordinarily been included as a calcium variety of mimetite to which it seems to correspond in composition, but if monoclinic, as suggested by Dx. (Bull. Soc. Min., **4**, 93, 1881), it must stand independently. It needs further investigation.

**Pleonectite.** Pleonektit *L. J. Igelström*, G. För. Förh., **11**, 210, 1889, Jb. Min., **2**, 40, 1889.

Occurs in embedded grains with arseniopleite and an undetermined antimonio-arsenate of manganese in a gangue of hausmannite, rhodonite, calcite at the Sjö mine, Grythytte parish, Örebro, Sweden. Massive with indistinct cleavage. H. = 4. Luster resinous. Color grayish white. Translucent in thin splinters. Contains $As_2O_5$, $Sb_2O_5$, PbO, Cl, but not analyzed.

Named from πλεονεκτεῖν, *to have more,* in allusion to the fact that several related minerals occur at the same mine.

## 4. Wagnerite Group. Monoclinic.

Phosphates of magnesium (calcium), iron and manganese containing fluorine (also hydroxyl). Formula $R_2FPO_4$ or $(RF)RPO_4$.

| | | | $\grave{a} : \bar{b} : \acute{c}$ | $\beta$ |
|---|---|---|---|---|
| 553. | **Wagnerite** | $(MgF)MgPO_4$ | 1·9145 : 1 : 1·5059; | 71° 53′ |
| 554. | **Spodiosite** | $(CaF)CaPO_4$? | | |
| 555. | **Triplite** | $(RF)RPO_4$<br>R = Fe : Mn = 2 : 1, 1 : 1, 1 : 2, etc. | | |
| 556. | **Triploidite** | $(ROH)RPO_4$<br>R = Mn : Fe = 3 : 1 | 1·8572 : 1 : 1·4925; | 71° 46′ |
| 557. | **Sarkinite** | $(MnOH)MnAsO_4$ | 2·0017 : 1 : 1·5154: | 62° 13½′ |

**553. WAGNERITE.** Wagnerit, Phosphorsaurer Talk, *Fuchs*, Schw. J., **33**, 269, 1821. Magnésie phosphatée *Fr.* Pleuroklas *Breith.*, Char., 50, 193, 1823. Kjerulfin *von Kobell*, J. pr. Ch., **7**, 272, 1873.

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c}$ = 1·9145 : 1 : 1·5059; $\beta$ = *71° 53′ = 001 ∧ 100 Miller[1].

100 ∧ 110 = 61° 12½′, 001 ∧ 101 = 30° 59½′, 001 ∧ 011 = 55° 3½′.

**Forms**[2]:
*a* (100, i-ī)
*b* (010, i-ì)[3]
*c* (001, *O*)
*l* (410, i-4̄)
*h* (310, i-3̄)

*M* (210, i-2̄)
*λ* (430, i-$\bar{\frac{4}{3}}$)[3]
*ν* (870, i-$\bar{\frac{8}{7}}$)[3]
*m* (110, *I* = *g* Mlr.)
*δ* (450, i-$\grave{\frac{5}{4}}$)[3]
*γ* (120, i-2̀)[3]

*π* (101, − 1-ī)[3]
*w* (1̄01, 1-ī)
*y* (2̄01, 2-ī)
*q* (3̄01, 3-ī)
*t* (014, ¼-ì)
*r* (012, ½-ì)

*f* (034, ¾-ì)
*e* (011, 1-ì)
*v* (112, − ½)
*i* (1̄12, ½)
*s* (212, − 1-2̀)
*o* (211, − 2-2̄)

*d* (6̄18, ¾-6)
*x* (4̄14, 1-4̄)
*n* (2̄14, ½-2̄)
*z* (2̄12, 1-2̀)
*u* (2̄11, 2-2̄)[3]

Also doubtful, Bgr.[3]: *μ* (890), *k* (054), *ξ* (1̄32), *ψ* (2̄31)

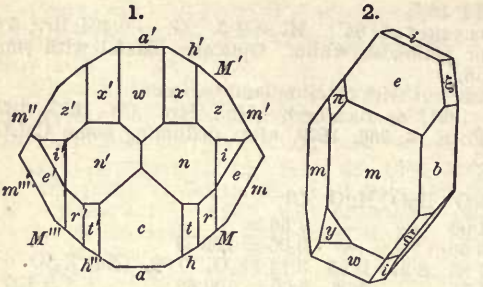


Fig. 1, *Wagnerite*, after Mlr. 2, *Kjerulfine*, Bgr.

| | | | |
|---|---|---|---|
| *ll'''* | = 48° 55′ | *cn* | = 30° 31′ |
| *hh'''* | = 62° 28½′ | *cz* | = 53° 52′ |
| *MM''* | = 84° 35½′ | *cu* | = 76° 8′ |
| *mm'''* | = *122° 25′ | *as* | = 47° 18′ |
| *γγ'* | = 30° 44′ | *av* | = 59° 23′ |
| *cw* | = *44° 42′ | *ar* | = 75° 21′ |
| *cy* | = 71° 8′ | *a'i* | = 86° 2½′ |
| *cq* | = 83° 14′ | *a'z* | = 68° 13′ |
| *tt'* | = 39° 22½′ | *vv'* | = 62° 21′ |
| *rr'* | = 71° 11′ | *oo'* | = 68° 18′ |
| *ff'* | = 94° 3′ | *ii'* | = 73° 45′ |
| *ee'* | = 110° 7′ | *nn'* | = 41° 7′ |
| *cv* | = 35° 44′ | *ss'* | = 27° 3′ |
| *cm* | = 81° 23′ | *xx'* | = 37° 13′ |
| *co* | = 54° 16′ | *zz'* | = 67° 54½′ |
| *ci* | = 42° 36½′ | *uu'* | = 84° 21′ |

Prismatic planes vertically striated. Crystals sometimes large and coarse. Also massive.

Cleavage: *a*, *m* imperfect; *c* in traces. Fracture uneven and splintery. Brittle. H. = 5–5·5. G. = 3·068, transparent crystal; 2·985, untransparent, Rg. Luster vitreous. Streak white. Color yellow, of different shades; often grayish, also flesh-red, greenish. Translucent.

Optically –. Ax. pl. ∥ *b*. $Bx_a \parallel \grave{c}$ Dx. $Bx_a \wedge \grave{c} = -21° 30'$ Bgr., kjerulfine. Dispersion $\rho > v$ marked; inclined nearly inappreciable.

*Wagnerite* $2E_r = 44° 48'$ $2E_{bl} = 43° 8'$ Dx.
*Kjerulfine* $2E_r = 60° 21'$ Li $2E_y = 59° 30'$ Na $2E_{gr} = 58° 23'$ Tl
" $2H_{a.y} = 39° 41'$ $2H_{o.y} = 167° 28'$ ∴ $2V_{a.y} = 37° 49'$ $\beta_y = 1·5313$ Bgr.

Refractive indices:

Bamle $\alpha = 1·569$ $\beta = 1·570$ $\gamma = 1·582$ Lévy-Lcx.

**Var.**—1. *Wagnerite*, in crystals, often highly modified.

2. *Kjerulfine*, massive cleavable, also in large, rough crystals. Madé a new species upon the basis of an incorrect analysis of altered material; the identity with wagnerite was first established by Bauer, Zs. G. Ges., **27**, 230, 1875, Jb. Min., **2**, 75, 1880.

**Comp.**—A fluo-phosphate of magnesium, $(MgF)MgPO_4$ or $Mg_3P_2O_8.MgF_2$ = Phosphorus pentoxide 43·8, magnesia 49·3, fluorine 11·8 = 104·9, deduct (O = 2F) 4·9 = 100. A little calcium replaces part of the magnesium.

**Anal.**—1, Rg., Pogg. Ann., **64**, 252, 1845. Also earlier Fuchs (1821) and Kbl., Ber. Ak. München, 155, 1873, cf. Rg., Min. Ch., 700, 1875, Bauer, l. c. 2, Friederici, Jb. Min., **2**, 77, 1880. 3, Rg., Zs. G. Ges., **31**, 107, 1879. Also Pisani, Bull. Soc. Min., **2**, 43, 1879.

| | G. | $P_2O_5$ | MgO | FeO | CaO | F |
|---|---|---|---|---|---|---|
| 1. *Wagnerite* | 3·068 | 40·61 | 46·27 | 4·59 | 2·38 | 9·36 = 103·21 |
| 2. *Kjerulfine* | 3·10 | 42·35 | 46·01 | 0·65[a] | 4·81 | 5·06 $Na_2O(K_2O)$ 1·54, insol. 2·04 = 102·46 |
| 3. " | 3·140 | 44·23 | 44·47 | — | 6·60 | 6·23 ign. 0·77 = 102·30 |

[a] $Fe_2O_3$ and $Al_2O_3$.

From 1, 2·68 p. c. $SiO_2$ has been deducted.

**Pyr., etc.**—B.B. in the forceps fuses at 4 to a greenish gray glass; moistened with sulphuric acid colors the flame bluish green. With borax reacts for iron. On fusion with soda effervesces, but is not completely dissolved; gives a faint manganese reaction. Fused with salt of phosphorus in an open glass tube reacts for fluorine. Soluble in nitric and hydrochloric acids. With sulphuric acid evolves fumes of hydrofluoric acid.

**Obs.**—*Wagnerite* occurs in the valley of Höllengraben, near Werfen, in Salzburg, Austria, in irregular veins of quartz, traversing clay slate. Named after the Oberbergrath Wagner. *Kjerulfine* is from Kjörrestad, near Bamle, Norway. Named after Prof. Th. Kjerulf of Christiania (1828–1888).

**Artif.**—Obtained by Deville & Caron (C. R., **47**, 985, 1858, Ann. Ch. Phys., **67**, 454, 1863) by fusing ammonium phosphate with magnesium fluoride and an excess of magnesium chloride. Other isomorphous compounds were formed with chlorine in place of fluorine, also iron, manganese, corresponding to triplite, etc. Lechartier (C. R., **65**, 172, 1867) has obtained an arsenical wagnerite.

**Ref.**—[1] Min., p. 489, the predominating prism (*g* of Mlr.) here, as in kjerulfine (and triploidite), is made the unit prism. [2] See Mlr., l. c. [3] Bgr. on Kjerulfine, Zs. Kr., **3**, 474, 1879.

CRYPHIOLITE. Crifiolite *A. Scacchi,* Acc. Sc. Napoli, 1, No. 5, 1886 (read Sept. 8, 1883). Kryphiolith.

In small monoclinic crystals, tabular ‖ *a* and showing the forms:

*a* (100, *i-ī*), *c* (001, *O*), *e* ($\bar{2}01$, 2-*ī*), *μ* (111, − 1), *n* ($\bar{1}11$, 1). Approximate measured angles: $ac = 65° 52'$, $ce = 78° 46'$, $c\mu = 51° 42'$, $cn = 69° 1'$, $a\mu = 54° 39'$, $\mu\mu' = 88° 44'$, $nn' = 112° 36'$, $\mu n = 49° 17'$.

H. about 6. Brittle. G. = 2·674. Luster vitreous. Color honey-yellow. Transparent.

Composition uncertain, but apparently not far from wagnerite. Anal.—Scacchi, on 0·07 gram (analysis corrected by Cathrein, Zs. Kr., **14**, 525, 1888):

| $P_2O_5$ | MgO | CaO |
|---|---|---|
| 47·59 | 33·72 | 14·74 |

Regarding the loss as fluorine, the amount is found to be 6·93 p. c. B.B. becomes opaque, without complete fusion.

Found at Vesuvius in a mass of a conglomerate, consisting of fragments of leucitophyre and volcanic sand, enveloped in the lava of 1872. The crystals are concealed by a coating of apatite, hence the name from *κρύφιος, concealed.*

**554. SPODIOSITE.** *H. V. Tiberg*, G. För. Förh., **1**, 84, 1872.

Orthorhombic? In flattened (‖ *b*) prismatic crystals with the forms:

*b* (010, *i-ĭ*), *m* (110, *I*), *e* (021, 2-*ĭ*), *p* (111, 1). Angles: $mm''' = 84°$, $ee' = 147°$.

Cleavage: *b* distinct; *c* indistinct. Fracture uneven. Brittle. H. = 5. G. = 2·94. Luster dull porcelain-like, but vitreous. Color ash-gray, inclining to brown. Streak white.

**Comp.**—A calcium fluo-phosphate, perhaps $(CaF)CaPO_4$ or $Ca_3P_2O_8.CaF_2$, analogous to wagnerite (A. Sjögren).

**Anal.**—C. H. Lundström, l. c.

| $P_2O_5$ | CaO | MgO | F | $As_2O_5$ | $CO_2$ | Cl | $Fe_2O_3$ | $Al_2O_3$ | MnO | $H_2O$ | insol. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 32·20 | 49·81 | 2·27 | [4·71][a] | 0·24 | 3·90 | 0·12 | 1·24 | 1·11 | 0·55 | 2·70 | 1·15 = 100 |

[a] Including loss [but the analysis should show an excess].

**Pyr.**—B.B. fuses in the thinnest splinters to a white enamel; does not decrepitate. Soluble in hydrochloric and nitric acids with effervescence.

**Obs.**—From the Krangrufva, Wermland, Sweden. Named from *σπόδιος, ash-gray.*

A relation to wagnerite which has $MM''' = 84° 36'$, is suggested by A. Sjögren, (ibid., **7**, 666, 1885), which suggestion is here provisionally accepted.

**555. TRIPLITE.** Phosphate natif de fer melangé de manganèse (fr. Limoges) *Vauq.*, J. de M., **11**, 295, 1802, Ann. Ch., **41**, 242, 1802. Eisenpecherz pt. *Wern.*, 1808. Manganèse phosphaté *Lucas*, Tabl., **1**, 169, 1806. Phosphormangan *Karst.*, Tabl., 72, 1808. Manganèse phosphaté ferrifère, *H.*, Tabl., 1809. Triplit *Hausm.*, Handb., 1079, 1813. Eisenapatit *Fuchs*, J. pr. Ch., **18**, 499, 1839. Zwiselit *Breith.*, Handb., **2**, 299, 1841. Phosphate of Iron and Manganese. Zwieselit *Glock.*, Syn., 244, 1847. Talktriplit *L. J. Igelström*, Öfv. Ak. Stockh., **39**, No. 2, 86, 1882.

Monoclinic Dx.[1] Massive, imperfectly crystalline.

Cleavage: unequal in two directions perpendicular to each other, one much the more distinct. Fracture small conchoidal. H. = 4–5·5. G. = 3·44–3·8; 3·617 Peilau, Berg. Luster resinous, inclining to adamantine. Color brown or blackish brown to almost black. Streak yellowish gray or brown. Subtranslucent to opaque. Somewhat pleochroic.

Optically +. Ax. pl. nearly ‖ to the difficult, and ⊥ to the easy cleavage; to the latter $Bx_a$ is inclined 42° 10′ red, and 41° 53′ yellow. Dispersion $\rho > v$. Axial angles, Dx.[1]:

$$2H_{a.r} = 96° 15' \qquad 2H_{a.y} = 95° 27' \qquad 2H_{a.gr} = 95° 20' \qquad 2H_o = 125° 30'$$

**Comp., Var.**—$(RF)RPO_4$ or $R_3P_2O_8.RF_2$ with R = Fe and Mn, also Ca and Mg. The ratio varies widely, in anal. 1, Fe : Mn = 1 : 1; in 2 (zwieselite), Fe : Mn = 2 : 1; in 3, 1 : 2; in 5, 1 : 7.

*Talktriplite* is a variety from Horrsjöberg, containing magnesium and calcium in large amount; it occurs in embedded grains of a yellow or yellowish red color.

**Anal.**—1. Kbl., J. pr. Ch., **92**, 390, 1864. 2, Rg., Min. Ch., 351, 1860. 3, 4, Siewert, light and dark colored, Min. Mitth., 225, 1873. 5, Penfield, priv. contr. 6, Igelström, l. c.

| | | $P_2O_5$ | FeO | MnO | CaO | MgO | F | |
|---|---|---|---|---|---|---|---|---|
| 1. | Schlackenwald G. = 3·77 | 33.85 | 26·98 | 30·00 | 2·20 | 3·05 | 8·10 | $K_2O$ *tr.* = 104·18 |
| 2. | " *Zwieselite* | 30·33 | 41·42 | 23·25 | — | — | 6·00 | = 101·00 |
| 3. | Sierra de Córdoba | 35·65 | 18·30 | 37·84 | 4·46 | — | 4·94 | $SiO_2$ 0·13 = 101·32 |
| 4. | " " " | 31·50 | 16·07 | 38·20 | 5·99 | — | 7·87 | $Fe_2O_3$ 2·25 = 101·88 |
| 5. | Branchville | 32·17 | 7·69 | 54·14 | 1·80 | — | 7·53 | $H_2O$ 0·36 = 103·69 |
| 6. | *Talktriplite* | 32·82 | 16·12 | 14·86 | 14·91 | 17·42 | *undet.* | = 96·13 |

Earlier analysts, Berzelius, Bergemann, overlooked the fluorine. See 5th Ed., p. 543.

**Pyr., etc.**—B.B. fuses easily at 1·5 to a black magnetic globule; moistened with sulphuric acid colors the flame bluish green. With borax in O.F. gives an amethystine colored glass (manganese); in R.F. a strong reaction for iron. With soda reacts for manganese. With sulphuric acid evolves hydrofluoric acid. Soluble in hydrochloric acid.

**Obs.**—Found by Alluaud at Limoges in France, in a vein of quartz in granite, accompanied by apatite; occurs also at Peilau in Silesia; from Helsingfors, Finland; also from Sierra de Córdoba, Argentine Republic, in masses in quartz with beryl, apatite, columbite; it is in part altered to a mineral like heterosite. Also found at Stoneham, Maine; at Branchville, Conn.

*Zwieselite*, a clove-brown variety, is from Rabenstein, near Zwiesel, in Bavaria, in quartz (G. = 3·97 Fuchs). *Talktriplite* occurs in a rock carrying lazulite at Horrsjöberg, Wermland, Sweden.

**Alt.**—Often occurs coated with manganese oxide as a result of its alteration, and is sometimes changed to a substance near heterosite, p. 757.

**Ref.**—[1] Dx., N. R., 180, 1867.

GRIPHITE *W. P. Headden*, Am. J. Sc., **41**, 415, 1891.

A problematical phosphate, occurring in embedded reniform masses. Optically amorphous. Cleavage none. Fracture uneven to conchoidal. Brittle. H. = 5·5. G. = 3·401. Luster resinous to vitreous. Color dark brown. Translucent.

Anal.—1, Headden, l.c., mean of two complete and three partial analyses. 2, L. G. Eakins, U. S. G. Surv., Bull. **60**, 135, 1890.

| | $P_2O_5$ | $Al_2O_3$ | $Fe_2O_3$ | MnO | FeO | CaO | $Na_2O$ | $K_2O$ | $Li_2O$ | F | Cl | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 38·52 | 10·13 | — | 29·64 | 4·00 | 7·62[a] | 5·52 | 0·30 | *tr.* | *tr.* | 0·11 | 4·29 | insol. 0·16 = 100·29 |
| 2. | 39·68 | 8·74 | 2·36 | 29·13 | 1·97 | 6·72 | 5·25 | *tr.* | 0·13 | 2·35 | 0·25 | 3·67 | $CO_2$ 0·26, $SiO_2$ 0·43 = 100·94 |

[a] Incl. 0·15 MgO.

In anal. 1 the oxygen ratio for bases (including water) to acid is 1 : 1 very nearly, and Headden suggests the formula $R_6P_2O_{10}$ or a salt of normal phosphoric acid $H_5PO_5$. The fact, however, that no other similar salts are known among minerals makes the suggestion of doubtful value. Other analyses gave confirmatory results, and it is significant that Eakins obtained so nearly the same composition on independent material, but the presence of fluorine lends support to the suggestion that the mineral may have been derived from triplite.

The material analyzed by Headden was from the Riverton lode near Harney City, Pennington Co., S. Dakota; occurs in kidney shaped masses, sometimes 50 lbs. in weight, embedded in granite. Externally the masses are dark brown due to oxidation. Eakins's mineral was from a tin mine near Rapid City, S. Dakota. Named from *γρίφος, an enigma.*

A phosphate occurring in green massive forms resembling apatite, at Stoneham, Me., afforded O. H. Drake (priv. contr.):

| $P_2O_5$ | FeO | MnO | CaO | MgO | $Na_2O$ | $K_2O$ | F | |
|---|---|---|---|---|---|---|---|---|
| 40·54 | 33·39 | 11·47 | 2·53 | 0·36 | 6·16 | 1·57 | 3·70 | $Fe_2O_3$ 0·79, $Al_2O_3$ 1·38=101·89, deduct O(=2F) 1·59 = 100·30 |

It is optically biaxial (Pfd.) and may represent a new species; the analysis, however, does not yield a satisfactory formula.

SARCOPSIDE. Sarkopsid *M. Websky*, Zs. G. Ges., **20**, 245, 1868.

Monoclinic? occurring in irregular ellipsoids, sometimes in distorted six-sided plates.

H. = 4. G. = 3·692–3·730. Luster glistening to silky and greasy. Color, on fresh surface, flesh-red to lavender-blue. Translucent in thin splinters. Streak straw-yellow, some grains give a green color. Analysis, Websky:

§ $P_2O_5$ 34·73 $Fe_2O_3$ 8·83 FeO 30·53 MnO 20·57 CaO 3·40 $H_2O$ [1·94] F *und.*

Soluble in dilute hydrochloric and sulphuric acids. Occurs with vivianite and hureaulite in a granite vein on a ridge between Michelsdorf and the valley of the Mühlbach in Silesia.

Perhaps an impure, partially altered triplite.

**556. TRIPLOIDITE.** *G. J. Brush* and *E. S. Dana,* Am. J. Sc., **16**, 42, 1878.

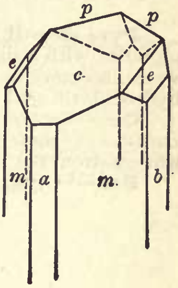
Monoclinic. Axes $\grave{a} : \overset{|}{b} : \grave{c} = 1·85715 : 1 : 1·49253$; $\beta = {*}71° 46' = 001 \wedge 100$ E. S. Dana.

$100 \wedge 110 = {*}60° 27'$, $001 \wedge 101 = 31° 22\frac{5}{6}'$, $001 \wedge 011 = {*}54° 48'$.

**Forms**[1]: *a* (100, *i-ī*), *b* (010, *i-ì*), *c* (001, *O*); *m* (110, *I*); *e* (011, 1-ì); *p* ($\bar{2}$11, 2-$\bar{2}$).

Angles: *mm‴* = 120° 54′, *ee′* = 109° 36′, *cm* = 81° 7′, *cp* = 76° 35′, *pp′* = 82° 53,′ *ap* = 52° 49′, *me* = 36° 53′.

Crystals striated vertically. Commonly in crystalline aggregates, parallel-fibrous to columnar; also divergent, or confusedly fibrous to nearly compact or massive.



Cleavage: *a* perfect. Fracture subconchoidal. Brittle. H. = 4·5–5. G. = 3·697. Luster vitreous to greasy adamantine. Color yellowish to reddish brown, in isolated crystals also topaz- to wine-yellow, occasionally hyacinth-red. Streak nearly white. Transparent to translucent. Pleochroism faint. The axes of elasticity in the clinodiagonal section nearly coincide respectively with the vertical axis (3° to 4° behind) and a normal to *a*.

**Comp.**—$(Mn,Fe)P_2O_8.(Mn,Fe)OH_2$ or $4(Mn,Fe)O.P_2O_5.H_2O$. If R = Mn : Fe = 3 : 1, the percentage composition is: Phosphorus pentoxide 32·0, iron protoxide 16·2, manganese protoxide 47·8, water 4·0 = 100.

**Anal.**—1, 2, S. L. Penfield, l. c.

| | $P_2O_5$ | FeO | MnO | CaO | $H_2O$ |
|---|---|---|---|---|---|
| 1. | $\frac{2}{2}$ 32·11 | 14·88 | 48·45 | 0·33 | 4·08 = 99·85 |
| 2. | 32·24 | 18·65 | 42·96 | *und.* | 4·09 quartz 1·09 = 99·03 |

**Pyr., etc.**—In the closed tube gives off neutral water, turns black and becomes magnetic. Fuses quietly in the naked lamp-flame, and B.B. in the forceps colors the flame green. Reacts for manganese and iron with the fluxes. Soluble in acids.

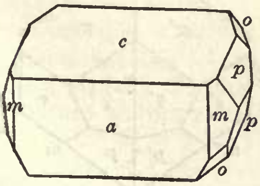
**Obs.**—Occurs at Branchville, Fairfield Co., Conn., intimately associated with eosphorite, dickinsonite, lithiophilite, and other species, in a vein of albitic granite. In crystalline form triploidite is very similar to wagnerite, and as the formulas of the latter species and of triplite are closely analogous, it is concluded that the three species are isomorphous; in triploidite, the hydroxyl (OH) takes the place of the fluorine. Named from triplite and εἶδος, *form,* in allusion to the close similarity between the two species.

Triplite also occurs at Branchville (anal. 5, p. 778), but it cannot be concluded from this fact that triploidite is only an altered triplite, which has lost its fluorine and taken up water, for the analyses of triploidite were made on perfectly clear glassy crystalline fragments.

**557. SARKINITE.** *A. Sjögren,* G. För. Förh., **7**, 724, 1885. Polyarsenite *L. J. Igelström,* Öfv. Ak. Stockh., **42**, 257, 1885, Bull. Soc. Min., **8**, 369, 1885.

Monoclinic. Axes $\grave{a} : \overset{|}{b} : \grave{c} = 2·0017 : 1 : 1·5154$; $\beta = 62° 13\frac{1}{2}' = 001 \wedge 100$ Flink[1].

$100 \wedge 110 = 60° 33'$, $001 \wedge \bar{1}01 = 45° 59'$, $001 \wedge 011 = 53° 17'$.



*Sarkinite,* Flink.

**Forms**[1]: *a* (100, *i-ī*), *b* (010, *i-ì*), *c* (001, O); *m* (110, *I*); *p* (021, 2-ì); *o* ($\bar{1}$11, 1).

Angles: *mm‴* = 121° 6′, *mm′* = *58° 54′, *pp′* = 139° 6′, *cm* = 76° 45′, *co* = 66° 39′, *a′o* = 79° 44′, *oo′* = 110° 26′, *m′o* = *36° 36′, *mo* = *51° 8′.

Crystals somewhat elongated ‖ axis $\overset{|}{b}$ and flattened ‖ *a*. Faces *a* striated vertically or uneven, *c* uneven. Sometimes grouped in spherical forms.

Cleavage: prismatic (?) distinct. H. = 4–5. G. = 4·17–4·19. Luster greasy.

Color rose-red, flesh-red, reddish yellow. Streak light rose-red. Optically −. Double refraction strong. Ax. pl. ∥ $\bar{b}$. Bx ∧ $\acute{c} = -54°$. Ax. angle about 83°, Btd.

**Comp.**—$Mn_3As_2O_8.Mn(OH)_2$ or $4MnO.As_2O_5.H_2O$ = Arsenic pentoxide 43·3, manganese protoxide 53·3, water 3·4 = 100.

**Anal.**—1, C. H. Lundström, G. För. Förh., **7**, 725, 1885. 2, H. G. Söderbaum, Öfv. Ak. Stockh., **42**, 258, 1885. 3, A. Hamberg, G. För. Förh., **10**, 381, 1888.

| | G. | | $As_2O_5$ | $P_2O_5$ | MnO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. *Sarkinite* | 4·145 | | 41·60 | 0·21 | 51·60 | 3·06 | PbO 0·25, FeO 0·13, CaO 1·40, MgO 0·98, [$CO_2$ 0·76, insol. 0·38 = 100·37 |
| 2. *Polyarsenite* | 4·085 | ⅔ | 39·04 | — | 50·18 | 3·15 | $Sb_2O_5$ 1·20, CaO 2·89, MgO 0·75, $CO_2$ 3·51 = [100·72 |
| 3. Pajsberg | | | 41·50 | *tr.* | 51·92 | 3·48 | CaO 1·22, MgO 0·38 = 98·50 |

**Pyr., etc.**—B.B. decrepitates and fuses with some difficulty to a black shining non-magnetic globule; with soda on charcoal a brownish mass and arsenical odor. In the tube gives off water, becomes brown, and the residue reacts for manganese with the fluxes. Easily soluble in hydrochloric acid.

**Obs.**—*Sarkinite* is from the iron-manganese mines of Pajsberg, Sweden. Named from *σάρκινος, made of flesh,* in double allusion to the blood-red color and greasy luster. *Polyarsenite* is from the Sjö mine, Grythytte parish, Örebro, Sweden.

**Ref.**—[1] Crystals from Harstig mine (anal. 3), Pajsberg, G. För. Förh., **10**, 380, 1888.

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## 5. Amblygonite Group. Monoclinic, Triclinic.

| | | | |
|---|---|---|---|
| 558. | **Durangite** | $Na(AlF)AsO_4$ | Monoclinic |
| | | | $\grave{a} : \overset{\lvert}{\bar{b}} : \acute{c} = 0·7716 : 1 : 0·8250$; $\beta = 64° 47'$ |
| 559. | **Amblygonite** | $Li(AlF)PO_4$ | Triclinic |
| | | | $\breve{a} : \bar{b} : \acute{c} = 0·7334 : 1 : 0·7633$; $\alpha = 108° 51'$, $\beta = 97° 48'$, $\gamma = 106° 27'$ |

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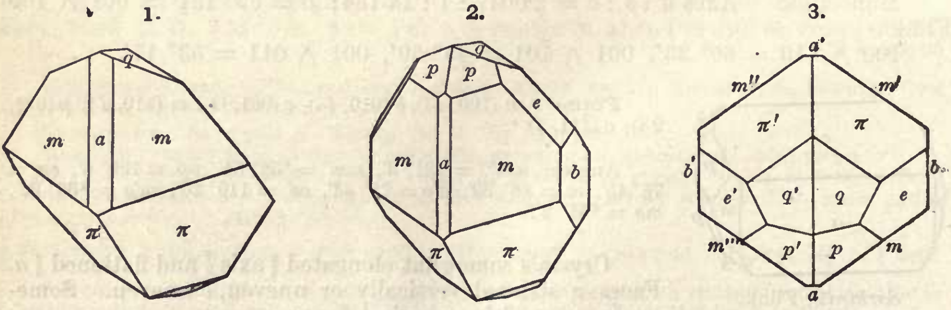
**558. DURANGITE.** *G. J. Brush*, Am. J. Sc., 48, 179, 1869.

Monoclinic. Axes $\grave{a} : \overset{\lvert}{\bar{b}} : \acute{c} = 0·77158 : 1 : 0·82499$; $\beta = 64° 47' = 001 \wedge 100$ Blake, Des Cloizeaux[1].

$100 \wedge 110 = 34° 55'$, $001 \wedge \bar{1}01 = 60° 37·6'$, $001 \wedge 011 = 36° 44\frac{1}{6}'$.

**Forms**[2]: *a* (100, *i-ī*), *b* (010, *i-ì*); *m* (110, *I*); *e* (021, 2-*ì*); *p* (111, − 1): *q* ($\bar{1}12$, ½), *π* ($\bar{1}11$, 1).

| | | | |
|---|---|---|---|
| $mm''' = {}^*69° 50'$ | $m'q = 72° 6'$ | $qq' = 44° 33'$ | $a'\pi = 61° 15\frac{1}{2}'$ |
| $ee' = 112° 22'$ | $m'\pi = {}^*44° 28'$ | $\pi\pi' = {}^*67° 50'$ | $p\pi = 80° 38'$ |
| $mp = 29° 32\frac{1}{2}'$ | $pp' = 46° 15'$ | $ap = 38° 6\frac{1}{2}'$ | |



Figs. 1–3, after Des Cloizeaux.

In crystals; habit oblique pyramidal *m* and *π* predominating; faces usually uneven.

Cleavage: *m* distinct. Fracture uneven. Brittle. H. = 5. G. = 3·94–4·07. Luster vitreous. Color orange-red, light and dark. Streak cream-yellow. Translucent.

Optically −. Ax. pl. ⊥ *b*. $Bx_a \wedge \dot{c} = -25° 7'$. Dispersion $\rho > v$ feeble; horizontal distinct. Axial angles, Dx.:

$2H_{a.r} = 80° 53'$   $2H_{a.y} = 80° 49'$ Dx.

**Comp.**—A fluo-arsenate of sodium and aluminium, $Na(AlF)AsO_4$ or $AlAsO_4.NaF$ = Arsenic pentoxide 55·3, alumina 24·5, soda 14·9, fluorine 9·2 = 103·9, deduct (O = 2F) 3·9 = 100. Part of the aluminium is replaced by ferric iron, and a little of the sodium by lithium.

**Anal.**—1, 2, G. J. Brush, light colored crystals, l. c. 3, G. W. Hawes, dark crystals, Am. J. Sc., **11**, 464, 1876.

| | G. | $As_2O_5$ | $Al_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ | $Na_2O$ | $Li_2O$ | F | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 3·94 | 55·10 | 20·68 | 4·78 | 1·30 MnO | 11·66 | 0·81 | *undet.* | |
| 2. | | 53·22[a] | 20·09 | 5·06 | 1·28 " | 11·86 | 0·70 | *undet.* | |
| 3. | 4·07 | 53·11 | 17·19 | 9·23 | 2·08 | 13·06 | 0·65 | 7·67[b] | = 102·99 |

[a] Regarded as too low.   [b] A second trial gave F = 7·49 p. c.

**Pyr., etc.**—In the forceps fuses at 2 giving an intense soda flame. In the closed tube blackens at a moderate temperature, but regains its color on cooling; at a higher heat fuses easily to a yellow glass and gives a faint white volatile sublimate, etching the tube slightly. The same in the open tube, with evolution of acid fumes, reddening litmus paper. On charcoal, B.B. fuses readily and gives a white sublimate with a strong arsenical odor in R.F. With soda and charcoal powder in a matrass yields a sublimate of metallic arsenic. With the fluxes reacts for iron and manganese. Decomposed by sulphuric acid with evolution of fluohydric acid.

**Obs.**—Found at the Barranca tin mine, eighteen miles northeast of Coneto, State of Durango, and about ninety miles northeast of the city of Durango, Mexico. Occurs in a vein four to six inches in thickness; the crystals are sometimes attached to the walls of the vein (here the large, light, orange-colored variety), sometimes with cassiterite in the white pulverulent matter which fills the veins (small, dark colored variety). The largest crystal found was 19 × 11 mm.

**Ref.**—[1] Ann. Ch. Phys., 4, 401, 1875.

**559. AMBLYGONITE.** Amblygonit *Breith.*, Hoffm. Min., 4, b, 159, 1817, Handb., 483. Montebrasite *Dx.*, C. R., **73**, 306, 1247, 1871. Hebronit *Kbl.*, Ber. Ak. München, 284, 1872.

Triclinic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·73337 : 1 : 0·76332$; $\alpha = 108° 51\frac{1}{4}'$, $\beta = 97° 48\frac{1}{6}'$, $\gamma = 106° 26\frac{2}{3}'$ J. D. Dana[1].

$100 \wedge 010 = 69° 35\frac{1}{2}'$, $100 \wedge 001 = *75° 30'$, $010 \wedge 001 = 67° 38'$.

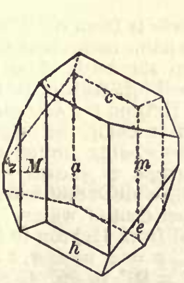
**Forms**[1]: *a* (100, *i-ī*), *c* (001, *O*); *m* (110, *I'*), *M* (1$\bar{1}$0, *'I*), *z* (1$\bar{2}$0, *'i-*$\breve{2}$); *l* (101, '1-ī' L, Dx.) as tw. pl., *h* ($\bar{1}$01, ,1-ī, H, Dx.), *e* (0$\bar{2}$1, '2-ĭ).

*am* = 29° 35'   *az* = 72° 7'   *lh* = 90° 24'   *cM* = *92° 20'
*aM* = *44° 30'   *al* = 37° 10'   *ce* = *74° 40'   *eM* = *66° 30'
*mM* = 74° 5'   *ch* = 53° 14'   *cm* = 68° 9'   *ae* = 101° 25½'

Crystals large and coarse; forms rarely distinct. Usually cleavable to columnar and compact massive. Polysynthetic twinning lamellæ common, parallel to *l* and *h*, two planes nearly at right angles to each other (89° 8' Dx.), and *h* usually the more prominent, nearly bisecting the interior angle *ac* (cf. f. 2).

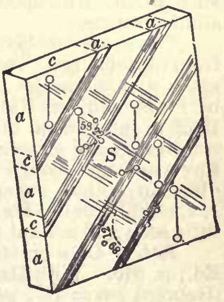
Cleavage: *c* perfect, with pearly luster; *a* somewhat less so, vitreous; *e* (0$\bar{2}$1) sometimes equally distinct; *M* (1$\bar{1}$0) difficult. Fracture uneven to subconchoidal. Brittle. H. = 6. G. = 3·01–3·09. Luster vitreous to greasy, on *c* pearly. Color white to pale greenish, bluish, yellowish, grayish or brownish white. Streak white. Subtransparent to translucent.

1.



Hebron.

2.



After Dx.

Optically −. For the Penig mineral (*amblygonite*, Dx. 1872): ax. pl. inclined $12\frac{1}{2}°$ to *a*, $67\frac{1}{4}°$ to *c*, and the plane ($S$) ⊥ $Bx_a$ inclined almost equally to *a* and *c*, normal angles $Sa = 80° 52'$, $Sc = 80° 35'$, Dx. $Bx_a$ inclined 11° 40′ to edge *a*/*c*. $\beta_y = 1·594$ Na. Dispersion $\rho > v$ small. $2E_r = 86° 23'$, $2E_y = 86° 21'$.

Some varieties (*montebrasite*, Dx., 1872, see below) are also optically negative, but the ax. pl. is inclined about 23° to *c* and 82° to *a*. $Bx_a$ nearly ∥ edge *a*/*c*. Axial angles large and variable:

$$2H_{a.r} = 95° 48'–102° 38' \qquad 2H_{o.r} = 102° 50'–106° 10'$$

Refractive indices:

$$\alpha = 1·579 \qquad \beta = 1·593 \qquad \gamma = 1·597 \text{ Lévy-Lcx.}$$

**Comp.**—A fluo-phosphate of aluminium and lithium, $Li(AlF)PO_4$ or $AlPO_4.LiF$ = Phosphorus pentoxide 47·9, alumina 34·4, lithia 10·1, fluorine 12·9 = 105·3, deduct (O = 2F) 5·3 = 100. Sodium often replaces part of the lithium, and hydroxyl part of the fluorine.

Cf. Rg., Jb. Min., **1**, 15, 1883, and Min. Ch. Erg., 5, 1886, who takes a somewhat different view of the composition. He regards the water as due to gradual alteration and proposes the formula: $Al_2F_6 + 2(R_3PO_4 + Al_2P_2O_8)$ or perhaps $\begin{cases} 2LiF + Al_2F_6 \\ 2Li_3PO_4 + 3Al_2P_2O_8 \end{cases}$.

**Anal.**—1–8, Penfield, Am. J. Sc., **18**, 295, 1879.

| | G. | $P_2O_5$ | $Al_2O_3$ | $LiO_2$ | $Na_2O$ | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|---|
| 1. Penig | | $\frac{2}{2}$ 48·24 | 33·55 | 8·97 | 2·04 | 1·75 | 11·26 | $Mn_2O_3$ 0·13 = 105·94 |
| 2. Montebras, A | 3·088 | $\frac{2}{2}$ 47·09 | 33·22 | 7·92 | 3·48 | 2·27 | 9·93 | CaO 0·24 = 104·15 |
| 3. Auburn, Me. | 3·059 | $\frac{2}{2}$ 48·48 | 33·78 | 9·46 | 0·99 | 3·57 | 6·20 | = 102·48 |
| 4. Hebron, Me., A | | [48·53] | 34·12 | 9·54 | 0·34 | 4·44 | 5·24 | = 102·21 |
| 5. Paris, Me. | 3·035 | $\frac{2}{2}$ 48·31 | 33·68 | 9·82 | 0·34 | 4·89 | 4·82 | $K_2O$ 0·03 = 101·89 |
| 6. Hebron, Me., B | 3·032 | $\frac{2}{2}$ 47·44 | 33·90 | 9·24 | 0·66 | 5·05 | 5·45 | = 100·74 [= 101·10 |
| 7. Branchville, Ct. | 3·032 | $\frac{2}{2}$ 48·80 | 34·26 | 9·80 | 0·19 | 5·91 | 1·75 | $Fe_2O_3$ 0·29, $Mn_2O_3$ 0·10 |
| 8. Montebras, B | 3·007 | $\frac{2}{2}$ 48·34 | 33·55 | 9·52 | 0·33 | 6·61 | 1·75 | CaO 0·35 = 100·45 |

Other analyses, Pisani, C. R., **75**, 79, 1872; Kbl., l. c.; Rg., Ber. Ch. Ges., 78, 1872, these are quoted in Min., 5th Ed., App. II, p. 271, 1875; see also 5th Ed., p. 546, where the early analyses of Berzelius and of Rammelsberg are quoted.

**Pyr., etc.**—In the closed tube yields water, which at a high heat is acid and corrodes the glass. B.B. fuses easily (at 2) with intumescence, and becomes opaque white on cooling. Colors the flame yellowish red with traces of green; the Hebron variety gives an intense lithia-red; moistened with sulphuric acid gives a bluish green to the flame. With borax and salt of phosphorus forms a transparent colorless glass. In fine powder dissolves easily in sulphuric acid, more slowly in hydrochloric acid.

**Obs.**—Occurs at Chursdorf and Arnsdorf, near Penig in Saxony, where it is associated with tourmaline and garnet in granite; near Geier, Saxony; also at Arendal, Norway. At Montebras, Creuze, France, in two varieties, cf. below.

In the U. States, in Maine, at Hebron, embedded in a coarse granite in masses, sometimes well crystallized, with lepidolite, albite, quartz, red, green, and black tourmaline, apatite, and rarely cassiterite; also at Mt. Mica in Paris, 8 m. from Hebron, with tourmaline; Auburn; at Peru, abundant with spodumene, petalite, lepidolite, etc. Occurs very sparingly at Branchville, Conn., with spodumene, also lithiophilite and other manganese phosphates in a vein of albitic granite.

The name *amblygonite* is from ἀμβλὺς, *blunt*, and γόνυ, *angle; montebrasite* and *hebronite* from the localities. The name montebrasite was first given to normal amblygonite from Montebras, made a new species on the basis of an analysis by Moissenet, later shown to be incorrect by Pisani and von Kobell (cf. App. I, p. 10, II, 27); this name was afterwards transferred (Dx., 1872) to the mineral of Hebron (= *hebronite*, Kbl.) and to another variety (B) from Montebras, translucent and greenish in color, the original Montebras mineral (A, dull white or with a violet tinge) and that from Penig being united (Dx.) under the name amblygonite; the two varieties differ in optical characters, as shown above, and perhaps also in composition; cf. analyses 1, 2, (amblygonite, Dx.), which show soda and but little water, with the other anals., which have little soda and several per cent of water.

**Ref.**—[1] On a crystal from Hebron in the Brush collection, re-examined by the author, cf. 5th Ed., p. 545. With Dx., *p* = *c*, *m* = *a*, *t* = *M*, for the angles for these three cleavages he gives (Hebron) *pm* = 75°, *pt* = 90° to 90° 45′, *mt* = 44° to 45°. On the Penig mineral and Montebras A he noted only the cleavages *a* and *c*, with *ac* = 74° 16′. C. R., **57**, 357, 1863, Ann. Ch. Phys., **27**, 385, 1872.

## B. Acid and Basic Phosphates, Arsenates, etc.

**560. Monetite** $HCaPO_4$ Triclinic
**Natrophite** $HNa_2PO_4$?

## **Olivenite Group.** Orthorhombic.

Basic phosphates, arsenates, etc., of copper, zinc, and lead.

$$R_2(OH)(P,As,V)O_4 \text{ or } (ROH)R(P,As,V)O_4 \quad R = Cu, Zn, Pb.$$

As noted by Groth this group corresponds in a measure to the monoclinic Wagnerite Group, p. 775, which also includes basic members.

$\breve{a} : \bar{b} : \dot{c}$
**561. Olivenite** $Cu_2(OH)AsO_4$ 0·9396 : 1 : 0·6726
**562. Libethenite** $Cu_2(OH)PO_4$ 0·9601 : 1 : 0·7019
**563. Adamite** $Zn_2(OH)AsO_4$ 0·9733 : 1 : 0·7158
**564. Descloizite** $(Pb,Zn)_2(OH)VO_4$
$\breve{a} : \bar{b} : \dot{c} = 0·6368 : 1 : 0·8045$ or $\frac{3}{2}\breve{a} : \bar{b} : \dot{c} = 0·9552 : 1 : 0·8045$
Cuprodescloizite $(Pb,Zn,Cu)_2(OH)VO_4$
**565. Calciovolborthite** $(Cu,Ca)_2(OH)VO_4$

**566. Brackebuschite** $(Pb,Fe,Mn)_2V_2O_8.H_2O$? Monoclinic
**567. Psittacinite** $(Pb,Cu)_4(OH)_2V_2O_8.H_2O$?

**568. Erinite** $Cu_5(OH)_4As_2O_8$
**569. Dihydrite** $Cu_5(OH)_4P_2O_8$ Monoclinic or Triclinic
$\bar{a} : \breve{b} : \dot{c} = 2·8252 : 1 : 1·5339 \quad \alpha = 89° 29\frac{1}{2}' \quad \beta = 91° 0\frac{1}{2}' \quad \gamma = 90° 39\frac{1}{2}'$

**570. Pseudomalachite** $Cu_3(OH)_3PO_4$ pt.

$\grave{a} : \overset{|}{\bar{b}} : \dot{c}$ $\beta$
**571. Clinoclasite** $Cu_3(OH)_3AsO_4$ Monoclinic 1·9069 : 1 : 3·8507 80° 30′
**572. Chondrarsenite** $Mn_3(OH)_3AsO_4$

$\breve{a} : \bar{b} : \dot{c}$
**573. Dufrenite** $\overset{III}{Fe}_2(OH)_3PO_4$ Orthorhombic 0·8734 : 1 : 0·4262
also $Fe_5(OH)_6(PO_4)_3$

$\grave{a} : \overset{|}{\bar{b}} : \dot{c}$ $\beta$
**574. Lazulite** $(Fe,Mg)Al_2(OH)_2P_2O_8$ Monoclinic 0·9750 : 1 : 1·6483 89° 14′
**575. Tavistockite** $Ca_3Al_2(OH)_6P_2O_8$
**576. Cirrolite** $Ca_3Al_2(OH)_3(PO_4)_3$
**577. Arseniosiderite** $Ca_3\overset{III}{Fe}_4(OH)_9(AsO_4)_3$

| | | | | | |
|---|---|---|---|---|---|
| | | | | $\grave{a} : \overset{\shortmid}{\bar{b}} : \acute{c}$ | $\beta$ |
| 578. | **Allactite** | $\mathrm{Mn_7(OH)_8As_2O_6}$ | Monoclinic | 0·6128 : 1 : 0·3338 | 84° 17′ |
| | | | | $\grave{a} : \overset{\shortmid}{\bar{b}} : \hat{}$ | $\beta$ |
| 579. | **Synadelphite** | $\overset{\text{II}}{\mathrm{Mn}}_5(\mathrm{Al},\overset{\text{III}}{\mathrm{Mn}})_2(\mathrm{OH})_{10}\mathrm{As_2O_8}$ | Monoclinic | 0·8582 : 1 : 0·9192 | 90° |
| | | | | $\breve{a} : \bar{b} : \acute{c}$ | |
| 580. | **Flinkite** | $\overset{\text{II}}{\mathrm{Mn}}_2\overset{\text{III}}{\mathrm{Mn}}(\mathrm{OH})_4\mathrm{AsO_4}$ | Orthorhombic | 0·4131 : 1 : 0·7386 | |
| 581. | **Hematolite** | $\overset{\text{II}}{\mathrm{Mn}}_4(\mathrm{Al},\overset{\text{III}}{\mathrm{Mn}})(\mathrm{OH})_8\mathrm{AsO_4}$ | Rhombohedral | $\acute{c} = 0{\cdot}8885$ | |
| 582. | **Arseniopleite** | $\overset{\text{II}}{\mathrm{R}}_9\overset{\text{III}}{\mathrm{R}}_2(\mathrm{OH})_6(\mathrm{AsO_4})_6$? | $\overset{\text{II}}{\mathrm{R}} = \mathrm{Mn,Ca(Pb,Mg)}$ | $\overset{\text{III}}{\mathrm{R}} = \mathrm{Mn(Fe)}$ | |

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583. **Manganostibiite** $\mathrm{Mn_{10}Sb_2O_{15}}$?
Hematostibiite $\mathrm{Mn_8Sb_2O_{13}}$?

| | | | | | |
|---|---|---|---|---|---|
| | | | | $\grave{a} : \overset{\shortmid}{\bar{b}} : \acute{c}$ | $\beta$ |
| 584. | **Atelestite** | $\mathrm{Bi_3(OH)_2AsO_6}$ | Monoclinic | 0·9334 : 1 : 1·5051 | 70° 43′ |

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**560. MONETITE.** *C. U. Shepard*, Am. J. Sc., **23**, 400, 1882.

Triclinic. In thin rhomboidal crystals with *a* (100), *b* (010), *c* (001), *m* (110), *M* ($1\bar{1}0$), the hemi-prisms *μ*, *n* ($\mathrm{h\bar{k}0}$) and *l* (hk0), dome *e* ($\bar{1}01$).

Approximate angles: *aM* = 42°, *ab′* = 81°, *aμ* = 17°, *an* = 28°, *al* = 18°, *ac* = 76°, *a′e* = 42° E. S. Dana.

Crystals small with rough faces, often arranged in interpenetrating groups. Also massive.

Cleavage: *a* distinct. Fracture uneven. Brittle. H. = 3·5. G. = 2·75. Luster vitreous. Color pale yellowish white. Semitransparent.

**Comp.**—Acid calcium phosphate, $\mathrm{HCaPO_4}$ or $\mathrm{2CaO.P_2O_5.H_2O}$ = Phosphorus pentoxide 52·2, lime 41·2, water 6·6 = 100.

**Anal.**—C. U. Shepard, Jr., l. c., after deducting 9·78 p. c. gypsum.

| | | | | |
|---|---|---|---|---|
| $\frac{2}{3}$ | $\mathrm{P_2O_5}$ 52·28 | CaO 41·14 | $\mathrm{H_2O}$ 6·58 | = 100 |

**Pyr.**—B.B. in the forceps turns white and fuses to a globule with crystalline facets; gives off water in the closed tube.

**Obs.**—Found in the Tertiary limestone of the islands Moneta and Mona, West Indies, underneath a bed of bird guano. Occurs in thick isolated masses, two or three inches across, also in irregular seams in gypsum, and in crusts lining cavities.

NATROPHITE *Pisani;* mentioned by Adam. Tabl. Min., 45, 1869. Pisani, Min., 288, 1883. Acid sodium phosphate, $\mathrm{HNa_2PO_4}$ = Phosphorus pentoxide 64·0, soda 27·9, water 8·1 = 100.

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## **Olivenite Group.** Orthorhombic.

**561. OLIVENITE.** Arseniksaures Kupfererz (fr. Cornwall) *Klapr.*, Schrft. Ges. Nat. Fr. Berl., **7**, 160, 1786; Olivenerz (fr. Cornwall) *Wern.*, Bergm. J., 382, 385, 1789. Olive Copper Ore *Kirwan*, **2**, 151, 1796. Olive-green Copper Ore *Rashleigh*, Brit. Min., **1**, pl. 11, f. 2, 1797, **2**, pl. 6, 1802. Cuivre arseniaté en octaèdre aigus *Bourn.*, Phil. Tr., 177, 1801. Pharmakochalzit pt. *Hausm.*, Min., **3**, 1042, 1813; Olivenkupfer, id., 1045; Pharmacolzit *id.*, 1025, 1847. Olivenite pt. *Jameson*, Syst., **2**, 335, 1820; *Leonh.*, Orykt., 283, 1821.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c}$ = 0·9396 : 1 : 0·6726 Washington[1].

100 ∧ 110 = 43° 13′, 001 ∧ 101 = 35° 35¾′, 001 ∧ 011 = 33° 55½′.

**Forms**[1]: *a* (100, *i*-$\bar{i}$), *b* (010, *i*-$\breve{i}$); *m* (110, *I*); *v* (101, 1-$\bar{i}$); *e* (011, 1-$\breve{i}$).

Angles: *mm‴* = *86° 26′, *vv′* = 71° 11½′, *ee′* = *67° 51′; *ve* = 47° 34′.

Crystals prismatic, often acicular; faces usually somewhat uneven. Also globular and reniform, indistinctly fibrous, fibers straight and divergent, rarely irregular; also curved lamellar and granular.

Cleavage: *m*, *b*, *e* (011) in traces. Fracture conchoidal to uneven. Brittle. H. = 3. G. = 4·1–4·4. Luster adamantine to vitreous; of some fibrous varieties pearly. Color various shades of olive-green, passing into leek-, siskin-, pistachio-, and blackish green; also liver- and wood-brown; sometimes straw-yellow and grayish white. Streak olive-green to brown. Subtransparent to opaque.

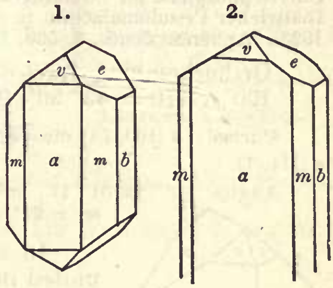


Fig. 1, Cornwall, Phillips. 2, Utah, Washington.

Optically +. Ax. pl. ∥ *c*. Bx ⊥ *a*. Dispersion $\rho < v$ large. Axial angles, Dx.[2]:

$$2H_{a.r} = 105° \ 5' \qquad 2H_{a.y} = 106° \ 6' \qquad 2H_{a.bl} = 109° \ 47'$$

**Var.**—(*a*) *Crystallized;* G. = 4·378 Cornwall, Damour; 4·135 ib., Hermann.

(*b*) *Fibrous;* finely and divergently fibrous, of green, yellow, brown, and gray, to white colors, with the surface sometimes velvety or acicular; G. = 3·913 Hermann; found investing the common variety or passing into it; called *wood-copper* or *wood-arsenate* (*Holzkupfererz*).

(*c*) *Earthy;* nodular or massive; sometimes soft enough to soil the fingers.

**Comp.**—$Cu_3As_2O_8.Cu(OH)_2$ or $4CuO.As_2O_5.H_2O$ = Arsenic pentoxide 40·7, cupric oxide 56·1, water 3·2 = 100.

**Anal.**—1, Damour, Ann. Ch. Phys., **13**, 412, 1845. 2, Hillebrand, Proc. Col. Soc., **1**, 113, 1884. Other analyses 5th Ed., p. 564.

| | | $As_2O_5$ | $P_2O_5$ | CuO | $H_2O$ |
|---|---|---|---|---|---|
| 1. Cornwall | G. = 4·378 | 34·87 | 3·43 | 56·86 | 3·72 = 98·88 |
| 2. Utah, *wood-copper* | | 40·05 | 0·06 | 55·40 | 3·39 gangue 0·81 = 99·71 |

**Pyr., etc.**—In the closed tube gives water. B.B. fuses at 2, coloring the flame bluish green, and on cooling the fused mass appears crystalline. B.B. on charcoal fuses with deflagration, gives off arsenical fumes, and yields a metallic arsenide which with soda yields a globule of copper. With the fluxes reacts for copper. Soluble in nitric acid.

**Obs.**—The crystallized varieties occur disposed on, or coating, cavities of quartz in Cornwall, at Wheal Gorland, Ting Tang, Wheal Unity, and other mines near St. Day; also near Redruth; near Tavistock, in Devonshire; also in inferior specimens at Alston Moor, in Cumberland; at Camsdorf and Saalfeld in Thuringia; Tyrol; the Banat; Nizhni Tagilsk in the Ural; Chili.

In the U. S., in Utah, at the American Eagle and Mammoth mines, Tintic district, both in crystals and the form of *wood-copper*.

The name olivenite alludes to the olive-green color.

**Ref.**—[1] Utah, Am. J. Sc., **35**, 298, 1888. Earlier measurements by Phillips, Min., 319, 1823, who gives $mm''' = 87° \ 30'$, $ee' = 69° \ 10'$, hence $\breve{a} : \bar{b} : \dot{c} = 0·9573 : 1 : 0·6894$. Cf. also **Dx.**, Ann. Ch. Phys., **13**, 417, 1845. [2] Propr. Opt., **2**, 43, 1859; N. R., 81, 1867.

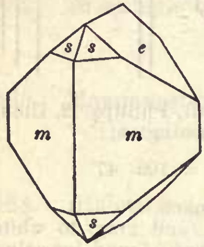
In general the mineral phosphates or arsenates were not distinctively recognized in ancient mineralogy. The species containing copper, if observed, were left to pass under the general names of *chrysocolla* and *malachites*. In 1747, Wallerius has, besides *Koppar-Lazur* or azurite, the two species Copper Green (malachite) and Copper Blue (chrysocolla and azurite in part), but without well-defined limits. Cronstedt, in 1758, describes the Mountain Blue as sometimes impure (terra calcarea mixta), and hence effervescing with aqua-fortis. Fontana, in 1778, announced the green *carbonate* after an analysis; and Bergmann in his Sciagraphia, 1782, recognizes only carbonate of copper, and calls wrongly the *green mica* of Werner (1780, and later *torbernite*) a chloride. In 1786 Klaproth analyzed an *arsenate*, and Werner soon after gave it the name of *Olivenerz;* and in Werner's system of 1789 (Bergm. J., 382, 1789), Azurite, Malachite, Copper green of compact texture not effervescing with acids (chrysocolla), and Olivenerz, together with a so-called *Eisenschüssig Kupfergrün* (mostly earthy green carbonate), were the only species. Karsten's Tabellen of 1800 contain no addition to the list. But in 1801 Bournon announced, from an analysis by Chenevix, a second arsenate, afterward called *Liroconite;* Vauquelin a third, afterward named *Chalcophyllite;* Klaproth a fourth, the *Strahliges Olivenerz*, or *Clinoclase.* Klaproth also published at the same time an analysis of the first *phosphate*, now called *Pseudomalachite;* besides one of the oxychloride *Atacamite*, which mineral had been brought from Chili as *copper sand* between 1780 and 1790, and was pronounced an oxide by Vauquelin, and a chloride by Karsten in his Tabellen of 1800.

**562. LIBETHENITE.** Olivenerz pt. Phosphorkupfererz pt. Phosphate of Copper pt. Cuivre phosphaté pt. Octaedrisches Phosphorkupfer *Leonh.*, Leonh. u. Selb's Min. Stud., 1812. Blättricher Pseudomalachite pt. *Hausm.*, Handb., 1036, 1813. Libethenit *Breith.*, Char., 267, 1823. Aphérèse *Beud.*, **2**, 569, 1832. Pseudo-libethenit *Rg.*, Min. Ch., 344, 1860.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}9601 : 1 : 0{\cdot}7019$ Rose[1].
$100 \wedge 110 = 43° 50'$, $001 \wedge 101 = 36° 10\frac{1}{6}'$, $001 \wedge 011 = 35° 4'$.

**Forms**[1]: *a* (100, $i$-$\bar{\imath}$) cleavage, *b* (010, $i$-$\breve{\imath}$); *t* (210, $i$-$\bar{2}$). *m* (110, *I*); *δ* (310 $i$ $\bar{3}$). *e* (011, 1-$\breve{\imath}$), *s* (111, 1).

Angles: $tt''' = 51° 17'$, $mm''' = {}^*87° 40'$. $\delta\delta' = 35° 30'$. $ee' = {}^*70° 8'$, $me = 66° 33'$; $ss' = 61° 47\frac{1}{2}'$, $ss'' = 90° 46$, $ss''' = 59° 4\frac{1}{2}'$.



In crystals usually small, short prismatic in habit; often united in druses. Also globular or reniform and compact.

Cleavage: *a*, *b* very indistinct. Fracture subconchoidal to uneven. Brittle. H. = 4. G. = 3·6–3·8. Luster resinous. Color olive-green, generally dark. Streak olive-green. Translucent to subtranslucent.

Optically —. Ax. pl. ∥ *c*. Bx ⊥ *b*. Dispersion $\rho > v$ large. Axial angles, Dx.[2]:

$2H_{a.r} = 101° 42'$ $2H_{o.r} = 127° 47'$ $\therefore 2V_r = 81° 38'$ $\beta_r = 1{\cdot}739$
$2H_{a.y} = 101° 8'$ $2H_{o.y} = 128° 56\frac{2}{3}'$ $\therefore 2V_y = 81° 8'$ $\beta_y = 1{\cdot}743$
$2H_{a.bl} = 99° 59'$ $2H_{o.bl} = 130° 22\frac{2}{3}'$ $\therefore 2V_{bl} = 80° 20'$ $\beta_{bl} = 1{\cdot}755$

**Comp.**—$Cu_3P_2O_8.Cu(OH)_2$ or $4CuO.P_2O_5.H_2O$ = Phosphorus pentoxide 29·8, cupric oxide 66·4, water 3·8 = 100.

**Anal.**—Kühn, Lieb. Ann., **51**, 124, 1844.

$P_2O_5$ 29·44 CuO 66·94 $H_2O$ 4·05 = 100·43

Other analyses (5th Ed., p. 563) agree closely, except one by Berthier which yielded 7·4 p. c. $H_2O$; this mineral is called *Pseudo-libethenite* by Rammelsberg, who writes the formula $Cu_3P_2O_8.Cu(OH)_2.H_2O$. Beudant cites the same analysis in connection with his name Aphérèse.

**Pyr., etc.**—In the closed tube yields water and turns black. B.B. fuses at 2 and colors the flame emerald-green. On charcoal with soda gives metallic copper, sometimes also an arsenical odor. Fused with metallic lead on charcoal is reduced to metallic copper, with the formation of lead phosphate, which treated in R.F. gives a crystalline polyhedral bead on cooling. With the fluxes reacts for copper. Soluble in nitric acid.

**Obs.**—Occurs in cavities in quartz, associated with chalcopyrite, at Libethen, near Neusohl, in Hungary; at Rheinbreitenbach and Ehl on the Rhine; at Nizhni Tagilsk in the Ural; in Bolivia, S. A., with malachite; at the Mercedes mine, near Coquimbo, Chili, with tagilite and limonite; also in small quantities near Gunnis Lake in Cornwall, and near Redruth.

**Artif.**—Cf. Friedel and Sarasin, Bull. Soc. Min., **2**, 157, 1879.

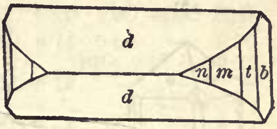
**Ref.**—[1] Hungary, Reis. Ural, **1**, 316, 1837. For Uralian crystals he obtained $mm''' = 84° 36'$, $ee' = 69° 19'$. Cf. Schrauf, Zs. Kr., **4**, 19, 1879, who discusses the irregularities in the angles, vicinal planes, etc., and suggests a monoclinic form. [2] Dx., Propr. Opt., **2**, 43, 1859; N. R., 73, 1867.

**563. ADAMITE.** Adamine *C. Friedel*, C. R., **62**, 692, 1866.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}9733 : 1 : 0{\cdot}7158$ Des Cloizeaux[1].
$100 \wedge 110 = 44° 13\frac{1}{2}'$, $001 \wedge 101 = 36° 20'$, $001 \wedge 011 = 35° 35\frac{2}{3}'$.

**Forms**[2]:
*a* (100, $i$-$\bar{\imath}$)
*b* (010, $i$-$\breve{\imath}$)
*c* (001, *O*)
*k* (410, $i$-$\bar{4}$)
*h* (210, $i$-$\bar{2}$)
*n* (530, $i$-$\bar{\frac{5}{3}}$)
*m* (110, *I*)
*s* (350, $i$-$\breve{\frac{5}{3}}$)
*t* (120, $i$-$\breve{2}$)
*f* (506, $\frac{5}{6}$-$\bar{\imath}$)
*d* (101, 1-$\bar{\imath}$)
*l* (011, 1-$\breve{\imath}$)
*o* (111, 1)

$hh''' = {}^*51° 54'$
$mm''' = 88° 27'$
$tt' = 54° 23'$
$ff' = 63° 0'$
$dd' = {}^*72° 40'$
$ll' = 71° 11\frac{1}{2}'$
$oo' = 61° 46'$
$oo'' = 91° 29'$
$oo''' = 59° 56'$



Laurium, Laspeyres.

Crystals small, sometimes prismatic ∥ $\dot{c}$ like olivenite; again prismatic ∥ $\bar{b}$, by extension of the macrodome *d* (101). Crystals often grouped in crusts and fine granular aggregations.

Cleavage: *d* distinct. Fracture uneven. Brittle. H. = 3·5. G. = 4·34–4·35. Luster vitreous, strong. Color honey-yellow, violet, rose-red, green, colorless. Streak white. Transparent,

Optically +. Ax. pl. ∥ *c*. Bx ⊥ *b*. Dispersion $\rho < v$ large. Axial angles:

Chili $2H_{a.r} = 108° 34'$ $2H_{a.bl} = 111° 39'$ $2H_{o.r} = 115° 50'$ $2H_{o.bl} = 113° 52'$
Laurium $2H_{a.r} = 100°–108°$, Dx.

**Comp.**—$Zn_3As_2O_8.Zn(OH)_2$ or $4ZnO.As_2O_5.H_2O$ = Arsenic pentoxide 40·2, zinc oxide 56·7, water 3·1 = 100. Copper and cobalt may also be present.

**Anal.**—1, Friedel, l. c. 2, Damour, C. R., **67**, 1124, 1868. 3, 4, Pisani, ib., **70**, 1001, 1870. 5, Friedel, Bull. Soc. Min., **1**, 31, 1878.

| | | $As_2O_5$ | ZnO | CuO | CoO | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. Chañarcillo | G. = 4·338 | 39·95 | 54·32 | — | — | 4·55 FeO 1·48, MnO *tr.* = 100·30 |
| 2. Cap Garonne | G. = 4·352 | 39·24 | 49·11 | 1·75 | 5·16 | 4·25 $Fe_2O_3$ *tr.* = 99·51 |
| 3. " " | *rose-red* | 38·50 | 52·50 | — | 3·92 | 3·57 = 98·49 |
| 4. " " | *sea-green* | 39·85 | 31·85 | 23·45 | 0·52 | 3·68 CaO 0·87 = 100·22 |
| 5. Laurium, *green* | | 40·17 | 55·97 | 0·64 | — | 4·01 FeO 0·18 = 100·97 |

**Pyr., etc.**—Heated in a closed tube decrepitates feebly, and yields a little water, becoming white and porcelanous. On charcoal fuses, producing a coating of zinc oxide, and a feeble odor of arsenic. In a closed tube with soda and charcoal gives a ring of arsenic. With borax in O.F. pearl-yellow while hot, colorless on cooling. Easily soluble in dilute hydrochloric acid.

**Obs.**—From Chañarcillo, Chili, with limonite and native silver. At Cap Garonne near Hyères, France. At the ancient zinc mines of Laurium, Greece, filling drusy cavities in a cellular smithsonite. Named after M. Adam, the mineralogist, of Paris.

**Ref.**—[1] Chañarcillo, N. R., 26, 1867; Laurium crystals gave *mm'''* = 89° 50'–88° 40' and *dd'* = 72° 20', also *mm'''* = 88° 20'–88° 30'. Bull. Soc. Min., **1**, 30, 1878.

[2] Chañarcillo, Dx., with *h m t d o;* Laurium, Dx., with *b h m t d f;* Laurium, Lasp. (Zs. Kr., **2**, 147, 1878), with *b n m t d* on "type I" colorless crystals, prismatic ∥ $\bar{b}$, with $\breve{a} : \bar{b} : \dot{c}$ = 0·996 : 1 : 0·718, and *a c k h n m s d? l* on "type II" emerald-green crystals, prismatic ∥ $\dot{c}$, with $\breve{a} : \bar{b} : \dot{c}$ = 0·996 : 1 : 0·685; a variation in composition (Cu) is suggested to account for this difference in $\dot{c}$ (20 : 19), but the observations need confirmation.

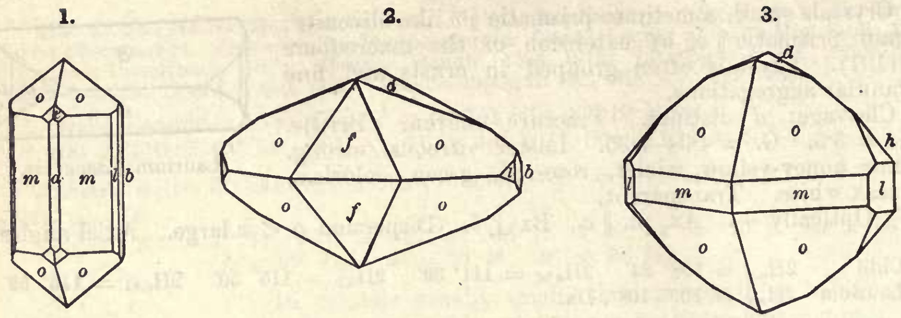
**564. DESCLOIZITE.** *A. Damour*, Ann. Ch. Phys., **41**, 72, 78, 1854. Rhombischer Vanadit *Zippe*, Ber. Ak. Wien, **44** (1), 197, 1861, *Tschermak*, ib., **44** (2), 157, 1861, Schrauf, Pogg., **116**, 355, 1862. Tritochorit *Frenzel*, Min. Mitth., **3**, 506, **4**, 97, 1881. Cuprodescloizite *Rg.*, Ber. Ak. Berlin, 1215, 1883. La Ramarita *Miguel Velazquez de Leon*, Naturaleza, **7**, 65, 1884. Schaffnerite (1886) mentioned by *Pisani*, Bull. Soc. Min., **12**, 43, 1889.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·6368 : 1 : 0·8045 Rath[1].

100 ∧ 110 = 32° 29⅔', 001 ∧ 101 = 51° 38⅙', 001 ∧ 011 = 38° 49'.

**Forms**[1]:
*a* (100, $i$-$\bar{i}$)
*b* (010, $i$-$\breve{i}$)
*c* (001, *O*)
*n* (510, $i$-$\bar{5}$)
*m* (110, *I*)
*l* (130, $i$-$\breve{3}$)
*e* (102, ½-$\bar{i}$)
*f* (201, 2-$\bar{i}$)
*d* (012, ½-$\breve{i}$)
*u* (011, 1-$\breve{i}$)
*v* (021, 2-$\breve{i}$)
*t* (1·1·10, $\frac{1}{10}$)
*o* (111, 1)
*ε* (211, 2-$\bar{2}$)
*i* (641, 6-$\bar{\frac{3}{2}}$)
*k* (861, 8-$\bar{\frac{4}{3}}$)
*q* (782, 4-$\breve{\frac{8}{7}}$)
*ω* (134, ¾-$\breve{3}$)
*h* (132, $\frac{3}{2}$-$\breve{3}$)

*mm'''* = 64° 59'
*ll'* = 55° 15½'
*ee'* = 64° 33½'
*ff'* = 136° 49'
*dd'* = 43° 49½'
*uu'* = 77° 38'
*vv'* = 116° 17'
*co* = 56° 16'
*cω* = 34° 15'
*ch* = 53° 43'
*oo'* = *89° 6'
*oo'''* = *53° 4'
*εε'''* = 32° 59'
*ωω'''* = 59° 50'
*hh'''* = 91° 9'
*fo* = 31° 4'
*do* = 47° 0½'



Figs. 1–3, Lake Valley, N. Mexico, Rath.

Crystals usually small, short prismatic ‖ *m* or *l* (130), or pyramidal, *o* (111). Faces seldom perfectly smooth; *l* strongly striated vertically; *f* (201) dull and striated ‖ *f*/*f‴*, *o* (111), *d* (012) bright. The crystals forming drusy surfaces and crusts, also in stalactitic aggregates. Also massive, fibrous radiated with mammillary surface.

Cleavage none. Fracture small conchoidal to uneven. Brittle. H. = 3·5. G. = 5·9–6·2. Luster greasy. Color columbine- or cherry-red, brownish red, hair-brown, reddish chestnut-brown, blackish brown, black. Streak orange to brownish red or yellowish gray. Transparent to nearly opaque.

Ax. pl. ‖ *b*. Bx ⊥ *c* negative, Bx ⊥ *a* positive; axial angle very large, the interference-rings hardly visible in oil.

**Comp., Var.**—$R_3V_2O_8.R(OH)_2$ or $4RO.V_2O_5.H_2O$; R = Pb, Zn chiefly and usually in the ratio 1 : 1 approx.; the percentage composition is then: Vanadium pentoxide 22·7, lead protoxide 55·4, zinc oxide 19·7, water 2·2 = 100. Copper is also sometimes present, and further arsenic replacing vanadium.

**Var.**—1. *Ordinary*, containing lead and zinc. Usually in distinct crystals as described. G. = 5·9–6·1.

2. *Cuprodescloizite*, containing copper in considerable amount; this variety also carries arsenic. It usually appears in crusts or reniform masses with mammillary surface and fine columnar structure, somewhat divergent or radiating. Color dull green to greenish black, yellowish brown. G. = 6·1–6·2.

**Anal.**—1, Rg., Ber. Ak. Berlin, 656, 1880, Zs. G. Ges., **32**, 709, 1880. 2–4, Doering, Bol. Acad. Cienc. Córdoba, **5**, 471, 1883. 5, 6, Genth, Am. Phil. Soc., **22**, 373, 1885. 7, 8, Hillebrand, Am. J. Sc., **37**, 434, 1889. 9, Penfield, Am. J. Sc., **26**, 361, 1883. 10, Rg., Ber. Ak. Berlin, 1215, 1883. 11, Genth, Am. Phil. Soc.. **24**, 36, 1887. 12, Pisani, Bull. Soc. Min., **12**, 38, 1889. 13, Velazquez de Leon, l. c. 14, Hillebrand, l. c.

For Damour's original analysis of descloizite, see p. 791.

| | G. | $V_2O_5$ | $As_2O_5$ | $P_2O_5$ | PbO | ZnO | CuO | FeO | MnO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Córdoba, *light brown* | 6·080 | $\frac{3}{8}$ 22·74 | — | — | 56·48 | 16·60 | — | — | 1·16 | 2·34 |
| | | | | | | | | | | [Cl 0·24 = 99·56 |
| 2. " *black* | 6·14 | 22·59 | 0·27 | | 56·00 | 17·02 | 0·02 | 0·26 | 0·40 | 2·14 |
| | | | | | | | | | | [Cl 0·08, insol. 0·31 = 99·09 |
| 3. " *gray* | | 21·85 | — | 0·30 | 56·01 | 17·56 | 0·40 | 0·07 | 0·77 | 2·57 |
| | | | | | | | | | | [Cl 0·27, insol. 0·78 = 100·58 |
| 4. " *yellow* | 5·93 | 20·23 | — | 0·05 | 63·63 | 11·41 | — | — | 0·24 | 1·16 |
| | | | | | | | | | | [Cl 1·07, insol. 1·26 = 99·05 |
| 5. Lake Valley, *red* | | $\frac{3}{8}$ 21·65 | 0·20 | — | 56·12 | 17·41 | 1·10 | 0·15 | 0·49 | 2·37 |
| | | | | | | | | | | [= 99·49 |
| 6. " " *black* | | $\frac{3}{8}$ 21·35 | 0·50 | 0·04 | 56·36 | 13·91 | 0·87 | 0·30 | 2·74 | 3·39 |
| | | | | | | | | | | [= 99·46 |
| 7. Beaverhead Co., Mont. | | $\frac{2}{3}$ 20·80 | 0·32 | 0·27 | 55·93 | 15·94 | 1·15 | 0·70 | — | 4·37 |
| | | | | | | | | | | [X[1] 0·34 = 99·82 |
| 8. Georgetown, N. M. | | 20·44 | 0·94 | 0·26 | 56·01 | 17·73 | 1·05 | 0·07 | — | 2·45 |
| | | | | | | | | | | [X[2] 1·12 = 100·07 |

| | | G. | $V_2O_5$ | $As_2O_5$ | $P_2O_5$ | PbO | ZnO | CuO | FeO | MnO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9. | *Cuprodescloizite* | 6·202 | ⅔ 18·95 | 3·82 | 0·18 | 54·93 | 12·24 | 6·74 | 0·06 | — | 2·70 | [$SiO_2$ 0·12 = 99·74 |
| 10. | " | 5·856 | ⅔ 22·47 | 0·28 | 0·17 | 54·03 | 12·62 | 8·13 | — | — | 2·52 | [= 100·22 |
| 11. | " | 6·203 | ⅔ 19·99 | 3·63 | 0·13 | 54·52 | 12·70 | 6·58 | — | — | 2·62 | [= 100·17 |
| 12. | " | 6·06 | 17·40 | 4·78 | — | 53·90 | 11·40 | 8·80 | — | — | 3·20 | [= 99·48 |
| 13. | *Ramirite* | 6·01–6·10 | 19·85 | 3·61 | 1·83 | 54·28 | 11·25 | 8·69 | — | — | 0·15[a] | [=99·66 |
| 14. | Tombstone | 5·88 | 19·79 | 1·10 | 0·19 | 57·00 | 4·19 | 11·21 | *tr.* | — | 2·50 | [X[3] 3·01 = 98·99 |

[a] $Mn_2O_3$.

[1] X = $SiO_2$ 0·18, CaO 0·10, MgO 0·06. [2] X = Cl 0·04, $SiO_2$ 1·01, CaO 0·04, MgO 0·03.
[3] X = Cl 0·07, $SiO_2$ 0·80, CaO 1·01, MgO 0·04, $K_2O$ 0·10, $Na_2O$ 0·17, $CO_2$ 0·82.

The material of anal. 2-4 contained some vanadinite.

Frenzel's analysis of *tritochorite* is as follows: $V_2O_5$ 24·41, $As_2O_5$ 3·76, PbO 53·90, ZnO 11·06, CuO 7·04 = 100·17. There is no question as to its identity with cuprodescloizite; he has since stated that the water present was neglected or overlooked.

**Pyr., etc.**—In the closed tube gives water. B.B. on charcoal fuses, and is partially reduced to a globule of metallic lead enveloped in a black scoria. With borax in R.F. a green glass, and with niter in O.F. a violet color due to manganese. With salt of phosphorus in R.F. a glass of a chrome-green color, which is orange-yellow in the O.F. Dissolves in cold dilute nitric acid.

**Obs.**—Occurs in small crystals, 1 to 2 mm. thick, clustered on a siliceous and ferruginous gangue from S. America, at the Venus mine and other points in the Sierra de Córdoba, Argentine Republic, associated with acicular green pyromorphite, vanadinite, etc. At Kappel in Carinthia, in small clove-brown rhombic octahedrons, with G. = 5·83 (*vanadite* of Zippe, cf. Schrauf, Pogg., **116**, 355, 1862).

Sparingly at the Wheatley mine, Phenixville, Penn., as a thin crystalline crust on wulfenite, quartz, and a ferruginous clay (J. L. Smith, confirmed by Genth). Abundant at the Sierra Grande mine, Lake Valley, Sierra Co., New Mexico, in red to nearly black crystals, pyramidal and prismatic in habit, associated with vanadinite, iodyrite, etc.; at the Mimbres and other mines, near Georgetown, New Mexico, in stalactitic crystalline aggregates. In Arizona near Tombstone; in Yavapai Co., in brownish olive-green crystals; at the Mammoth Gold mine, near Oracle, Pinal Co., in orange-red to brownish red crystals with vanadinite and wulfenite.

A vanadate probably identical with descloizite occurs at the Mayflower mine, Bald Mountain distr., in Beaverhead Co., Montana, see anal. 7; it is in an impure earthy form of a dull yellow to pale orange color. The water present is double in amount that required by normal descloizite, but in view of the nature of the material this may not be significant; cf. brackebuschite beyond.

A massive variety, containing copper, in crusts and reniform masses with radiated structure occurs in San Luis Potosi, also in a vein of argentiferous galena in Zacatecas (Pisani), Mexico; it has been variously named *tritochorite, cuprodescloizite. ramirite*. A similar variety occurs as an incrustation on quartz at the Lucky Cuss mine, Tombstone, Cochise Co., Arizona.

Named after the French mineralogist. A. Des Cloizeaux. *Ramirite* is after the Mexican mining engineer Santiago Ramirez. *Tritochorite*, from *τρίτος, third*, and *χωρεῖν, to follow*, was given on the supposition that the mineral formed a third member of a series with eusynchite and aræoxene.

**Ref.**—[1] N. Mexico, Zs. Kr., **10**, 464, 1885. The form was made monoclinic by Websky, Ber. Ak. Berlin, 672, 1880, Zs. Kr., **5**, 542, 1881; the orthorhombic character is established by Des Cloizeaux, Bull. Soc. Min., **9**, 138, 191, 1886. See earlier Dx., Ann. Ch. Phys., **41**, 78, 1854.

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The pages immediately following contain descriptions of several other vanadates of more or less uncertain composition and probably in part to be united with descloizite.

EUSYNCHITE *Fischer & Nessler*, Ber. Ges. Freiburg, 1854, Jb. Min., 570, 1855. Aræoxen *Kbl.*, J. pr. Ch., **50**, 496, 1850.

Massive: in nodular, stalactitic forms. H. = 3·5. G. = 5·596. Luster resinous. Color yellowish red, reddish brown, greenish. Streak orange-yellow to pale yellow.

Composition, perhaps $R_3V_2O_8$ with R = lead, zinc, and sometimes copper, and the vanadium in part replaced by arsenic. It is to be noted, however, that the analyses are unsatisfactory, and the mineral may contain water like the so-called tritochorite which was originally described as anhydrous and belonging to this series. If this is the case eusynchite would be simply identical with descloizite.

Sandberger has recently made it almost certain that aræoxene is only descloizite; he quotes Pecher as having found 3·2 p. c. $H_2O$ in the original mineral. Jb. Min., **1**, 258, 1889.

Anal.—1, Rg., Ber. Ak. Berlin, 40, 1864. 2, Id., Min. Ch. Erg., 91, 1886. 3, 4, Czudnowicz, Pogg., **120**, 26, 1863; Rg., Min. Ch., 290, 1875. 5, Bergemann, Jb. Min., 397, 1857, and Rg., ib., 291.

| | | $V_2O_5$ | $As_2O_5$ | $P_2O_5$ | PbO | ZnO | CuO | |
|---|---|---|---|---|---|---|---|---|
| 1. Hofsgrund | G. = 5·596 | [24·22] | 0·50 | 1·14 | 57·66 | 15·80 | 0·68 | = 100 |
| 2. " | G. = 5·462 | *undet.* | — | 1·54 | 57·38 | 16·27 | — | |
| 3. " | | 24·32 | — | *tr.* | 58·35 | 17·33 | — | = 100 |
| 4. " | | 20·28 | — | *tr.* | 57·06 | 22·66 | — | = 100 |
| 5. *Aræoxene* | | 17·04 | 10·66 | — | 53·26 | 18·36 | — | = 99·32 |

From 3, 3·2 p. c. $SiO_2$ and from 4, 5·5 $SiO_2$ have been deducted; from 5, 1·34 p. c. gangue.

Eusynchite is from Hofsgrund near Freiburg in Baden; aræoxene from Dahn near Nieder-Schlettenbach, Rhenish Bavaria, with dechenite.

DECHENITE, vanadinsaures Bleioxyd *C. Bergemann*, Pogg., **80**, 393, 1850.

Massive, botryoidal, nodular, stalactitic; sometimes traces of a columnar structure. H. = 3–4. G. = 5·6–5·81. Luster of fresh fracture greasy. Color fine deep red to yellowish red and brownish red; also leather-yellow. Streak orange-yellow to ocher- and pale yellow.

Composition usually accepted as $PbV_2O_6$ or $PbO.V_2O_5$ = Vanadium pentoxide 45·0, lead protoxide 55·0 = 100. The old analyses, however, are faulty, for the mineral contains zinc as shown by Brush (Am. J. Sc., **24**. 116, 1857). and Pisani (Bull. Soc. Min., **12**, 40, 1889). New analyses may prove that the composition is essentially the same as that of eusynchite and aræoxene, and like them it may have to be united with descloizite.

Analyses.—1–3, Bergemann, l. c. 4, Nessler [Ber. Ges. Freiburg, 1854] Rg., Min. Ch., 311, 1860.

| | $V_2O_5$ | PbO | |
|---|---|---|---|
| 1. Dahn, *dark red cryst.* | 47·16 | 52·92 | = 100·08 |
| 2. " " " " | 46·10 | 53·72 | = 99·82 |
| 3. " *ywh. verruciform* | 49·27 | 50·57 | = 99·84 |
| 4. Zähringen G. = 4·945? | 45·12 | 55·70 | = 100·82 |

Pyr., etc.—B.B. fuses easily without decrepitation to a yellow glass. On charcoal in R.F. gives lead globules and a white coating, which, treated with cobalt solution, becomes green (zinc). With salt of phosphorus and borax gives an emerald-green bead in R.F., becoming yellowish green to yellow in O.F. Decomposed by hot hydrochloric acid, yielding an emerald-green solution. This treated with alcohol, boiled and decanted from the separated lead chloride, yields, after evaporation, a solution which, diluted with water, has an azure-blue color (v. Kobell).

Occurs with other ores of lead near Nieder-Schlettenbach in the Lauterthal, Rhenish Bavaria. A lead vanadate occurs with the lead ores at Leadville, Col. (Iles, Am. J. Sc., **23**, 381, 1882), and it has been suggested that this may be dechenite; it is, however, probably descloizite.

Named after the German geologist, Heinrich von Dechen (1800–1889).

**565. CALCIOVOLBORTHITE.** Kalk-volborthit *Credner*, Pogg., **74**, 546, 1848. Calciovolborthite *A. D'Achiardi*, I Metalli, **2**, 492, 1883. Calcvolvorthite *Adam*, Tabl. Min., 33, 1869.

Occurs in two varieties: (1) green, in thin tables, cleaving easily in one direction, greenish yellow in streak, pearly in luster, with G. = 3·495; (2) gray, fine crystalline granular, brownish yellow in streak, with H. = 3·5, and G. = 3·860.

**Comp.**—Probably $(Cu,Ca)_3V_2O_8.(Cu,Ca)(OH)_2$ or $4(Cu,Ca)O.V_2O_5.H_2O$; if Cu : Ca = 3 : 2, this requires: Vanadium pentoxide 38·0, cupric oxide 39·6, lime 18·6, water 3·8 = 100.

**Anal.**—Credner, l. c.

| | | | $V_2O_5$ | CuO | CaO | MgO | MnO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. *Green* | G. = 3·495 | ⅔ | 36·58 | 44·15 | 12·28 | 0·50 | 0·40 | 4·62 | gangue 0·10 | = 98·63 |
| 2. *Light green* | | | [36·91] | 38·90 | 17·40 | 0·87 | 0·53 | 4·62 | " 0·77 | = 100 |
| 3. *Gray* | G. = 3·860 | | 39·02 | 38·27 | 16·65 | 0·92 | 0·52 | 5·05 | " 0·76 | = 101·19 |

The results correspond most nearly with the formula above given. The ratio of Cu to Ca in No. 1 is about 5 : 2; and in 2 and 3, 3 : 2.

**Obs.**—From Friedrichsrode, Thuringia. For the ordinary volborthite see p. 838.

**566. BRACKEBUSCHITE.** *Doering*, quoted by Rg., Zs. G. Ges., **32**, 711, 1880; also Bol. Acad. Cienc. Córdoba, **5**, 501, 1883.

In groups of small prismatic crystals flattened and vertically striated; monoclinic? Color black, reddish by transmitted light. Streak yellow. Translucent to nearly opaque.

Optically − ? Ax. pl. ⊥ striations. Bx (obtuse?) oblique to the large face of the crystals. Ax. angle large, Dx. (quoted by Pisani).

**Comp.**—Perhaps $R_3V_2O_8 + H_2O$ with R = Pb chiefly, also Fe, Mn ; if 4 : 1 : 1 = Vanadium pentoxide 25·4, lead protoxide 62·1, iron protoxide 5·0, manganese protoxide 5·0, water 2·5=100.

If this composition is confirmed brackebuschite belongs with the hydrous phosphates, etc., near hopeite, p. 808.

**Anal.**—1, Doering, quoted by Rg., l. c., after deducting 4·36 insol. 2, 3, Doering, l.c., 1883.

| | $V_2O_5$ | $As_2O_5$ | $P_2O_5$ | PbO | ZnO | CuO | FeO | MnO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 25·32 | — | 0·18 | 61·00 | 1·29 | 0·42 | 4·65 | 4·77 | 2·03 | = 99·66 |
| 2. | 24·22 | 0·17 | | 58·34 | — | — | 5·78[a] | 5·54[b] | 1·94 | insol. 3·40 = 99·39 |
| 3. | 24·74 | 0·11 | — | 58·02 | 1·23 | 0·41? | 4·46 | 4·56 | 2·43 | X[c] 1·29, insol. 3·07 = 100·32 |

[a] And $Fe_2O_3$. [b] And $Mn_3O_4$. [c] $Fe_2O_3 + Mn_3O_4$.

The above analyses agree tolerably well with that of Damour of descloizite (ref. on p. 787) as recalculated by Rg., l. c., deducting obvious impurities (3·44 p. c. sand), viz.:

| $V_2O_5$ | PbO | ZnO | CuO | $Fe_2O_3$ | $Mn_2O_3$ | $H_2O$ | Cl | |
|---|---|---|---|---|---|---|---|---|
| 24·80 | 60·40 | 2·25 | 0·99 | 1·65 | 6·52 | 2·43 | 0·35 | = 99·39 |

It is to be noted, however, that Damour regarded the oxides of manganese, iron, copper also as impurities, so that the result is doubtful at best.

Groth suggests that brackebuschite may be the monoclinic equivalent of descloizite, but the evidence now in hand gives it another formula.

**Obs.**—Occurs with descloizite and vanadinite, at several localities in the State of Córdoba, Argentine Republic. Named for Dr. D. Luis Brackebusch, of Buenos Aires.

**567. PSITTACINITE.** *F. A. Genth*, new tellurate of lead and copper, Proc. Am. Phil. Soc., **14**, 229, 1874; Id., Am. J. Sc., **12**, 35, 1876.

In thin crypto-crystalline coatings, sometimes small mammillary or botryoidal; also pulverulent.

Color siskin- to olive-green, sometimes with grayish tint.

**Comp.**—Perhaps, as suggested by Rg., $R_3V_2O_8.R(OH)_2.H_2O$ or $4RO.V_2O_5.2H_2O$, with R = Pb : Cu = 1 : 1, hence requiring: Vanadium pentoxide 22·2, lead protoxide 54·1, cupric oxide 19·3, water 4·4 = 100.

Genth deduces for anal. 1: the mean oxygen ratio for Pb : Cu : V : H = 1 : 0·98 : 2·25 : 2·15 = 9 : 9 : 20 : 18, corresponding to the formula $3Pb_3V_2O_8.Cu_3V_2O_8.6Cu(OH)_2.12H_2O$, for which he calculates: $V_2O_5$ 19·3, PbO 53·2, CuO 18·9, $H_2O$ 8·6 = 100. This, however, is not far from $5RO.V_2O_5.5H_2O$. Other analyses give much less water.

**Anal.**—1, Genth, l. c., after deducting impurities (see below). 2–4, Doering. Bol. Acad. Cienc. Córdoba, **5**, 506, 1883. 5, 6, Doering, as recalc. by Rg., after deducting gangue, cerussite, malachite, etc., Min., Ch. Erg., 189, 1886. 7, Pisani, C. R., **92**, 1292, 1881.

| | $V_2O_5$ | $As_2O_5$ | $P_2O_5$ | PbO | CuO | ZnO | $Fe_2O_3$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Montana | 18·83 | — | — | 53·19 | 18·44 | — | — | 9·54 | = 100 |
| 2. Argentine R. | 17·18 | 0·34 | 0·95 | 51·53 | 16·10 | 0·73 | 0·82 | 5·54[a] | $H_2O$ (105°) 0·29, insol. 5·74 [= 99·22 |
| 3. " | 17·23 | 0·29 | 1·14 | 49·25 | 16·29 | 1·08 | 0·39 | 3·41 | $H_2O$ (310°) 0·73, $CO_2$ 1·93, [insol. 7·91 = 99·65 |
| 4. " | 17·76 | 0·07 | 0·75 | 49·71 | 17·19 | 0·96 | 0·42 | 3·70 | MnO 0·11, $H_2O$ (310°) 0·74, [$CO_2$ 1·97, insol. 6·30 =99·68 |
| 5. " | 21·65 | 0·37 | 1·43 | 53·70 | 17·54 | 1·35 | — | 3·96 | = 100 |
| 6. " | 21·97 | 0·09 | 0·93 | 53·24 | 18·34 | 1·19 | — | 4·24 | = 100 |
| 7. Laurium | 25·53 | — | — | 50·75 | 18·40 | 1·53[b] | — | 4·25 | = 100·46 |

[a] Incl. $CO_2$ [b] CaO.

From anal. 1, 22 p. c. impurities have been deducted ($SiO_2$ 15·13, $Fe_2O_3$ 2·72, $Al_2O_3$ 1·29, CaO,MgO 2·86); other analyses on material with 7·60 to 48·84 p. c. gangue agreed with 1.

**Pyr., etc.**—B.B. fuses easily to a black, shining mass. Reacts for lead, copper, and vanadium with the fluxes. Soluble in dilute nitric acid.

**Obs.**—Occurs associated with gold, cerussite, chalcopyrite, and limonite, on quartz, at the Iron Rod mine and New Career mine, in the Silver Star District, Montana; also probably the same mineral in the province of San Luis, near Las Cortaderas, east of Villa San Martin, Argentine Republic, as a crystalline incrustation on quartz with vanadinite. A vanadate from Laurium, Greece (anal. 7), seems to belong here (Rg., Pisani). Named from *psittacinus*, siskin- or parrot-green.

Mottramite *H. E. Roscoe*, Proc. Roy. Soc., **25**, 111, 1876.

In thin crystalline incrustations, occasionally in distinct, minute crystals, also compact. H. = 3. G. = 5·894. Luster resinous. Color velvety black; in thin sections yellow. Streak yellow. Translucent.

A vanadate of lead and copper. Roscoe calculates $R_3V_2O_8.2R(OH)_2$, which corresponds to dihydrite and erinite. If R = Pb : Cu = 1 : 1, the percentage composition is: Vanadium pentoxide 18·7, lead protoxide 57·2, cupric oxide 20·4, water 3·7 = 100. Rg., however, suggests $R_3V_2O_8.3R(OH)_2$. The imperfect analysis, with a loss of 3 p. c., makes the result doubtful. It seems not improbable that it may be identical with psittacinite.

Analysis.—1, Roscoe. 2, the same, after deducting impurities:

| | $V_2O_5$ | PbO | CuO | $\underbrace{FeO, ZnO, MnO}$ | MgO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. | $\frac{3}{2}$ 17·14 | 50·97 | 19·10 | 2·52 | 0·26 | 2·13 | 3·63 hygr. water 0·22, $SiO_2$ 1·06=97·03 |
| 2. | 18·87 | 56·12 | 21·02 | — | — | — | 3·99 = 100 |

**Obs.**—Occurs on the Keuper Sandstone, at Alderley Edge, and at Mottram St. Andrew's, Cheshire, England.

Chileite *Kenngott*, Mohs'sche Min., 28, 1853. Vanadate of Lead and Copper *Domeyko* Ann. Mines, **14**, 150, 1848 Vanadinkupferbleierz. Cuprovanadite *Adam*, Tabl. Min., 33, 1869.

An ore having a dark brown or brownish black color, and observed only in an earthy state, looking much like a ferruginous clay or earth. It occurs in cavities in an arseno-phosphate of lead along with amorphous carbonates of lead and copper.

An uncertain vanadate of lead and copper. Analyses by Domeyko, l. c.:

| | $V_2O_5$ | $As_2O_5$ | $P_2O_5$ | CuO | PbO | $PbCl_2$ | CaO | $Fe_2O_3, Al_2O_3$ | $SiO_2$ | $H_2O$ | clay | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 13·5 | 4·6 | 0·6 | 14·6 | 54·9 | 0·3 | 0·5 | 3·5 | 1·0 | 2·70 | 1·0 | = 97·2 |
| 2. | 13·33 | 4·68 | 0·68 | 16·97 | 51·97 | 0·37 | 0·58 | 3·42 | 1·33 | 2·70 | 1·52 | = 97·55 |

B.B. fuses easily, and affords a black pearl, a little blebby; gives a clear green pearl with salt of phosphorus or borax, and a globule of lead containing copper on charcoal. In nitric acid easily soluble.

This ore occurs at the silver mine called Mina Grande, or Mina de la Marqueza, in Chili; it has been worked for copper and silver.

*Vanadate from the Lake Superior Copper Region.* An ore similar in color and clayey appearance to Domeyko's mineral has been announced by J. E. Teschemacher among specimens from the Cliff mine, in the Lake Superior Copper Region. The presence of vanadium was ascertained by both blowpipe and acid tests. The color is a dark chocolate, and also a bright yellow. The exact state of composition of the vanadic acid is doubtful. There is no lead oxide in the ore, and the brown variety is mixed with an earthy iron oxide; when carefully separated from the gangue it was found to contain no copper. This Min., 531, 1850.

Vanadiolite *Hermann*, J. pr. Ch., **1**, 445, 1870.

Form not determined. Occurs in small crystals, partly in druses. Color dark green, almost black, in small fragments dark emerald-green. Streak grayish green. Luster vitreous, brilliant. G. = 3·96. Analysis gave:

$V_2O_5$ 44·85 $SiO_2$ 15·61 $Al_2O_3$ 1·10 FeO 1·40 CaO 34·43 MgO 2·61 = 100

B.B. fuses to a black slag with cauliflower-like intumescence. With salt of phosphorus gives a dark green bead, and a silica skeleton. Decomposed on fusion with a mixture of sodium carbonate. From the Sliudianka river near Lake Baikal in Siberia, associated with lavroffite.

A doubtful substance, regarded by Rammelsberg as a mixture of augite and a vanadate.

Wicklowite. Vichlovite *A. D'Achiardi*, I Metalli, **2**, 568, 1883. A doubtful lead vanadate, apparently that mentioned by Thomson (Min., 574, 1836) as said to have come from Wicklow county, Ireland.

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### 568. ERINITE. *Haidinger*, Phil. Mag., 4, 154, 1828.

In mammillated crystalline groups, concentric in structure and fibrous, and rough from the terminations of very minute crystals; the concentric layers compact, and often easily separable.

Cleavage in one direction in traces. Brittle. H. = 4·5–5. G. = 4·043. Luster almost dull, slightly resinous. Color fine emerald-green, slightly inclining to grass-green. Streak green, paler than the color. Subtranslucent to nearly opaque.

**Comp.**—$Cu_3As_2O_8.2Cu(OH)_2$ or $5CuO.As_2O_5.2H_2O$ = Arsenic pentoxide 34·7, cupric oxide 59·8, water 5·4 = 100.

There is some question as to the amount of water present.

**Anal.**—1, Turner, Phil. Mag., **4**, 155, 1828. 2, 3, Pearce, Proc. Col. Soc., **2**, 150, 1886. 4, 5, Hillebrand, Am. J. Sc., **35**, 399, 1888.

| | $As_2O_5$ | CuO | ZnO | $H_2O$ |
|---|---|---|---|---|
| 1. Cornwall | 33·78 | 59·44 | — | 5·01 $Al_2O_3$ 1·77 = 100 |
| 2. Utah | 32·07 | 56·56 | — | 6·86 $Fe_2O_3$ 0·85, CaO 0·43, $SO_3$ *tr.* = 96·77 |
| 3. " | 32·54 | 57·43 | — | 7·67 = 97·64 |
| 4. " | 33·53 | 57·67 | 1·06 | 7·22 $P_2O_5$ 0·10, $Fe_2O_3$ 0·14, CaO 0·32 = 100·04 |
| 5. " | 31·91 | 57·51 | 0·59 | 9·15 $Fe_2O_3$ 0·20, CaO 0·51 = 99·87 |

**Pyr., etc.**—In the closed tube decrepitates and yields water. B.B. on charcoal emits arsenical fumes and fuses, giving an arsenide, which in O.F. yields a globule of copper. Soluble in nitric acid.

**Obs.**—Stated by Haidinger to come from the county of Limerick, Ireland; but shown by Church to be a Cornish species.

Occurs with olivenite and implanted upon clinoclasite, azurite, enargite, or barite at the American Eagle and Mammoth mines, Tintic district, Utah.

Erinite of Beudant (1832), Des Cloizeaux (1845), Schrauf (1860) is chalcophyllite.

**569. DIHYDRITE.** *Hermann*, J. pr. Ch., **37**, 178, 1846. Pseudomalachite, Phosphorchalcite, Phosphorkupfer pt. See also Pseudomalachite, p. 794.

Monoclinic or triclinic. Axes $\bar{a} : \breve{b} : \acute{c} = 2{\cdot}8252 : 1 : 1{\cdot}53395$; $\alpha = 89° 29\frac{1}{2}'$, $\beta = 91° 0\frac{1}{2}'$, $\gamma = 90° 39\frac{1}{2}'$ Schrauf[1].

100 ∧ 010 = 89° 21′, 100 ∧ 001 = 88° 59⅔′, 010 ∧ 001 = 90° 29⅚′.

**Forms:**
*a* (100, $i$-$\breve{i}$)
*b* (010, $i$-$\bar{i}$)
*c* (001, *O*)
*l* (430, $i$-$\frac{4}{3}'$)
*n* (540, $i$-$\frac{5}{4}'$)

*m* (110, *I*′)
*L* ($4\bar{3}0$, $'i$-$\frac{4}{3}$)
*N* ($5\bar{4}0$, $'\bar{i}$-$\frac{5}{4}$)
*M* ($1\bar{1}0$, ′*I*)
*q* (102, $'\frac{1}{2}$-$\breve{i}'$)

*t* (101, $'1$-$\breve{i}'$)
*z* (302, $'\frac{3}{2}$-$\breve{i}'$)
*τ* ($\bar{1}01$, $,1$-$\breve{i},$)
*ζ* ($\bar{3}02$, $,\frac{3}{2}$-$\breve{i},$)
*W* ($\bar{5}01$, $,5$-$\breve{i},$)
*κ* ($0\bar{4}5$, $'\frac{4}{5}$-$\bar{i}$)

*d* (445, $\frac{4}{5}'$)
*f* (334, $\frac{3}{4}'$)
*h* (434, $1$-$\frac{4}{3}'$)
*Ω* ($\bar{3}12$, $,\frac{3}{2}$-$\breve{3}$)
*X* ($\bar{4}34$, $,1$-$\frac{4}{3}$)
*Γ* ($\bar{5}45$, $,1$-$\frac{5}{4}$)

*ω* ($\bar{3}\bar{1}2$, $\frac{3}{2}$-$\breve{3},$)
*χ* ($\bar{4}\bar{3}4$, $1$-$\frac{4}{3},$)
*γ* ($\bar{5}\bar{4}5$, $1$-$\frac{5}{4},$)
*D* ($4\bar{4}5$, $'\frac{4}{5}$)
*H* ($4\bar{3}4$, $'1$-$\frac{4}{3}$)

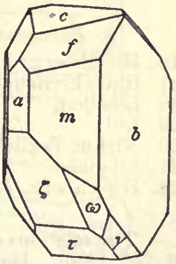
*am* = 69° 56′
*aM* = 71° 5′
*mM* = 141° 1′
*cm* = 90° 8′

*cM* = 89° 12′
*ct* = 28° 16′
*bt* = 90° 8′
*ct* = 28° 44′

*cζ* = 39° 34′
*cd* = 52° 39′
*cf* = 50° 51′
*bΩ* = 59° 38′

*cΩ* = 48° 38½′
*b′ω* = 58° 27′
*cω* = 48° 35′
*ωΩ* = 61° 54½′

Crystals monoclinic in habit with embedded tw. lamellæ ∥ *a*; also tw. pl. *b* (cf. Schrauf). Crystals often united in aggregates with drusy surface or in hemispherical forms; also lamellar; reniform or massive with concentric structure; indistinctly fibrous.



Ehl, Schrauf.

Cleavage: *b* imperfect. Fracture small conchoidal to uneven. Brittle. H. = 4·5–5. G. = 4–4·4. Luster adamantine, inclining to vitreous. Color dark emerald-green. Streak green, a little paler than the color. Translucent to subtranslucent.

Pleochroism distinct: 𝔠 deep bluish green, 𝔟 yellowish green, 𝔞 bluish green. Optically −. $Bx_a \perp t$ (101) approx., and inclined + 68½° to normal to *a*. $Bx_o$ nearly ⊥ *b*; but inclined at a maximum 5½°.

**Comp.**—Essentially $Cu_3P_2O_8.2Cu(OH)_2$ or $5CuO.P_2O_5.2H_2O$ = Phosphorus pentoxide 24·7, cupric oxide 69·0, water 6·3=100.

**Anal.**—See anals. 1–3, under pseudomalachite, p. 794.

**Pyr., etc.**—Like libethenite.

**Obs.**—The distinctly crystallized forms of pseudomalachite, lunnite, or phosphocalchite, as the group has been variously called, are here included. The typical localities are: Ehl near Linz on the Rhine; Rheinbreitenbach; also Nizhni Tagilsk, in the Ural.

**Ref.**—Zs. Kr., **4**, 1 *et seq.*, 1879.

**570. PSEUDOMALACHITE.** Phosphorsaures Kupfer pt. *Karst.*, *Klapr.*, N. Schrift. Berl. Ges. Nat. Fr., 3, 304, 1801. Phosphorkupfer *id.*, Tab., 64, 97, 1808. Phosphorkupfererz *Wern.* Cuivre phosphaté *H.*, Tabl., 92, 1809. Phosphate of copper. Pseudomalachit *Hausm.*, Handb., 1035, 1813. Phosphorochalcit *Glocker*, Handb., 847, 1831. Ypoléime *Beud.*, Tr., **2**, 570, 1832. Ehlit, Prasin-chalzit, *Breith.*, Char., 45, 49, 1832. Lunnit *Bernhardi.* Kupferdiaspore *Kühn*, Lieb. Ann., **51**, 125, 1844.

Usually massive, reniform, and botryoidal, with a radiating fibrous structure. H. = 4·5–5. G. = 3·4–4·4. Luster vitreous. Color dark emerald-green, verdigris-green, blackish green, often darker on the surface. Streak paler green.

**Comp.**—In part $Cu_3P_2O_8.3Cu(OH)_2$ or $6CuO.P_2O_5.3H_2O$ = Phosphorus pentoxide 21·2, cupric oxide 70·8, water 8·0 = 100. Here belongs ordinary amorphous pseudomalachite. Perhaps also $Cu_3P_2O_8.2Cu(OH)_2.H_2O$ or $5CuO.P_2O_5.3H_2O$ = Phosphorus pentoxide 24·0, cupric oxide 66·9, water 9·1 = 100. To the mineral with the latter composition the name *Ehlite* is ordinarily given.

Dihydrite, ehlite, pseudomalachite form a closely related series of phosphates of copper, but their relations are not entirely certain (cf. Schrauf, below). The first occurs in distinct crystals and is set apart as an independent species; the others are only known in fibrous, foliated, or massive forms.

**Anal.**—1, Hermann, l. c., also Nordenskiöld [Act. Soc. Fenn., 1857], 5th Ed., p. 568. 2, Arfvedson, Berz. JB., **4**, 143, 1825. 3, Schrauf, Zs. Kr., **4**, 12, 1879.

4, Hermann, l. c. 5, A. E. Nordenskiöld, Rg., Min. Ch., 346, 1860. 6, Bergemann, Schw. J., **54**, 305, 1828. 7, Id., Jb. Min., 195, 1858. 8, Heddle, Phil. Mag., **10**, 39, 1855. 9, Hermann, l. c. 10, Wendel, Rg., Min. Ch., 326, 1875. 11, Maskelyne and Flight (local. not given), J. Ch. Soc., **25**. 1057, 1872. 12–14, Church, ibid., **26**, 107, 1873. 15, Schrauf, l. c.

16, Kühn, Lieb. Ann., **34**, 218, 1840. 17, Id., ibid., **51**, 126, 1844. 18, Church, Ch. News, **10**, 217, 1864. 19, Bergemann, Pogg., **104**, 190, 1858. 20, 21, Schrauf, l. c. 22, Kühn, l. c.

| | | G. | $P_2O_5$ | CuO | $H_2O$ |
|---|---|---|---|---|---|
| | 1. *Dihydrite.* | | | | |
| 1. | Nizhni Tagilsk | 4·4 | 25·30 | 68·21 | 6·49 = 100 |
| 2. | Rheinbreitenbach | | 24·70 | 68·20 | 5·97 = 98·87 |
| 3. | " | 4·309 | 23·86 | 69·25 | 6·76 FeO 0·19 = 100·06 |
| | 2. *Ehlite.* | | | | |
| 4. | Libethen | 4·4 | 24·55 | 67·25 | 8·20 = 100 |
| 5. | Ehl | 4·198 | 23·00 | 67·98 | 9·02 = 100 |
| 6. | " | | 24·93 | 65·99 | 9·06 = 99·98 |
| 7. | " | | 17·89 | 64·09 | 8·90 $V_2O_5$ 7·34 = 99·22 |
| 8. | Cornwall | 4·25 | 22·73 | 68·13 | 8·51 quartz 0·48 = 99·85 |
| 9. | Nizhni Tagilsk | 4·25 | 23·75 | 68·75 | 7·50 = 100 |
| 10. | " " | | 23·45 | 68·05 | 8·94 = 100·44 |
| 11. | *Prasine* | 3·98 | 23·45 | 64·76 | 8·63 $As_2O_5$ 1·49, $SiO_2$ 0·96, $Al_2O_3$ 1·03, [$H_2O$ (hygr.) 0·41 = 100·73 |
| 12. | Cornwall | 3·911–4·23 | 20·38 | 66·29 | 8·25 $As_2O_5$ 2·42, $Fe_2O_3$ 1·42 = 98·76 |
| 13. | " | | 23·73 | 66·84 | 9·26 $As_2O_5$ *tr.* = 99·83 |
| 14. | " | | [23·96] | 66·88 | 9·16 $As_2O_5$ *tr.* = 100 |
| 15. | Ehl, *fibrous* | 4·102 | 22·07 | 66·97 | 7·59 FeO 0·30, $SiO_2$ 3·01 = 99·94 |
| | 3. *Pseudomalachite.* | | | | |
| 16. | Hirschberg | | [20·87] | 71·73 | 7·40 = 100 |
| 17. | Rheinbreitenbach | | 21·52 | 68·74 | 8·64 = 98·90 |
| 18. | Libethen | | 19·63 | 71·16 | 8·82 = 99·61 |
| 19. | Ehl | | 19·89 | 69·97 | 8·21 $As_2O_5$ 1·78 = 99·85 |
| 20. | Nizhni Tagilsk | 4·175 | 23·23 | 69·02 | 8·09 = 100·34 |
| 21. | Libethen | 4·156 | 22·16 | 69·11 | 8·02 FeO 0·22, $SiO_2$ 0·11 = 99·62 |
| 22. | Hirschberg, *Kupferdiaspore* | | 24·13 | 69·61 | [6·26] = 100 |

The relations of these phosphates of copper have been studied by Schrauf (Zs. Kr., **4**, **1879**, **8**, 231, 1883). He embraces the whole group under the name Lunnite. For the crystalline varieties, which he makes pseudo-monoclinic (triclinic), with G. = 4·4, and corresponding mostly to $Cu_5P_2H_4O_{12}$, he uses the name *dihydrite* (D); they show no loss at 200°. The names *ehlite* (E) and *phosphorocalcite* (P) he gives to the compounds $Cu_5P_2H_6O_{13}$ and $Cu_5P_2H_8O_{14}$, respectively, and he regards the three as entering in varying proportions to form the different massive varieties; the latter have a lower specific gravity, and lose water on ignition at 200°.

According to Schrauf's view, anal. 3 corresponds to a molecular mixture of 3D + 1P; 15, after deducting 8·8 p. c. chrysocolla, to simply "dihydrite;" 20 to D + E + P; 21 to 4P + 2E + D; where the letters D, E, P have the values explained above. The value of this complex hypothesis, especially in view of the uncertain homogeneity of much of the material analyzed, seems doubtful.

All these compounds are embraced, in the 5th Edition, under the name *pseudomalachite* of Hausmann, which is the earliest of the names of this species, and is as short and as good as the later *Phosphorochalcite* of Glocker. *Lunnite* was substituted by Bernhardi, and has been used in some recent works, also by Schrauf (1879). But Lunn's one analysis (see below) was not made until 1821, and gives a different composition from that since obtained.

**Pyr.**—Like libethenite.

**Obs.**—Occurs in veins traversing slate at Virneberg, near Rheinbreitenbach, and at Ehl, near Linz, on the Rhine, along with other copper ores; at Hirschberg in Voigtland; Libethen in Hungary; Kreuzberg in Bohemia; Nizhni Tagilsk in the Ural. Also in Cornwall, in minute globular concretions. Also met with in the Perkiomen mine, Pa.; in Cabarras Co., N. C.

The phosphates of copper were included in the olivenerz and malachite of the mineralogists of last century, cf. p. 785.

A hydrous cupric phosphate from Phillipsburg, Montana, gave Pearce: $P_2O_5$ 20·10, CuO 62·56, $H_2O$ [17·34] = 100. Proc. Col. Sc. Soc., **1**, 119, 1884.

Rev. F. Lunn obtained for an ore from Rheinbreitenbach (Ed. Phil. J., **5**, 211, 1821): $P_2O_5$ 21·69, CuO 62·85, $H_2O$ 15·45 = 99·99, giving the formula $5CuO.2P_2O_5.5H_2O$. But no later analyst has found as much water. Beudant cites this analysis under his *ypoleime.*

**571. CLINOCLASITE.** Strahliges Olivenerz *Karst.*, Klapr., N. Schrift. Berl. Ges. Fr., 3, 298, 1801. Cupreous Arsenate of Iron *Bourn.*, Phil. Trans., 1801 (with anal. by Chenevix). Strahlenerz *Karsten*, Tab., 64, 97. 1808. Cuivre arseniaté férrifère *H.*, Tabl., 91, 1809. Strahlenkupfer *Hausm.*, Handb., 1050, 1813. Strahlerz *Wern.* Klinoklas *Breith.*, Uib., 1830. Siderochalcit *Glocker*, Grundr., 840, 1831. Aphanèse *Beud.*, Tr., **2**, 602, 1832. Aphanesite *Shep.*, Min., 1835. Abichit *Bernhardi*, Glocker's Grundr., 579, 1839.

Monoclinic. Axes $\grave{a} : \overset{|}{b} : \grave{c} = 1·9069 : 1 : 3·8507$; $\beta = {}^*80° \; 30' = 001 \wedge 100$ Phillips[1].

$100 \wedge 110 = 62° \; 0'$, $001 \wedge 101 = 56° \; 12'$, $001 \wedge 011 = 75° \; 15'$.

**Forms**[1]: *a* (100, *i*-$\bar{i}$), *c* (001, *O*); *m* (110, *I*); *r* (101, − 1-$\bar{i}$), *s* ($\bar{3}02$, $\frac{3}{2}$-$\bar{i}$), *p* ($\bar{1}13$, $\frac{1}{3}$)[2], *t* ($\bar{1}11$, 1)[2].

$mm''' = 124°$ $cs = {}^*80° \; 30'$ $ct = 81° \; 10'$ $tt' = 122° \; 7'$
$mm' = {}^*56°$ $cm = 85° \; 33'$ $pp' = 97° \; 32'$ $m's = 63° \; 39'$
$ar = 24° \; 18'$ $cp = 58° \; 7\frac{1}{2}'$

Crystals prismatic (*m*); also elongated ∥ $\overset{|}{b}$; sometimes in acute forms, rhombohedral in aspect (f. 2). Faces rounded or uneven. Often grouped in nearly parallel position and further inclined both in the direction of the axes $\grave{c}\,\overset{|}{b}$ and $\grave{c}\,\grave{a}$, yielding finally spherical forms bounded by the curving basal faces. Also massive, hemispherical, or reniform; structure radiated fibrous.

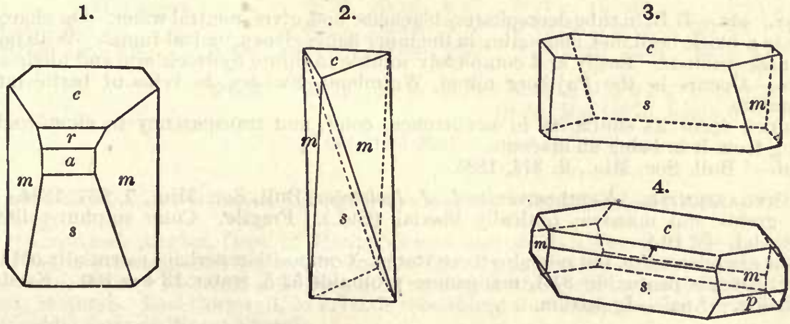


Fig. 1, Cornwall, after Phillips. 2–4, Utah. 3, 4, Washington.

Cleavage: *c* highly perfect. Brittle. H. = 2·5–3. G. = 4·19–4·36; 4·36, 4·38 Utah. Luster: *c* pearly; elsewhere vitreous to resinous. Color internally dark verdigris-green; externally blackish blue-green. Streak bluish green. Subtransparent to translucent.

Optically —. Ax. pl. ‖ *b*. Bx inclined about 90° to *à*. Dispersion $\rho < v$ very large, inclined small. Axial angles somewhat variable, Dx.:

(1) $2H_{a \cdot gr} = 81° \ 56'$ ∴ $2E_{gr} = 134° \ 36'$ (2) $2H_{a \cdot gr} = 84° \ 12'$ ∴ $2E_{gr} = 141° \ 14'$
(1) $2H_{a \cdot bl} = 83° \ 42'$ ∴ $2E_{bl} = 160° \ 52'$ (2) $2H_{a \cdot bl} = 86° \ 42'$ ∴ in air total reflection.

**Comp.**—$Cu_3As_2O_8.3Cu(OH)_2$ or $6CuO.As_2O_5.3H_2O$ = Arsenic pentoxide 30·3, cupric oxide 62·6, water 7·1 = 100.

**Anal.**—1, Rg., Min. Ch., 378, 1860. 2, Damour, Ann. Ch. Phys., **13**, 412, 1845. 3, Pearce, Proc. Col. Soc., **2**, 134, 1886. 4, Hillebrand, Am. J. Sc., **35**, 303, 1888.

| | | | $As_2O_5$ | $P_2O_5$ | CuO | $H_2O$ | $Fe_2O_3$ | |
|---|---|---|---|---|---|---|---|---|
| 1. | Cornwall | G. = 4·26–4·36 | 29·71 | 0·64 | 60·00 | 7·64 | 0·39 | CaO 0·50, $SiO_2$ 1·12 = 100 |
| 2. | " | G. = 4·312 | 27·08 | 1·50 | 62·80 | 7·57 | 0·49 | = 99·44 |
| 3. | Utah | G. = 4·36 | 29·10 | — | 61·45 | 7·29 | *tr.* | = 97·84 |
| 4. | " | G. = 4·38 | $\frac{2}{2}$ 29·59 | 0·05 | 62·44 | 7·72 | 0·12 | ZnO 0·05, $SiO_2$ 0·06 = 100·03 |

**Pyr., etc.**—Same as for olivenite.

**Obs.**—Occurs in Cornwall, with other ores of copper, at Ting Tang mine, Wheal Unity, and Wheal Gorland, and at Bedford United Mines, near Tavistock. The crystals usually present a very dark blue color and brilliant luster, but are rarely recognizable, being aggregated in diverging groups, or disposed in extremely minute individuals, in cavities of quartz; whence the name *aphanesite*, from ἀφανής, *unmanifest*. Also found (about 1825) with chalcophyllite at mines now abandoned near Saida in Saxony.

In Utah, Tintic district, at the Mammoth mine, in fine crystallizations, with other copper and iron arsenates associated with enargite.

Named *Clinoclasite* in allusion to the basal cleavage being oblique to the sides of the prism.

**Ref.**—[1] Min., 331, 1837; cf. Dx., Ann. Ch. Phys., **13**, 419, 1845; Schrauf, Atlas, xx.
[2] H. S. Washington, Utah, Am. J. Sc., **35**, 303, 1888.

### 572. CHONDRARSENITE. Kondroarsenit *Igelström*, Öfv. Ak. Stockh., **22**, 3, 1865.

In small embedded grains.

Brittle. Fracture conchoidal. H. = 3. Color yellow to reddish yellow. Translucent. Biaxial; optically —. Ax. angle large, Btd.[1]

**Comp.**—Perhaps $Mn_3As_2O_8.3Mn(OH)_2$ or $6MnO.As_2O_5.3H_2O$ = Arsenic pentoxide 32·5, manganese protoxide 59·9, water 7·6 = 100.

The analysis gives about ½ molecule more water than the above formula demands, and the mineral obviously needs further examination.

**Anal.**—Igelström, l. c.

$As_2O_5$ 33·50 MnO 51·59 MgO 2·05 CaO 4·86 $H_2O$ 7·00 $CO_2$ *tr.* = 99·00

**Pyr., etc.**—B.B. in tube decrepitates, blackens, and gives neutral water. On charcoal easily fusible to a black bead, not magnetic; in the inner flame gives arsenical fumes. With borax gives manganese reaction. Easily and completely soluble in dilute hydrochloric and nitric acids.

**Obs.**—Occurs in the Pajsberg mines, Wermland, Sweden, in veins of barite intersecting hausmannite.

Named from its similarity in occurrence, color, and transparency to chondrodite, while differing from it in being an arsenate.

**Ref.**—[1] Bull. Soc. Min., 8, 374, 1885.

XANTHARSENITE. Xanthoarsénite *L. J. Igelström*, Bull. Soc. Min., **7**, 237, 1884.

In grains and massive; optically biaxial (Btd.). Fragile. Color sulphur-yellow. Optically biaxial, +? Btd.

Near chondarsenite, but contains more water. Composition perhaps essentially $5MnO.As_2O_5.5H_2O$ = Arsenic pentoxide 34·1, manganese protoxide 52·5, water 13·4 = 100. Needs further examination. Anal.—Igelström.

| $As_2O_5(Sb_2O_5$[a]$)$ | MnO | FeO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|
| $\frac{2}{2}$ 33·26 | 43·60 | 3·11 | 6·08 | 1·93 | 12·02 | = 100 |

[a] Perhaps 3 p. c.

Occurs with hausmannite, also with hematite and magnetite in crystalline limestone at the Sjö mine, parish of Grythytte, Örebro, Sweden.

**573. DUFRENITE.** Strahlstein (var.) *Jordan*, Min., etc., Reisebem., 243, 1803. Grüneisenstein (strahlicher) *Ullmann*, Syst. Tab. Uebers., 152, 319, 1814. Faseriche Grün-Eisenerde *W.* Dufrenite *Brongn.*, Tabl., 20, 1833. Green Iron Ore. Kraurit *Breith.*, Handb., 152, 1841.

Orthorhombic. Axes (approx.) $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}8734 : 1 : 0{\cdot}4262$ Streng[1].
$100 \wedge 110 = 41° 8'$, $001 \wedge 101 = 26° 0\frac{2}{3}'$, $001 \wedge 011 = 23° 5'$.

**Forms**[1]: *a* (100, *i-ī*), *b* (010, *i-ĭ*); *m* (110, *I*), *l* (120, *i-2̆*)?; *e* (011, 1-*ĭ*).

Angles: *mm'''* = *82° 16', *ee'* = *46° 10', *ll'* = 59° 35'.

Crystals rare, small and indistinct in consequence of grouping; *e* much rounded, *a*, *b* vertically striated. Usually massive, in nodules; radiated fibrous with drusy surface.

Cleavage: *a*, probably also *b*, but indistinct. H. = 3·5–4. G. = 3·2–3·4; 3·227 Dufr. Luster silky, weak. Color dull leek-green, olive-green, or blackish green; alters on exposure to yellow and brown. Streak siskin-green. Subtranslucent to nearly opaque. Strongly pleochroic.

**Comp.**—Doubtful; in part (anal. 1, 2) corresponds to $FePO_4.Fe(OH)_3 = 2Fe_2O_3.P_2O_5.3H_2O$ = Phosphorus pentoxide 27·5, iron sesquioxide 62·0, water 10·5 = 100. Other analyses give somewhat different results.

The crystallized mineral of Waldgirmes corresponds nearly to $3FePO_4.2Fe(OH)_3$ or $5Fe_2O_3.3P_2O_5.6H_2O$ = Phosphorus pentoxide 33·2, iron sesquioxide 58·4, water 8·4 = 100. Ferrous iron is present only in small amount.

Further, some analyses show ferrous iron, and perhaps these kinds do not belong here. Anal. 8 gives $FeO.3Fe_2O_3.2P_2O_5.6H_2O$ (cf. chalcosiderite).

**Anal.**—1, Karsten [Arch., **15**, 243], Rg., 329, 1860. 2, Diesterweg, B. H. Ztg., **22**, 257, 1863. 3, Deichsel, Rg., Min. Ch., 316, 1875. 4, 5, Boricky, Ber. Ak. Wien, **56** (1), 6, 1867. 6, Streng, Jb. Min., **1**, 110, 1881. 7, E. Kinch and Butler, Min. Mag., **7**, 65, 1886 8, E. Kinch, ibid., **8**, 112, 1888. 9, Schnabel, Rg., Min. Ch., 329. 1860. 10, Kurlbaum, Am. J. Sc., **23**, 423, 1857. 11, Massie, Ch. News, **42**, 181, 1880. 12, Campbell, Am. J. Sc., **22**, 65, 1881. Also 5th Ed., p. 583.

For a discussion of the composition, see Church, Ch. News, **10**, 157, 1864, Streng, l. c., and Kinch, l. c.

| | | G. | $P_2O_5$ | $Fe_2O_3$ | FeO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. | Siegen, *dark green* | | 27·72 | 63·45 | — | 8·56 | = 99·73 |
| 2. | “ “ | | 27·71 | 62·02 | 0·25 | 10·90 | = 100·88 |
| 3. | “ “ | | 28·11 | 58·53 | 2·19 | 9·72 | = 98·55 |
| 4. | St. Benigna, *dark green* | | 30·05 | 59·82 | *tr.* | 9·33 | = 99·20 |
| 5. | “ *light green* | | 32·09 | 57·93 | *tr.* | 9·04 | = 99·06 |
| 6. | Waldgirmes, *crystals* | | 31·82 | 60·20 | 1·53 | 8·03 | = 101·58 |
| 7. | East Cornwall, *crystals* | 3·233 | 30·42 | 55·93 | — | 10·68 | CuO 0·96, CaO 1·51 = 99·50 |
| 8. | Wh. Phœnix, Corn., *botr.* | | 31·23 | 47·23 | 6·83 | 11·52 | $Al_2O_3$ 0·87, CaO 1·69, MgO 0·17 = 99·54 |
| 9. | Siegen, *dark green* | | 28·39 | 53·66 | 9·97 | 8·97 | = 100·99 |
| 10. | Allentown, N.J., “ | | 32·61 | 53·74 | 3·77 | 10·49 | $SiO_2$ 0·72 = 101·33 |
| 11. | Rockbridge Co., Va. | 3·454 | 31·66 | 50·89 | 6·30[a] | 8·35 | MgO 2·16, $Al_2O_3$ 0·29, $SiO_2$ 0·20 = 99·85 |
| 12 | “ “ | 3·382 | 31·76 | 50·85 | 6·14 | 8·53 | $Al_2O_3$ 0·21, CaO 1·12, MnO 0·40, MgO 0·76, insol. 0·12 = 99·89 |

[a] Incl. 0·24 MnO.

**Pyr., etc.**—Same as for vivianite, but less water is given out in the closed tube. B.B. fuses easily to a slag.

**Obs.**—Occurs near Anglar, Dept. of Haute Vienne, and at Hirschberg in Westphalia (the localities of the specimens, according to Dufrénoy, originally named *dufrenite*); at Rochefort-en-Terre, Morbihan, France; Eiserfeld near Siegen. From the Rothläufchen mine near Waldgirmes; St. Benigna, Bohemia; East Cornwall, in crystals resembling those described by Streng (Miers); also in botryoidal form at Wheal Phœnix.

In the U. States, at Allentown, N. J., as a fibrous leek-green coating, sometimes half an inch thick, in the Green Sand formation; it changes to brown in altering to limonite. In Rockbridge Co., Va., in radiated coarsely fibrous masses of a dark greenish brown color, forming an irregular bed of about 10 inches in depth, underlying limonite.

Named after the French mineralogist, P. A. Dufrénoy (1792–1857). Kraurite is from *κραῦρος*, *harsh, dry*.

**Ref.**—[1] Jb. Min., **1**, 110, 1881.

**574. LAZULITE.** Himmelblau Fossil von Steiermark [Styria] *Widenmann*, Bergm. J., 346, Ap. 1791; Smalteblaue F. von Vorau, Schrift. Ges. N. Berlin, 9, 352, 1791; Natürliche Smalt; Berlinerblau, Eisenblau [= Vivianite]; Bergblau [= Chrysocolla]; Unächter Lasurstein [= False Lapis-Lazuli], *Stütz*, Einricht. Nat. Wien, 49, 1793; Lazulit = Kieselerde + Thonerde + Eisenerde, *Klapr.*, Schrift. Ges. N. Berl., 10, 90, 1792, Beitr., 1, 197, 1795. Dichter blauer Feldspath (fr. Krieglach, Styria) *Klapr.*, Beitr., 1, 14, 1795; Lazulith *Klapr.*, Beitr., 4, 279, 1807. Blue Spar, Blue Feldspar. Wahrscheinlich n. Foss. aus d. Salzburgischen, Siderit, *v. Moll*, Jahrb. B. H., 4, 71, 1799 (with bad anal. by Heim); Mollit *Haberle*, Handb., 1804; = Lazulith *Mohs*, Null Kab., 1, 427, 1804. Blauspath *Wern.* Voraulite *Delameth.*, Min., 1812. Azurite *Jameson*, Min., 1, 341, 1816. Phosphorsäure Thonerde, etc., *Fuchs*, Schw. J., 24, 373, 1818. Klaprothite *Beud.*, Tr., 464, 1824; Klaprothine *id.*, 2, 576, 1832.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 0{\cdot}97496 : 1 : 1{\cdot}6483$; $\beta = 89° \ 13\frac{2}{3}' = 001 \wedge 100$ Prüfer[1].

$100 \wedge 110 = 44° \ 16\frac{1}{4}'$, $001 \wedge 101 = 58° \ 49\frac{1}{2}'$, $001 \wedge 011 = 58° \ 45\frac{1}{6}'$.

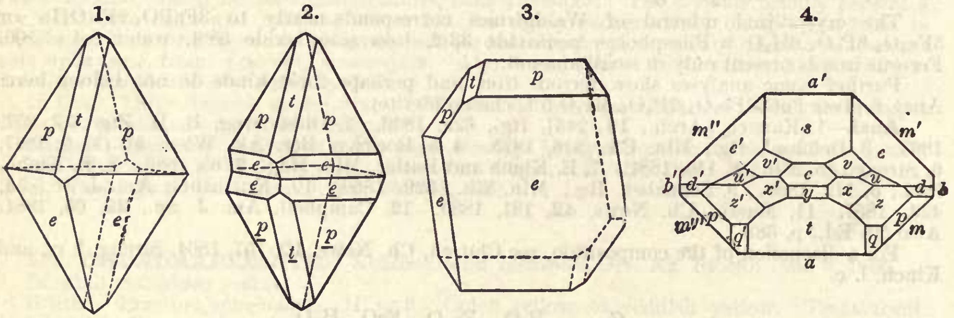
**Forms**[1]:
*a* (100, *i*-$\bar{i}$) tw. pl.
*b* (010, *i*-$\grave{i}$)
*c* (001, *O*)

*m* (110, *I*)
*y* (103, $-\frac{1}{3}$-$\bar{i}$)
*t* (101, $-$ 1-$\bar{i}$)

*s* ($\bar{1}$01, 1-$\bar{i}$)
*u* (012, $\frac{1}{2}$-$\grave{i}$)
*d* (011, 1-$\grave{i}$)

*x* (113, $-\frac{1}{3}$)
*z* (112, $-\frac{1}{2}$)
*p* (111, $-$ 1)
*r* (221, $-$ 2)[2]

*v* ($\bar{1}$13, $\frac{1}{3}$)
*e* ($\bar{1}$11, 1)
*q* (212, $-$ 1-$\bar{2}$)



Figs. 1–3, Georgia. 4, after Prüfer.

*mm''* = 88° $32\frac{1}{2}'$
*cy* = 29° 13′
*at* = 30° 24′
*cs* = 59° 58′
*ts* = 118° $47\frac{1}{2}'$
*uu'* = 78° 59′

*dd'* = 117° 30′
*cx* = 37° $59\frac{1}{2}'$
*cz* = 49° 25′
*cp* = 66° $34\frac{1}{2}'$
*cm* = 89° 27′
*cv* = 38° 25′

*ce* = 67° 31′
*cq* = 61° 28′
*pe''* = 45° $54\frac{1}{2}'$
*xx'* = 50° 54′
*zz'* = 64° 2′
*pp'* = *79° 40′

*vv'* = 51° 25′
*ee'* = *80° 20′
*qq'* = 45° 17′
*ap* = 48° $31\frac{1}{2}'$
*pe* = *82° 30′

Twins: (1) tw. pl. *a*, or tw. axis $\grave{c}$; (2) 223, rare. Crystals usually acute pyramidal in habit; also flattened (f. 3) by extension of one pair of pyramidal planes. Also massive, granular to compact.

Cleavage: prismatic, indistinct. Fracture uneven. Brittle. H. = 5–6. G. = 3·057 Fuchs; 3·067–3·121 Prüfer; 3·122 Smith and Brush. Luster vitreous. Color azure-blue; commonly a fine deep blue viewed along one axis, and a pale greenish blue along another. Streak white. Subtranslucent to opaque.

Pleochroism strong in colored varieties: $\mathfrak{c}$ and $\mathfrak{b}$ azure-blue, $\mathfrak{a}$ colorless. Optically $-$. Ax. pl. ∥ *b*. $Bx_a \wedge \grave{c} = 9° \ 20'$ approx. Dispersion $\rho > v$ (in oil) small, $\rho < v$ (in air) distinct; inclined, small. Axial angles, Dx.[3]:

(1) $2H_{a.r} = 77° \ 16'$ ∴ $2E_r = 132° \ 29'$ (2) $2H_{a.r} = 78° \ 36'$ ∴ $2E_r = 136° \ 25'$
(1) $2H_{a.bl} = 77° \ 11'$ ∴ $2E_{bl} = 134° \ 25'$ (2) $2H_{a.bl} = 78° \ 22'$ ∴ $2E_{bl} = 138° \ 4'$
Also $Bx_a \wedge \grave{c} = 9° \ 45'$ $2E_r = 110°$ Lcx.[4]

Indices, Brazil $\alpha = 1{\cdot}603$ $\beta = 1{\cdot}632$ $\gamma = 1{\cdot}639$ Lévy-Lcx.[5]

**Comp.**—$RAl_2(OH)_2P_2O_8$ or $2AlPO_4.(Fe,Mg)(OH)_2 = (Fe,Mg)O.Al_2O_3.P_2O_5.H_2O$

with Fe : Mg(Ca) = 1 : 12, 1 : 6, 1 : 2, 2 : 3 (Rg.). For 1 : 2 the formula requires: Phosphorus pentoxide 45·4, alumina 32·6, iron protoxide 7·7, magnesia 8·5, water 5·8 = 100.

**Anal.**—1, Fuchs, Schw. J., **24**, 373, 1818. 2, Rg., Min. Ch. Erg., 148, 1886. 3, Igelström, J. pr. Ch., **64**, 253, 1855. 4, Blomstrand, Öfv. Ak. Stockh., **25**, 201, 1868. 5, Smith and Brush, Am. J. Sc., **16**, 370, 1853. 6, Gamper, Jb. G. Reichs., **29**, 611, 1878. 7, Hoffmann, Geol. Canada, 1879–80. Also 5th Ed., p. 573.

| | G. | $P_2O_5$ | $Al_2O_3$ | FeO | MgO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. Rädelgraben | 3·057 | 41·81 | 35·73 | 2·64 | 9·34 | — | 6·06 SiO 2·10 = 97·68 |
| 2. Fischbacher Alp | | 42·95 | 31·57 | 8·31 | 10·34 | 0·40 | 6·40 = 99·97 |
| 3. Horrsjöberg | 2·78(?) | 42·52 | 32·86 | 10·55 | 8·58 | *tr.* | 5·30 MnO *tr.* = 99·81 [100·36 |
| 4. Westanå | | 43·83 | 32·82 | 7·82 | 9·05 | 0·84 | 5·72 MnO 0·18, CuO 0·10 = |
| 5. Sinclair Co., N. C. | 3·122 | ⅔ 43·76 | 31·70 | 8·17 | 10·04 | — | 5·59 $SiO_2$ 1·07 = 100·33 |
| 6. Zermatt | | 44·21 | 28·87 | 12·26 | 8·89 | — | 5·77 = 100 |
| 7. Keewatin, Canada | 3·045 | 46·39 | 29·14 | 2·09 | 13·84 | 2·83 | 6·47 = 100·76 |

From 7, 3 p. c. $SiO_2$, and from 8, 3·8 p. c. $SiO_2$ deducted.

**Pyr., etc.**—In the closed tube whitens and yields water. B.B. with cobalt solution the blue color of the mineral is restored. In the forceps whitens, cracks open, swells up, and without fusion falls to pieces, coloring the flame bluish green. The green color is made more intense by moistening the assay with sulphuric acid. With the fluxes gives an iron glass; with soda on charcoal an infusible mass. Unacted upon by acids, retaining perfectly its blue color.

**Obs.**—Occurs both massive and crystallized in narrow veins, traversing clay slate, in the torrent beds of Schladming and Rädelgraben, near Werfen in Salzburg, with siderite; in Graz, near Vorau; Krieglach, in Styria; at Hochthäligrat, at the Gorner Glacier, Rympfischwang, Upper Valais, Switzerland; also in veins or pockets in quartzyte, in Horrsjöberg, Wermland, Sweden massive and granular, sometimes in 8-sided crystals 6 inches long and 2 inches in diameter; in the iron mine of Westanå, in Scania, Sweden, massive, of a dark azure color; also at Tijuco in Minas Geraes, Brazil. At Gulabgarh, India (La Touche, Rec. G. Surv., 23, 59, 1890).

Abundant with corundum at Crowder's Mt., Gaston Co., N. C.; and in fine sky-blue crystals, often 1–1½ inch long and broad, on Graves Mt., Lincoln Co., Ga., 50 m. above Augusta, with cyanite, rutile, pyrophyllite, etc. In Keewatin, Canada, near the mouth of the Churchill river.

The name lazulite is derived from an Arabic word, *azul*, meaning *heaven*, and alludes to the color of the mineral.

**Ref.**—[1] Haid., Nat. Abhandl. Wien, 1, 169, 1847. [2] Gamper, Krieglach, Vh. G. Reichs., 118, 1877. [3] Dx., N. R., 142, 1867. [4] Lasaulx, Zs. Kr., 9, 424, 1884. [5] Lévy-Lcx., Min. Roches, 229, 1888.

**575. TAVISTOCKITE.** Hydrated Calcium-aluminic Phosphate (?) *A. H. Church*, J. Ch. Soc., 18, 263, 1865. Tavistockite *Dana*, Min., 582, 1868.

In microscopic acicular crystals, sometimes aggregated in irregular stellate groups, constituting a white pearly powder.

Fragile. Luster pearly. Color white. Transparent to translucent.

**Comp.**—$Ca_3P_2O_8.2Al(OH)_3$ or $3CaO.Al_2O_3.P_2O_5.3H_2O$ = Phosphorus pentoxide 30·5, alumina 21·9, lime 36·0, water 11·6 = 100.

**Anal.**—Church, l. c.

| $P_2O_5$ | $Al_2O_3$ | CaO | $H_2O$ |
|---|---|---|---|
| 30·36 | 22·40 | 36·27 | 12·00 = 101·03 |

**Pyr., etc.**—B.B. becomes opaque. With cobalt nitrate gives a blue color. Difficultly soluble in acids.

**Obs.**—Occurs at Tavistock, Devonshire, in cavities with quartz crystals, pyrite, chalcopyrite, and childrenite.

**576. CIRROLITE.** Kirrolith *C. W. Blomstrand*, Öfv. Ak. Stockh., **25**, 202, 1868.

Compact, without a trace of cleavage.

H. = 5–6. G. = 3·08. Color pale yellow.

**Comp.**—Perhaps $Ca_3Al(PO_4)_3.Al(OH)_3$ or $6CaO.2Al_2O_3.3P_2O_5.3H_2O$ = Phosphorus pentoxide 41·8, alumina 20·0, lime 32·9, water 5·3 = 100.

**Anal.**—Blomstrand, l. c., after removal of 4·60 not dissolved in the acid solution, of which 3·17 was silica.

| $P_2O_5$ | $Al_2O_3$ | FeO | MnO | PbO | MgO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|
| ⅔ 41·17 | 20·54 | 0·91 | 2·24 | 0·11 | 0·21 | 29·37 | 5·06 = 99·61 |

**Pyr., etc.**—B.B. fuses very easily to a white enamel. With soda a manganese reaction. Decomposed on digestion in fine powder in hydrochloric acid.

**Obs.**—Occurs at the iron mine at Westanå, in Scania, Sweden.

Named from κιρρός, *pale yellow*.

**577. ARSENIOSIDERITE.** Arseniosiderite *Dufr.*, Ann. Mines, **2**, 343, 1842, C. R., **16**, 22, 1843. Arsenokrokit, Arsenocrocites, *Glocker*, Syn., 226, 1847.

Tetragonal or hexagonal? Optically uniaxial, negative, Lcx.[1] In fibrous concretions resembling cacoxenite; the fibers large and easily separable between the fingers.

H. = 1–2. G. = 3·520 Dufr.; 3·88 Rg. Luster silky. Color yellowish brown and somewhat golden. Pleochroic. Powder yellowish brown, rather deeper in color than that of yellow ocher.

**Comp.**—$Ca_3Fe(AsO_4)_3.3FeOH)_3$ or $6CaO.4Fe_2O_3.3As_2O_5.9H_2O$ = Arsenic pentoxide 37·8, iron sesquioxide 35·0, lime 18·3, water 8·9 = 100.

**Anal.**—1, Dufrenoy, l. c., recalc. 2, 3, Rg., Pogg., **68**, 508, 1846. 4, Church, J. Ch. Soc., **26**, 102, 1873.

| | | G. | $As_2O_5$ | $Fe_2O_3$ | CaO | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. | Romanêche | 3·52 | 35·69 | 44·38[a] | 10·03 | 9·11 = 100·01 |
| 2. | " | 3·88 | [39·16] | 40·00 | 12·18 | 8·66 = 100 |
| 3. | " | | 38·74 | 39·37 | 12·53 | 9·36 = 100 |
| 4. | " | 3·36 | ⅜ 39·86 | 35·75 | 15·53 | 7·87 MgO 0·18, $K_2O$ 0·47 = 99·66 |

[a] Incl. 1·35 $Mn_2O_3$.

**Pyr., etc.**—Like scorodite.

**Obs.**—Occurs in a manganese bed at Romanêche, near Mâcon, Department of Saone-et-Loire, France; also at Schneeberg, Saxony, with erythrite and roselite.

Named from *arsenic* and σίδηρος, *iron*. Changed to *arsenocrocite* (fr. κρόκη, *fiber*) by Glocker, because of a previous use of arsenosiderite (see p. 96).

**Ref.**—[1] Bull. Soc. Min., **9**, 3, 1886.

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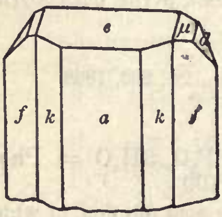
**578. ALLACTITE.** Allaktit *A. Sjögren*, G. För. Förh., **7**, 109, 1884; Öfv. Ak. Stockh., **41**, No. 3, 29, 1884.

Monoclinic. Axes $\grave{a} : \overset{|}{b} : \grave{c} = 0·61278 : 1 : 0·33385$; $\beta = 84° 16\frac{2}{3}' = 100 \wedge 001$ H. Sjögren[1].

$100 \wedge 110 = 31° 22\frac{1}{3}'$, $001 \wedge 101 = 27° 12\frac{2}{3}'$, $001 \wedge 011 = 18° 22\frac{1}{2}'$.

| Forms[1]: | | | | |
|---|---|---|---|---|
| | *g* (910, *i*-$\bar{9}$) | *m* (110, *I*) | *e* (101, – 1-$\bar{i}$) | *μ* (111, – 1) |
| *a* (100, *i*-$\bar{i}$) | *k* (310, *i*-$\bar{3}$) | *o* (340, *i*-$\frac{4}{3}$) | *p* (504, – $\frac{5}{4}$-$\bar{i}$) | *i* (252, – $\frac{5}{2}$-$\frac{5}{2}$) |
| *b* (010, *i*-$\grave{i}$) | *l* (210, *i*-$\bar{2}$) | *r* (150, *i*-$\grave{5}$) | *h* ($\bar{1}$01, 1-$\bar{i}$) | *d* (141, – 4-$\grave{4}$) |
| | *f* (320, *i*-$\frac{\bar{3}}{2}$) | | | |

Also numerous vicinal planes in the prismatic zone.



Sjögren.

| | | | | | |
|---|---|---|---|---|---|
| *kk‴* | = 22° 59′ | *rr′* | = 36° 19′ | *cd* | = 53° 42′ |
| *ll‴* | = 33° $54\frac{1}{2}'$ | *ae* | = *57° 4′ | *aμ* | = 58° 26′ |
| *ff‴* | = 44° $14\frac{1}{2}'$ | *cp* | = 32° 24′ | *μμ′* | = 31° 18′ |
| *ff′* | = *135° $45\frac{1}{2}'$ | *ah* | = *65° 54′ | *ii′* | = 70° 1′ |
| *mm‴* | = 62° 45′ | *ch* | = 57° 2′ | *dd′* | = 96° 31′ |
| *oo′* | = 101° 47′ | *cμ* | = 31° $5\frac{1}{2}'$ | *ef* | = 59° $45\frac{1}{2}'$ |

Crystals small, prismatic, often tabular ‖ *a*, vertically striated. Resembles axinite.

Cleavage: *e* (101) distinct, *a* less so. Fracture uneven, splintery. H. = 4·5. G. = 3·83–3·85. Luster vitreous, on the fracture greasy. Color brownish red. Streak brownish gray. Transparent. Strongly pleochroic, hyacinth-red to olive-green.

Optically —. Double refraction strong. Ax. pl. in acute angle of axes $\grave{a}\grave{c}$. $Bx_{r.y}$ in plane $b$. $Bx_{r.y} \wedge \grave{c} = -49° 12'$. $Bx_{bl} \perp b$. Axial angles, Knr.[2]

$2H_{a.r} = 12° 22'$ $2H_{a.y} = 9° 12'$ Na $2H_{a.gr} = 0°$ Tl $2H_{a.bl} = 11° 36'$ $CuSO_4$

Also $\beta_r = 1·778$ $\beta_y = 1·786$ H. Sj. and $\therefore$ $2V_{a.r} = 10° 12'$ $2V_{a.y} = 7° 34'$

**Comp.**—$Mn_3As_2O_8.4Mn(OH)_2$ or $7MnO.As_2O_5.4H_2O$ = Arsenic pentoxide 28·8, manganese protoxide 62·2, water 9·0 = 100.

**Anal.**—1, A. Sjögren, Öfv. Ak. Stockh., **41**, No. 3, 29, 1884; other analyses gave like results. 2, Lundström, ibid. 3, A. Sjögren, Öfv. Ak. Stockh., **44**, 109, 1887. 4, Lundström, ibid.

| | $As_2O_5$ | MnO | FeO | CaO | MgO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|
| 1. Nordmark | 28·76 | 62·19 | — | tr. | 0·55 | 8·97 | = | 100·47 |
| 2. " | 28·16 | 62·08 | 0·24 | 0·48 | 0·36 | 8·86 | = | 100·18 |
| 3. Långban | 29·10 | 58·64 | | 2·01 | 1·34 | 8·97 | = | 100·06 |
| 4. " | 28·89 | 58·86 | 0·25 | 1·53 | 1·37 | 9·02 | = | 99·92 |

**Pyr.**—B.B. nearly infusible, reactions for arsenic and manganese. Loses water and becomes black at a low red heat. Easily soluble in acids.

**Obs.**—Found with other manganese arsenates, with magnetite, hausmannite, pyrochroite, fluorite, etc., in druses in a manganiferous dolomite at the Moss mine, Nordmark, Sweden. Also at Långban with manganiferous barite (2 p. c. MnO).

Named from *ἀλλάττειν, to change*, in allusion to its strong pleochroism.

**Ref.**—[1] G. För. Förh., **7**, 220, 1884, Zs. Kr., **10**, 114, 1885. [2] Knr., Zs. Kr., **10**, 83, 1884.

**579. SYNADELPHITE.** Synadelphit *A.* and *H. Sjögren*, G. För. Förh., **7**, 235, 382, 1884.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 0·8582 : 1 : 0·9192$; $\beta = 90° = 001 \wedge 100$ H. Sjögren[1].

$100 \wedge 110 = 40° 38\frac{1}{6}'$, $001 \wedge 101 = 46° 58'$, $001 \wedge 011 = 42° 35\frac{1}{3}'$.

**Forms:** *a* (100, $i$-$\bar{i}$); *u* (230, $i$-$\frac{3}{2}$), *o* (120, $i$-$\grave{2}$); *i* (102, $-\frac{1}{2}$-$\bar{i}$), *e* ($\bar{1}02$, $\frac{1}{2}$-$\bar{i}$), *f* (111, $-1$), *d* ($\bar{1}11$, 1), *h* (786, $-\frac{4}{3}$-$\frac{8}{7}$), *g* ($\bar{7}86$, $\frac{4}{3}$-$\frac{8}{7}$).

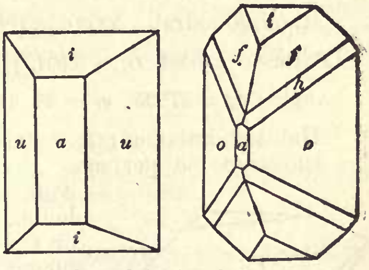
| | | | |
|---|---|---|---|
| *uu'* = 75° 41' | *ff'* = *76° 31' | *hh''* = 120° 31' | *if* = 36° 41' |
| *oo'* = 60° 27' | *ff''* = 109° 22' | *hh'''* = 74° 53' | *of* = 39° 34' |
| *ai* = 61° 50' | *f'f''* = *64° 12' | *ui* = 73° 10' | *ih* = 43° 7' |
| *ie* = 56° 20½' | *hh'* = 76° 37' | *oi* = 76° 15' | |

The form shows some resemblance to that of lazulite and liroconite, cf. Sjögren.

Crystals prismatic with *u*, *o*, vertically striated, also pyramidal with *f* (111) largely developed. Also in embedded grains.

Cleavage not observed. Fracture uneven to conchoidal. Brittle. H. = 4·5. G. = 3·45–3·50. Luster vitreous to greasy. Color brownish black to black. Feebly pleochroic. Nearly opaque. Optically +. Ax. pl. $\perp b$ and inclined 45° to $\grave{c}$. $Bx_a \perp b$. Ax. angle small.

**Comp.** — $2(Al,Mn)AsO_4.5Mn(OH)_2$. If Mn(Fe) : Al = 2 : 1, this requires: Arsenic pentoxide 28·3, alumina 4·2, manganese sesquioxide 12·9, manganese protoxide 43·5, water 11·1 = 100. Calcium and magnesium are also present in small amount.



Synadelphite, Sjögren.

**Anal.**—A. Sjögren, Zs. Kr., **10**, 146, 1885.

| $As_2O_5$ | $Al_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ | MnO | CaO | MgO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|
| 29·31 | 6·16 | 1·23 | 11·79 | 35·71 | 3·76 | 2·19 | 11·39 | = | 101·54 |

**Pyr.**—Fuses easily on charcoal to a black slaggy bead: with soda gives arsenical reacts for manganese. Gives off water in the closed tube and becomes black. Dissolves readily in acids, giving off chlorine when warmed with hydrochloric acid.

**Obs.**—Occurs in a porous manganiferous limestone, often on barite, at the Moss mine, Nordmark, Sweden.

Named from σύν, *with*, ἀδελφός, *brother*, because intimately associated with other related species.

**Ref.**—[1] Zs. Kr., **10**, 143, 1885; the + and − signs attached to the planes are given provisionally, as the direction of obliquity is not fixed. Cf. Hamberg, G. För. Förh., **11**, 222, 1889.

**580. FLINKITE.** *A. Hamberg*, G. För. Förh., **11**, 212, 1889.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}41306 : 1 : 0{\cdot}73862$ Hamberg[1].
$100 \wedge 110 = 22^\circ\ 26\frac{2}{3}'$, $001 \wedge 101 = 60^\circ\ 47'$, $001 \wedge 011 = 36^\circ\ 27'$.

**Forms:** *c* (001, *O*), *b* (010, *i*-ĭ); *m* (110, *I*); *e* (101, 1-ī), *k* (111, 1). Also doubtful *p* (0·1·10, $\frac{1}{10}$-ĭ), *μ* (014, $\frac{1}{4}$-ĭ), *n* (027, $\frac{2}{7}$-ĭ).

Angles: *mm‴* = 44° 53′, *ee′* = 121° 34′, *ck* = *62° 40′, *kk′* = 110° 23′, *kk″* = 39° 39′, *bk* = *70° 10½′, *cμ* = 10° 28′, *cn* = 11° 55′.

In minute crystals, thin tabular ‖ *c*; faces *c* often striated ‖ *ă*, also *m*, *k*, *e* sometimes vertically striated. Crystals grouped in feather-like aggregates.

Brittle. H. = 4–4·5. G. = 3·87. Luster vitreous to greasy. Color greenish brown. Transparent. Strongly pleochroic: 𝔠 (= *a*) orange-brown, 𝔞 (= *b*) yellowish to brownish green, 𝔟 (= *c*) yellowish green. Optically +. Ax. pl. ‖ *c*. Bx ⊥ 100. Axial angle large; dispersion probably $\rho < v$.

**Comp.**—$MnAsO_4.2Mn(OH)_2$ or $4MnO.Mn_2O_3.As_2O_5.4H_2O$ = Arsenic pentoxide 30·5, manganese sesquioxide 22·3, manganese protoxide 37·6, water 9·6 = 100.

The composition is near that of synadelphite, and there is some resemblance in form, but, as shown by Hamberg, they can hardly be united.

**Anal.**—Hamberg, on 0·05 gr.

| $As_2O_5$ | $Sb_2O_5$ | $Mn_2O_3$ | $Fe_2O_3$ | MnO | MgO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 29·1 | 2·5 | 20·2 | 1·5[a] | 35·8 | 1·7 | 0·4 | 9·9 = 101·1 |

[a] Also $Al_2O_3$?.

**Pyr., etc.**—Same as synadelphite.

**Obs.**—Occurs with caryopilite and sarkinite at the Harstig mine near Pajsberg, Sweden.

Named after the Swedish mineralogist, Gustav Flink.

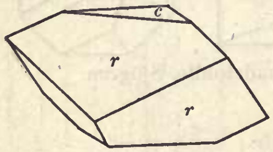
**581. HEMATOLITE.** Aimatolith *L. J. Igelström*, Öfv. Ak. Stockh., **41**, No. 4, 85, 1884, G. För. Förh., **7**, 211, 1884. Hämatolith. Diadelphit *H. Sjögren*, G. För. Förh., **7**, 233, 369, 1884, Zs. Kr., **10**, 130, 1885.

Rhombohedral. Axis $\dot{c} = 0{\cdot}8885$; $0001 \wedge 10\bar{1}1 = {}^*45^\circ\ 44'$ H. Sjögren[1].

**Forms**[2]: *c* (0001, *O*); *q* ($30\bar{3}4$, $\frac{3}{4}$), *r* ($10\bar{1}1$, *R*), *s* ($20\bar{2}1$, 2), *t* ($70\bar{7}3$, $\frac{7}{3}$)[2].

Angles: *cq* = 37° 35′, *cr* = 45° 44′, *cs* = 64° 1′, *qq′* = 63° 45½′, *rr′* = 76° 39′, *ss′* = 102° 15′.

Habit rhombohedral; *r* striated horizontally.



Cleavage: *c* perfect. Fracture uneven. Brittle. H. = 3·5. G. = 3·30–3·40. Luster vitreous to greasy, on cleavage face metalloidal. Color brownish red, garnet-red, becoming black on the surface. Streak bright chocolate-brown. Translucent when fresh.

Optically negative. Refractive indices: $\omega_r = 1{\cdot}723$, $\omega_v = 1{\cdot}740$ Sj. Exhibits striking optical anomalies, sometimes biaxial with small axial angle[3].

**Comp.**—According to Sjögren, $(Al,Mn)AsO_4.4Mn(OH)_2$. The manganese protoxide is in part replaced by magnesia. The percentage composition (Sj., calc.) is: Arsenic pentoxide 22·6, alumina 7·6, iron sesquioxide 1·2, manganese protoxide 48·9, magnesia 5·5, water 14·2 = 100.

**Anal.**—1, C. H. Lundström, Zs. Kr., **10**, 142, 1885. 2, A. Sjögren, ibid.

|  | $As_2O_5$ | $Al_2O_3$ | $Fe_2O_3$ | MnO | CaO | MgO | $H_2O$ |  |
|---|---|---|---|---|---|---|---|---|
| 1. | 21·55 | 6·39 | 1·01 | 46·86 | 0·66 | 6·66 | 13·93 | insol. 0·64 = 97·70 |
| 2. | 22·54 | 8·61 |  | 50·98 | 0·71 | 5·38 | 14·02 | = 102·24 |

Igelström's analysis gave: $As_2O_5$ 25·70, MnO 34·55, FeO 13·05, MgO 8·10, CaO 2·52, $H_2O$ 16·08 = 100.

H. Sjögren argues that the manganese is chiefly present as sesquioxide.

**Pyr.**—B.B. does not fuse; gives off water and becomes black, on strong ignition becomes brown ($Mn_3O_4$). On charcoal gives arsenical fumes, and with soda a manganese reaction. Easily soluble in acids.

**Obs.**—Occurs in crystals lining cavities in a manganiferous limestone with magnetite, jakobsite, and fluorite at the Moss mine in Nordmark, Sweden.

Named from *αἷμα*, *blood*, in allusion to its color; diadelphite from *δις-*, *twice*, and *ἀδελφός*, *brother*, because of its close association with allactite. The former name has the priority.

**Ref.**—[1] L. c. [2] Lorenzen, Öfv. Ak. Stockh., **41**, No. 4, 95, 1884. [3] See Btd., Bull. Soc. Min., **7**, 124, 1884, who refers it to the monoclinic system, also Lorenzen and H. Sj.

**582. ARSENIOPLEITE.** *Igelström*, Bull. Soc. Min., **11**, 209, 1888, Jb. Min., **2**, 117, 1888.

Massive, cleavable (rhombohedral?). Optically uniaxial, positive. Color brownish red. Streak yellowish brown. Opaque in the mass. Transparent and blood-red in thin section.

**Comp.**—Perhaps $\overset{II}{R}_9\overset{III}{R}_2(OH)_6(AsO_4)_6$ or $\overset{II}{R}_3\overset{III}{R}(AsO_4)_2.\frac{3}{2}R(OH)_2$ or $9RO.R_2O_3.3As_2O_5.3H_2O$. $\overset{II}{R}$ = Mn,Ca, also Pb,Mg; $\overset{III}{R}$ = Mn, also Fe.

**Anal.**—Igelström, l. c.

| $As_2O_5$ | $Sb_2O_5$ | $Fe_2O_3$ | MnO | PbO | CaO | MgO | $H_2O$ |  |
|---|---|---|---|---|---|---|---|---|
| 44·98 | *tr.* | 3·68 | 28·25[a] | 4·48 | 8·11 | 3·10 | 5·67 | Cl *tr.* = 98·27 |

[a] Regarded as $Mn_2O_3$ 7·80, MnO 21·25.

It is believed that the manganese is present in part as sesquioxide, and the relation $Mn_2O_3$ 7·80, MnO 21·25 is suggested, but this is assumed somewhat arbitrarily and needs confirmation.

**Pyr.**—Decrepitates and on charcoal fuses B.B. easily, leaving a black slag, giving arsenical fumes, and a trace of a lead sublimate. Easily soluble in hydrochloric acid.

**Obs.**—Occurs at the Sjö mine, Grythytte parish, Sweden, with rhodonite in crystalline limestone; it forms thin veins or nodules.

Named irregularly from the Latin *arsenicum* and Greek *πλεῖον*, *more*, because it adds to the number of related minerals already described.

PLEURASITE *L. J. Igelström*, G. För. Förh., **11**, 391, 1889; Jb. Min., **1**, 253, 1890.

In masses of a bluish black color and opaque. H. = 4. Fracture conchoidal. Luster submetallic. Color bluish black, and streak black with a faint tinge of red. Opaque. Contains arsenic, a little antimony, manganese and iron protoxide, water; not analyzed. Occurs at the Sjö mine, Grythytte parish, Örebro, Sweden. It form bands, 1 cm. or less in thickness, on the side of arseniopleite, and is hence named from *πλευρά*, *side*.

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**583. MANGANOSTIBIITE.** *L. J. Igelström*, G. För. Förh., **7**, 210, 1884; Bull. Soc. Min., **7**, 120, 1884. Hämatostibiite *Id.*, ibid., **8**, 143, 1886. Hematostibiite.

In embedded grains; orthorhombic?. Compact.

Color black. Streak brownish. Opaque.

**Var.**—The above characters apply to manganostibiite. Hematostibiite is blood-red in thin splinters. Optically −. Bx ⊥ cleavage. Ax. angle small. Pleochroic.

**Comp.**—Highly basic manganese antimonates. For manganostibiite the formula $10MnO.Sb_2O_5$ is suggested; for hematostibiite, $8MnO.Sb_2O_5$ or $9MnO.Sb_2O_5$. Arsenic may replace part of the antimony, and iron, etc., the manganese.

**Anal.**—1, 2, Igelström, l. c.

|  | $Sb_2O_5$ | $As_2O_5$ | MnO | FeO | CaO | MgO |  |
|---|---|---|---|---|---|---|---|
| 1. *Manganostibiite* | 24·09 | 7·44 | 55·77 | 5·00 | 4·62 | 3·00 | = 99·92 |
| 2. *Hematostibiite* | 37·2 | — | 51·7 | 9·5 | 1·6 |  | = 100 |

**Pyr.**—B.B. does not fuse, but gives an antimony coating on charcoal; with soda reacts for manganese. Dissolves completely in hydrochloric acid; with nitric acid gives a clouded solution.

**Obs.**—Manganostibiite occurs at Nordmark, Sweden, in crystalline manganesian limestone with other manganiferous minerals, as hausmannite, pyrochroite, allactite.

Hematostibiite is found at the Sjö mine, Grythytte parish, Örebro, Sweden, filling veins with calcite, also tephroite.

The following are other antimonates containing manganese, but imperfectly investigated and of doubtful relations:

FERROSTIBIAN *L. J. Igelström*, G. För. Förh., **11**, 389, 1889; Jb. Min., **1**, 250, 1890.

In monoclinic (?) crystals with *a* (100), *b* (010), *c* (001). Cleavage in two or three directions. H. = 4. Luster submetallic. Color black. Streak brownish black tending to red. Weakly magnetic. Anal.—Igelström, l. c.

$Sb_2O_5$ 14·80 FeO 22·60 MnO 46·97 MgO,CaO 2·14 $H_2O$ 10·34 $SiO_2$ 2·24 = 99·09

B.B. fuses on thin edges to a black magnetic glass. Gives antimony fumes on charcoal. Dissolves only imperfectly in acids.

Occurs embedded in massive rhodonite at the Sjö mine, Grythytte parish, Örebro, Sweden.

STIBIATIL *L. J. Igelström*, G. För. Förh., **11**, 391, 1889; Jb. Min., **1**, 254, 1890.

In prismatic crystals (monoclinic?) with rectangular and rhombic cross-section. H.= 5–5·5. Luster metallic. Color and streak iron black. Opaque. Not magnetic. Contains antimony, manganese, iron, water. An approximate analysis gave:

$Sb_2O_5$ 30 $Mn_2O_3$ 44 FeO 26 = 100

Occurs embedded in polyarsenite (sarkinite, p. 779) and associated with tephroite at the Sjö mine, Grythytte parish, Örebro, Sweden.

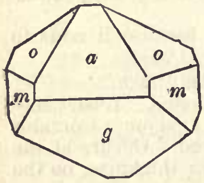
### 584. ATELESTITE. *Breithaupt*, Char. Min. Syst., 307, 1832.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 0·9334 : 1 : 1·5051$; $\beta = {}^*70° \ 43' = 001 \wedge 100$ Busz[1].

$100 \wedge 110 = 41° \ 22\frac{5}{6}'$, $001 \wedge 101 = 44° \ 48\frac{1}{6}'$, $001 \wedge 011 = 54° \ 51\frac{1}{2}'$.

**Forms:** *a* (100, *i*-$\bar{i}$), *b* (010, *i*-$\grave{i}$), *c* (001, *O*), *l* (310, *i*-$\bar{3}$); *m* (110, *I*), *d* (101, − 1-$\bar{i}$), *g* ($\bar{1}$01, 1-$\bar{i}$), *e* (011, 1-$\grave{i}$), *o* (111, − 1), *q* (313, − 1-$\bar{3}$).

Angles: $ll''' = 32° \ 44'$, $mm''' = {}^*82° \ 45\frac{3}{4}'$, $cd = 44° \ 48'$, $cg = 72° \ 55\frac{1}{2}'$, $a'g = {}^*36° \ 21\frac{1}{2}'$, $ee' = 109° \ 43'$, $co = 53° \ 39'$, $oo' = 66° \ 40'$, $qq' = 24° \ 44'$.



In minute crystals tabular ‖ *a* and with *g* ($\bar{1}$01) also prominent; faces usually smooth and brilliant.

Cleavage: basal, indistinct. H. = 3–4·5. G. = 6·4 Busz. Luster adamantine. Color sulphur-yellow. Transparent to translucent.

**Comp.**—Basic bismuth arsenate, $H_2Bi_3AsO_8$ or $3Bi_2O_3.As_2O_5.2H_2O$ = Arsenic pentoxide 13·9, bismuth trioxide 83·9, water 2·2 = 100.

The composition is interpreted by Busz as either $(BiO)_2(Bi(OH)_2)AsO_4$ or (more probably) $BiAsO_4.2(BiO)OH$.

**Anal.**—K. Busz, Zs. Kr., **15**, 625, 1889.

$As_2O_5$ 14·12 $Bi_2O_3$ 82·41 $Fe_2O_3$ 0·51 $H_2O$ 1·92 = 98·96

**Obs.**—Occurs very sparingly on bismutoferrite, associated with erythrite at the Neuhilfe mine, Schneeberg, Saxony.

Named from ἀτελής, *incomplete*, presumably because its composition was unknown when first described. Breithaupt remarks upon the resemblance of the crystals to the Swiss titanite.

**Ref.**—[1] Zs. Kr., **15**, 625, 1889. Cf. earlier Rath (Pogg., **136**, 422, 1869), who made *g* = 205 and *o* = $\bar{1}$11.

## C. Hydrous Phosphates, Arsenates, etc.—Normal Division.

| | | | | $\breve{a} : \bar{b} : \acute{c}$ |
|---|---|---|---|---|
| 585. | **Struvite** | $(NH_4)MgPO_4 + 6H_2O$ | Orthorhombic | 0·5664 : 1 : 0·9121 |
| 586. | **Collophanite** | $Ca_3P_2O_8 + H_2O$ | Amorphous | |
| 587. | **Hopeite** | $Zn_3P_2O_8 + H_2O$? | Orthorhombic | 0·5722 : 1 : 0·4717 |

| | | | | $\grave{a} : \bar{b} : \acute{c}$ | $\beta$ |
|---|---|---|---|---|---|
| 588. | **Dickinsonite** | $R_3P_2O_8 + \frac{1}{3}H_2O$<br>$R = Mn : Fe(Ca) : Na_2(K_2,Li_2) = 6 : 3 : 2$ | Monoclinic | 1·7320 : 1 : 1·1981 | 61° 30′ |
| 589. | **Fillowite** | $R_3P_2O_8 + \frac{1}{3}H_2O$<br>$R = Mn : Fe(Ca) : Na_2 = 6 : 2 : 1$ | Monoclinic | 1·7303 : 1 : 1·4190<br>or 1·7303 : 1 : 1·1093 | 89° 51′<br>58° 31′ |

### Roselite Group. Triclinic.

590. **Roselite** $(Co,Ca)_3As_2O_8 + 2H_2O$

$\breve{a} : \bar{b} : \acute{c} = 0·4536 : 1 : 0·6560$; $\alpha = 90° 34'$, $\beta = 91° 0'$, $\gamma = 89° 20'$

591. **Brandtite** $Ca_2MnAs_2O_8 + 2H_2O$

592. **Fairfieldite** $Ca_2MnP_2O_8 + 2H_2O$

$\breve{a} : \bar{b} : \acute{c} = 0·2797 : 1 : 0·1976$; $\alpha = 102° 9'$, $\beta = 94° 33'$, $\gamma = 77° 20'$

593. **Messelite** $(Ca,Fe)_3P_2O_8 + 2\frac{1}{2}H_2O$ Triclinic

| | | | | $\breve{a} : \bar{b} : \acute{c}$ |
|---|---|---|---|---|
| 594. | **Reddingite** | $Mn_3P_2O_8 + 3H_2O$ | Orthorhombic | 0·8678 : 1 : 0·9486 |
| 595. | **Picropharmacolite** | $(Ca,Mg)_3As_2O_8 + 6H_2O$ | | |

596. **Trichalcite** $Cu_3As_2O_8 + 5H_2O$

### Vivianite Group. Monoclinic.

Hydrous phosphates, etc., of magnesium, iron, cobalt, nickel, zinc.
$R_3P_2O_8 + 8H_2O$. $R = Mg,Fe,Co,Ni,Zn$.

| | | | $\grave{a} : \bar{b} : \acute{c}$ | $\beta$ |
|---|---|---|---|---|
| 597. | **Vivianite** | $Fe_3P_2O_8 + 8H_2O$ | 0·7498 : 1 : 0·7015 | 75° 34′ |
| 598. | **Symplesite** | $Fe_3As_2O_8 + 8H_2O$ | 0·7806 : 1 : 0·6812 | 72° 43′ |
| 599. | **Bobierrite** | $Mg_3P_2O_8 + 8H_2O$ | | |
| 600 | **Hœrnesite** | $Mg_3As_2O_8 + 8H_2O$ | | |
| 601. | **Erythrite** | $Co_3As_2O_8 + 8H_2O$ | 0·75 : 1 : 0·70 | 75° |
| 602. | **Annabergite** | $Ni_3As_2O_8 + 8H_2O$ | | |
| 603. | **Cabrerite** | $(Ni,Mg)_3As_2O_8 + 8H_2O$ | | |
| 604. | **Köttigite** | $Zn_3As_2O_8 + 8H_2O$ | | |

| | | | |
|---|---|---|---|
| 605. | **Rhabdophanite** | $(La,Di,Y)PO_4 + H_2O$ | |
| 606. | **Churchite** | $CePO_4 + 4H_2O$ | Monoclinic |

### Scorodite Group. Orthorhombic.

| | | $\breve{a} : \bar{b} : \acute{c}$ |
|---|---|---|
| **607. Scorodite** | $FeAsO_4 + 2H_2O$ | 0·8658 : 1 : 0·9541 |
| **608. Strengite** | $FePO_4 + 2H_2O$ | 0·8652 : 1 : 0·9827 |

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| | | | $\breve{a} : \bar{b} : \acute{c}$ |
|---|---|---|---|
| **609. Phosphosiderite** | $2FePO_4 + 3\frac{1}{2}H_2O$ | Orthorhombic | 0·5330 : 1 : 0·8772 |
| **610. Barrandite** | $(Al,Fe)PO_4 + 2H_2O$ | | |
| **611. Variscite** | $AlPO_4 + 2H_2O$ | Orthorhombic | $\breve{a} : \bar{b}$ = 0·648 : 1 |
| **612. Callainite** | $AlPO_4 + 2\frac{1}{2}H_2O$ | | |
| **613. Zepharovichite** | $AlPO_4 + 3H_2O$ ? | | |
| **614. Koninckite** | $FePO_4 + 3H_2O$ | | |

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**585. STRUVITE.** Struvit *Ulex*, Öfv. Ak. Stockh., **3**, 32, 1845, Lieb. Ann., **58**, 99, 1846, **66**, 41, 1848. Guanite *E. F. Teschemacher*, Phil. Mag., **28**, 546, 1846.

Orthorhombic, hemimorphic. Axes $\breve{a} : \bar{b} : \acute{c}$ = 0·56643 : 1 : 0·91207 Sadebeck[1]. 100 ∧ 110 = 29° 31¾′, 001 ∧ 101 = *58° 9½′, 001 ∧ 011 = 42° 22′.

| **Forms[2]:** | *c* (001. *O*) | *s* (101, 1-ī) | *q* (011, 1-ĭ) | *β* (0·16·1, 16-ĭ)[4] |
|---|---|---|---|---|
| *a* (100, *i*-ī)[4] | *p* (120, *i*-2̆) | *μ* (301, 3-ī)[4] | *h* (021, 2-ĭ) | *t* (121, 2-2̆) |
| *b* (010, *i*-ĭ) | *x* (507, $\frac{5}{7}$-ī)[5] | *i* (025, $\frac{2}{5}$-ĭ)[4] | *k* (041, 4-ĭ)[4] | |

| | | | |
|---|---|---|---|
| *pp‴* = 97° 8′ | *hh′* = 122° 32′ | *tt″* = 135° 19′ | *sq* = *67° 3½′ |
| *ss′* = 116° 19′ | *kk′* = 149° 20½′ | *tt‴* = 87° 48′ | *pq* = 59° 40′ |
| *qq′* = 84° 44′ | *tt′* = 75° 29′ | *ps* = 55° 47½′ | |

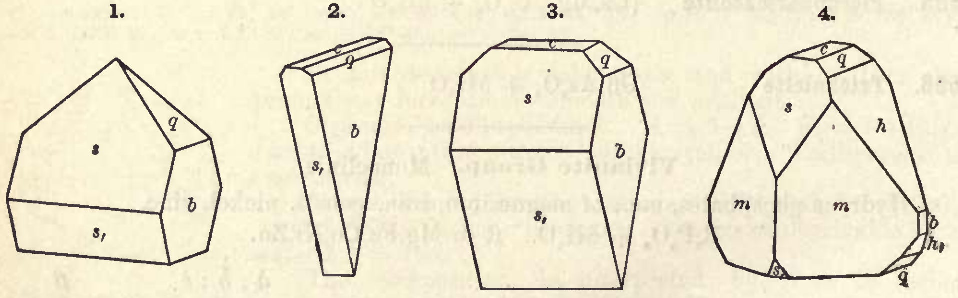
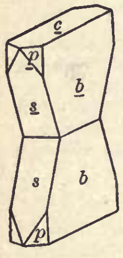


Fig. 1, Sadebeck. 2, 3, Kalkowsky. 4, Rath.

5.



Sadebeck.

Twins: tw. pl. *c* (f. 5). Habit varied: prismatic ∥ $\acute{c}$, or ∥ axis $\breve{a}$; also flattened ∥ *b*, or again ∥ *c*. Usually hemimorphic, the extremity terminated by the domes, *s* (101), *q* (011), etc., being the antilogous pole, and the basal plane, *c*, predominating at the analogous pole, cf. f. 1–4.

Cleavage: *c* sometimes perfect; *b* less so. Fracture conchoidal to uneven. Brittle. H. = 2. G. = 1·65–1·7. Color slightly yellowish to brown; white. Luster vitreous. Translucent; sometimes opaque. Tasteless, being but slightly soluble. Pyroelectric[3], see above.

Optically +. Ax. pl. ∥ *c*. Bx ⊥ *b*. Dispersion $\rho < v$ large. Axial angle variable, increased by heat, Dx.[6]

$2E = 59° 30'$ Mlr. $2E = 60° 30'$ Lang $2E = 60°$ Solly
$2E_r = 46° 32'$ $2E_y = 47° 30'$ $2E_v = 48° 46'$ Dx. $\beta_r = 1·497$ $\beta_y = 1·502$
Also $2E_r = 41° 49'$ at 6°·6 C., 43° 14′ at 21½°, 46° 4′ at 47°, 51° 50′ at 95°·5
$2E_r = 59° 40'$ Li $2E_y = 60° 56'$ Na, Kalkowsky[3]

**Comp.**—$NH_4MgPO_4 + 6H_2O$ = Phosphorus pentoxide 29·0, magnesia 16·3, ammonium oxide 10·6, water 44·1 = 100.

**Anal.**—1, Ulex, Jb. Min., 51, 1851, also other anals. 2, Pittman. Contr. Min. Victoria, 56, 1870. 3, Quoted by Rath, Ber. nied. Ges., 8, 1879. 4, MacIvor, Ch. News, **55**, 215, 1887.

| | $P_2O_5$ | MgO | $(NH_4)_2O$ | $H_2O$ | FeO | MnO | |
|---|---|---|---|---|---|---|---|
| 1. Hamburg | 28·56 | 13·46 | 53·76 | | 3·06 | 1·12 | = 99·96 |
| 2. Skipton Caves | 28·81 | 16·57 | 54·49 | | 0·95 | *tr.* | = 100·82 |
| 3. " " | 28·45 | 16·27 | 10·74 | 44·28 | | — | = 99·74 |
| 4 " " | 28·82 | 16·07 | 10·57 | [43·57] | 0·81 | 0·16 | = 100 |

**Pyr., etc.**—In the closed tube gives off water and ammonia and becomes opaque. B.B. colors the flame green, and fuses easily to an enamel which, heated with cobalt solution, assumes a beautiful purple color. Soluble in acids.

**Obs.**—Found in guano from Saldanha Bay, coast of Africa, embedded in patches of crystals; also under an old church in Hamburg, where quantities of cattle-dung existed in the soil above a bed of peat which contained the crystals. Also similarly at Homburg v. d. H. (Kalkowsky[3]). In the bat guano of the Skipton Caves near Ballarat in Victoria.

Named after the Russian statesman, v. Struve.

**Artif.**—A not uncommon artificial product, cf. Haushofer, l. c. Well-developed crystals of struvite have been obtained by Robinson in tubes of nutrient gelatin and agar-sugar, in which various micro-organisms were being cultivated; see Cambr. Phil. Soc., May 20, 1889; also Solly, ref.[4] below. Formed also from Koch's "Fleischpepton," Arzruni, ref.[5].

**Ref.**—[1] Hamburg, Min Mitth., 113, 1877; the position of Sbk. is here taken.

[2] See Sbk., l. c., for early literature, etc. On struvite from the Skipton Caves near Ballarat, Victoria, see Ulrich, Contr. Min. Vict., 1870, and Rath, Ber. nied. Ges., 10, 1878. On artif. cryst., see Haushofer, Zs. Kr., **4**, 43, 1880, also Solly, Arzruni, below. [3] Kalkowsky, Zs. Kr., **11**, 1, 1885. [4] Solly, on artif. cryst., Min. Mag., **8**, 279, 1889; possible tetartohedrism is suggested, cf. Sbk. [5] Arzruni. artif. cryst., Zs. Kr., **18**, 60, 1890. [6] Propr. Opt., **2**, 30, 1859; N. R., 95, 1867.

GUANO MINERALS. C. U. Shepard, Rural Carolinian, **1**, 470, 1870. The substances described occur in the guano of Guañape Island, 400 miles north-east of the Chincha Islands.

*Guanapite* occurs in irregular balls and veins looking like red rock-salt but having a rhombic cleavage. H. = 1–2. G. = 2·3. Soluble in 4–5 pts. of water at 60°. Taste bitter and saline. Analysis gave: Potassium sulphate 67·75, ammonium sulphate 27·88, ammonium oxalate 3·75 = 99·38. It loses ammonia on exposure to the air. Heated to redness leaves a residue of about 70 p. c. of potassium sulphate. It is near taylorite (p. 895) in composition. *Guanoxalate* is stated to be a pseudomorph of birds' eggs; the specimens are exteriorly white, "and seem to retain portions of the original shell, but these when tested seemed to be a mixture of phosphate and oxalate of lime." Within the substance is foliated and has a rhombic cleavage. Color cream white; luster pearly; translucent. H. = 1–2. G. = 1·58. When heated swells up, turns black, partially fuses, gives off ammonia fumes, and leaves a white residue of potassium sulphate. Composition stated to be potassium sulphate 40·20, ammonium oxalate 29·57, water 30·46 = 100·23—a very doubtful compound. *Oxammite*, *phosphammite*, and *biphosphammite* are other names given by Shepard for supposed new species consisting of ammonium oxalate, ammonium phosphate, and ammonium biphosphate.

*Epiglaubite* and crystallized *Glaubapatite* of Shepard (Am. J. Sc., **22**, 98, 99, 1856). One or the other of these may be metabrushite or brushite. On glaubapatite see p. 769.

*Epiglaubite* is described as occurring in "small aggregates or interlaced masses of minute semi-transparent crystals of a shining vitreous luster, which are always implanted on druses of glaubapatite, with H. = about 2·5," and as being "a largely hydrate phosphate, chiefly of lime, and may also contain magnesia and soda." It is not impossible that the mineral is metabrushite, although some characters are inconsistent with such a conclusion. If so, the name *epiglaubite* (meaning occurring implanted on glaubapatite) is inapplicable, and should be rejected.

*Redondite.* A name given by C. U. Shepard to a hydrous phosphate of aluminium and iron from Redonda, W. I. Found in nodular aggregations Translucent to opaque. Color grayish to yellowish white. H. = 3·5. G. = 1·90–2·07. Specimen analyzed contained: $SiO_2$ 8·8, $P_2O_5$ 40·19, $H_2O$ 24·73, Am. J. Sc., **50**, 96, 1870. An earlier analysis gave: $P_2O_5$ 43·20, $Fe_2O_3$ 14·40, $Al_2O_3$ 16·60, $H_2O$ 24·00, $SiO_2$ 1·60, CaO 0·57 = 100·37, contained also traces of $SO_3$, Na, Cl, and MgO. B.B. infusible. Heated with solution of cobalt gives a deep blue color. Am. J. Sc., **47**, 428, 1869.

DITTMARITE, MÜLLERITE *MacIvor*, Ch. News, **55**, 215, 1887. Stated to be new species from the guano of the Skipton Caves near Ballarat, Victoria.

**586. COLLOPHANITE.** Kollophan *Sandberger*, Jb. Min., 308, 1870. Monite *C. U. Shepard*, Am. J. Sc., **23**, 402, 1882.

Amorphous. Collophanite appears in layers resembling gymnite or opal, with conchoidal fracture; monite in slightly coherent masses, with earthy fracture. H. = 2–2·5; G. = 2·7, collophanite; 2·1, monite. Luster dull. Colorless or snow-white, yellowish white.

**Comp.**—$Ca_3P_2O_8 + H_2O$ or $3CaO.P_2O_5.H_2O$ = Phosphorus pentoxide 43·3, lime 51·2, water 5·5 = 100.

**Anal.**—1, Köttnitz, quoted by Sandberger, l. c.; 1*a*, same, after deducting calcium carbonate. 2, C. U. Shepard, Jr., after deducting 4·64 p. c. gypsum.

| | | G. | $P_2O_5$ | CaO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. | Sombrero | 2·70 | 39·10 | 50·70 | 0·80 | 5·02[a] | $CO_2$ 3·96 = 99·58 |
| 1*a*. | " | | 43·16 | 50·00 | 0·88 | 5·54 | = 99·58 |
| 2. | Mona | 2·1 | 41·92 | 51·15 | — | 6·93 | = 100 |

[a] At 100°, 3·36 $H_2O$.

**Pyr., etc.**—Fuses with difficulty to a white enamel; gives off water in the closed tube; collophanite decrepitates violently B.B. Soluble in hydrochloric acid.

**Obs.**—Collophanite occurs on the island of Sombrero, having been formed in the elevated coral reef by infiltration of the salts from the overlying guano. Monite is found intimately associated with monetite, as also with gypsum and calcite, at the islands Mona and Moneta in the West Indies. Cf. monetite, p. 784.

*Collophanite* is named from *κόλλα, glue*, and *φαίνεσθαι*, to appear, in allusion to its colloidal aspect. *Monite* from the locality.

PYROPHOSPHORITE *C. U. Shepard, Jr.*, Am. J. Sc., **15**, 49, 1878.

Massive, earthy. H. = 3–3·5. G. = 2·50–2·53. Color snow-white, dull; also in part bluish gray, with small botryoidal structure. Analysis: Shepard after deducting impurities (about 2 p. c.):

$\frac{2}{2}$ $P_2O_5$ 51·67 CaO 45·16 MgO 3·17 = 100

The formula calculated is: $Mg_2P_2O_7 + 4(Ca_3P_2O_8 + Ca_2P_2O_7)$. Named in allusion to its apparent composition as a pyrophosphate; the nature of the material, however, makes its homogeneity seem very questionable. From the West Indies; exact locality not stated.

**587. HOPEITE.** *Brewster*, Trans. R. Soc. Edinb., **10**, 107, 1826 (1823). Prismatoidischer Zinkphyllit *Breith.*, Char., 38, 1832. Stilbite duovigésimale *Häuy*, cf. Dx., Bull. Soc. Min., **2**, 133, 1879.

Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c}$ = 0·5722 : 1 : 0·4717 Lévy[1].

100 ∧ 110 = 29° 46¾′, 001 ∧ 101 = 39° 30′, 001 ∧ 011 = 25° 15¼′.

**Forms:** *b* (010, *i*-$\breve{\imath}$) *x* (320, *i*-$\frac{\breve{3}}{2}$) *s* (120, *i*-$\breve{2}$) *e* (101, 1-$\bar{\imath}$)
*a* (100, *i*-$\bar{\imath}$) *c* (001, *O*) *m* (110, *I*) *u* (103, $\frac{1}{3}$-$\bar{\imath}$) *r* (111, 1)

*xx‴* = 41° 46′ *uu′* = 30° 44′ *ae* = *50° 30′ *rr′* = 73° 25′
*mm‴* = 59° 33′ *ee′* = 79° 0′ *cr* = 43° 31½ *rr‴* = *40° 0′
*ss′* = 82° 18′

Crystals minute, prismatic. Faces *b, s* striated vertically. Also in reniform masses, and amorphous.

Cleavage: *a* perfect; *b* less perfect. Fracture uneven. Brittle. H. = 2·5–3. G. = 2·76 Br.; 2·85 L. Luster vitreous; *a* somewhat pearly. Color grayish white; reddish brown when compact. Streak white. Transparent to translucent.

Optically –. Ax. pl. ∥ *c*. Bx ⊥ *b*. Dispersion $\rho < v$ weak. Ax. angles:

$2E_r$ = 78° 3′ glass $2E_y$ = 78° 35′ Na
$2H_{a.r}$ = 54° 47′ $2H_{a.y}$ = 54° 52′ also $2E_r$ = 84° 49½′ $2E_y$ = 85° 7′
$2H_{o.r}$ = 125° 52′ $2H_{o.y}$ = 125° 47′ ∴ $2V_r$ = 54° 39′ $2V_y$ = 54° 44′ $\beta_r$ = 1·469
$\beta_y$ = 1·471 Dx.

**Comp.**—Probably hydrous zinc phosphate, $Zn_3P_2O_8 + H_2O$ = Phosphorus pentoxide 35·2, zinc oxide 69·3, water 4·5 = 100.

The natural mineral has not been analyzed; the above is the composition of an artificial salt having the form (Dx., l. c.) of hopeite, Friedel and Sarasin, Bull. Soc. Min., **2**, 153, 1879.

**Pyr., etc.**—Dissolves without effervescence in hydrochloric or nitric acid. B.B. gives out water, and fuses with difficulty to a clear colorless globule, tingeing the flame green. With soda it affords a scoria which is yellow when hot, and gives out copious fumes of zinc and some of cadmium.

**Obs.**—Found in cavities in calamine at the zinc mines of Altenberg, near Aix-la-Chapelle. Named in honor of Prof. Hope of Edinburgh.

**Ref.**—[1] Ann. Mines, **4**, 517, 1843. Cf. also Haid., quoted by Brewster, l. c., and Dx., l. c.

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### 588. DICKINSONITE. *G. J. Brush* and *E. S. Dana*, Am. J. Sc., **16**, 114, 1878.

Monoclinic. Axes $\grave{a} : \overset{|}{b} : \grave{c} = 1{\cdot}73205 : 1 : 1{\cdot}19806$; $\beta = {}^{*}61° 30' = 001 \wedge 100$ E. S. Dana[1].

$100 \wedge 110 = 56° 41\frac{5}{6}'$, $001 \wedge 101 = 42° 13\frac{1}{6}'$, $001 \wedge 011 = 46° 28\frac{1}{2}'$.

**Forms:** *a* (100, *i-ī*), *c* (001, *O*); *x* (301, – 3-*ī*); *γ* (1̄03, ⅓-*ī*), *n* (051, 5-*ĭ*), *p* (1̄11, 1), *s* (2̄21, 2).

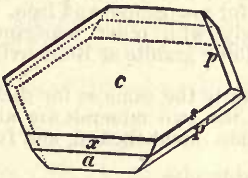
**Angles:** *cγ* = 12° 50′, *cx* = *42° 30′, *cn* = 79° 15′, *cp* = 61° 8½′, *cs* = 82° 2½′, *pp′* = 98° 40′, *ss′* = 118° 7′, Angle *a′cp* = *60°.

Crystals tabular, pseudo-rhombohedral; triangular striations on *c*. Commonly foliated to micaceous; also curved lamellar, radiated or stellated.

Cleavage: *c* perfect, separable into thin lamellæ. Fracture uneven. Brittle. H. = 3·5–4. G. = 3·338–3·343. Luster vitreous, on *c* somewhat pearly. Color olive- to oil-green, grass-green; slightly dichroic. Optically biaxial.

**Comp.**—$3R_3P_2O_8 + H_2O$ with R = Mn, Fe, $Na_2$ chiefly, also Ca, $K_2$, $Li_2$. The ratio for Mn : Fe(Ca) : $Na_2$ ($K_2$,$Li_2$) is closely 6 : 3 : 2, which requires: Phosphorus pentoxide 39·9, iron protoxide 16·5, manganese protoxide 32·6, soda 9·3, water 1·7 = 100.

1.



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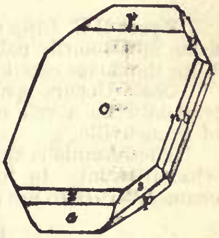


**Anal.**—1, 2, H. L. Wells, Am. J. Sc., **39**, 214, 1890, upon material of established purity.

| | | $P_2O_5$ | FeO | MnO | CaO | $Na_2O$ | $K_2O$ | $Li_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | G. = 3·143 | 39·57 | 13·25 | 31·58 | 2·15 | 7·46 | 1·52 | 0·17 | 1·65 | quartz 2·58 = 99·93 |
| 2. | | 40·89 | 12·96 | 31·83 | 2·09 | 7·37 | 1·80 | 0·22 | 1·63 | quartz 0·82 = 99·61 |

Earlier analyses, 3, 4, by Penfield (quoted by Brush and Dana, l. c.) were made on much less pure material, they show more lime and water and less alkalies.

3, after deduction of impurities, viz., 3·30 p. c. quartz and 6·89 p. c. eosphorite; 4, after deducting 1·89 p. c. quartz, 6·89 p. c. eosphorite.

| | $P_2O_5$ | FeO | MnO | CaO | $Li_2O$ | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 3. | 39·36 | 12·40 | 25·10 | 13·36 | 0·03 | 5·25 | 0·89 | 3·86 = 100·25 |
| 4. | 39·53 | 11·90 | 23·96 | [14·98] | 0·24 | 4·78 | 0·73 | 3·88 = 100 |

**Pyr., etc.**—In the closed tube gives water, the first portions of which are neutral, but the last portions react faintly acid; the residue is magnetic. Fuses in the naked lamp-flame, and B.B. in the forceps colors the flame at first green, then greenish yellow; reacts for iron and manganese with the fluxes. Soluble in acids.

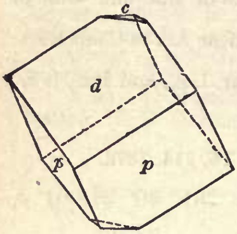
**Obs.**—Occurs at Branchville, Fairfield Co., Conn., intimately associated with eosphorite, triploidite, and other species in nests in a vein of albitic granite. Often disseminated in minute plates through massive eosphorite, giving it a green color; similarly embedded in lithiophilite. Named after Rev. Wm. Dickinson, formerly of Redding.

**Ref.**—[1] L. c., 1878. [2] Id., ibid., **39**, 213, 1890.

### 589. FILLOWITE. *G. J. Brush* and *E. S. Dana*, Am. J. Sc., **17**, 363, 1879.

Monoclinic. Axes $\breve{a} : \overset{|}{b} : \grave{c} = 1{\cdot}7303 : 1 : 1{\cdot}4190$; $\beta = 89° 50\frac{2}{3}' = 001 \wedge 100$ E. S. Dana.

$100 \wedge 110 = 59° 58\frac{1}{2}$, $001 \wedge \bar{1}01 = 39° 25'$, $001 \wedge 011 = 54° 49\frac{1}{2}'$.



**Forms:** *c* (001, *O*); *d* (201, – 2-$\bar{i}$), *p* ($\bar{1}11$, 1).

Angles: *cd* = *58° 31′, *cp* = *58° 40′, *pp′* = *95° 23′, *dp* = 95° $18\frac{1}{2}'$.

If *d* be made 100, the axial ratio becomes somewhat similar to that of dickinsonite, as shown below.

Habit pseudo-rhombohedral. In granular crystalline masses.

Cleavage: *c* nearly perfect. Fracture uneven. Brittle. H. = 4·5. G. = 3·43. Luster subresinous to greasy. Color wax-yellow, yellowish to reddish brown, colorless. Transparent to translucent. Optically biaxial, bisectrix ⊥ *c* approx.

**Comp.**—A hydrous phosphate of manganese, iron, calcium, and sodium, $3R_3P_2O_8 + H_2O$. If R = Mn : Fe(+Ca) : $Na_2$ = 6 : 2 : 1, this requires: Phosphorus pentoxide 39·6, iron protoxide 13·4, manganese protoxide 39·5, soda 5·8, water 1·7 = 100.

**Anal.**—1, Penfield, Am. J. Sc., **17**, 363, 1879. 2, H. L. Wells, ib., **39**, 215, 1890.

| | | $P_2O_5$ | FeO | MnO | CaO | $Na_2O$ | $Li_2O$ | $H_2O$ | quartz | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | $\frac{2}{3}$ | 39·10 | 9·33 | 39·42 | 4·08 | 5·74 | 0·06 | 1·66 | 0·88 | = | 100·27 |
| 2. | | 39·68 | 9·69 | 39·58 | 3·63 | 5·44 | 0·07 | 1·58 | 1·02 | = | 100·69 |

**Pyr.**—B.B. fuses at 1·5, with intumescence to a black feebly magnetic mass, coloring the flame momentarily pale green, then intensely yellow. In the closed tube a little neutral water. With the fluxes reactions for manganese and iron. Soluble in acids.

**Obs.**—Occurs sparingly with other manganesian phosphates, especially reddingite and triploidite, in a vein of albitic granite at Branchville, Conn. Named after Mr. A. N. Fillow, of Branchville.

The formula is apparently the same as for dickinsonite, but the ratio for the bases is somewhat different. In form the two minerals are also related, though widely diverse in physical characters. Both are pseudo-rhombohedral, and further we have:

| Dickinsonite. | Fillowite. |
|---|---|
| $001 \wedge 100 = 61° 30'$ | $001 \wedge 100 = 58° 31'$ |
| $001 \wedge \bar{1}11 = 61° 8'$ | $001 \wedge \bar{1}11 = 58° 40'$ |
| $001 \wedge \bar{1}\bar{1}1 = 61° 8'$ | $001 \wedge \bar{1}\bar{1}1 = 58° 40'$ |

Here *d* of fillowite is made 100, which gives the axial ratio, compared with that of dickinsonite:

| | | |
|---|---|---|
| Dickinsonite | $\grave{a} : \bar{b} : \acute{c}$ = 1·7320 : 1 : 1·1981 | $\beta$ = 61° 30′ |
| Fillowite | 1·7303 : 1 : 1·1093 | 58° 31′ |

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## Roselite Group. Triclinic.

**590. ROSELITE.** *Lévy*, Ann. Phil., 8, 439, 1824; Edinburgh J. Sc., **2**, 177, 1825.

Triclinic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·45360 : 1 : 0·65604; $\alpha$ = 90° 34′, $\beta$ = 91°, $\gamma$ = 89° 20′ Schrauf[1].

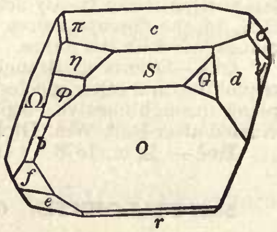
$100 \wedge 010 = 90° 39\frac{1}{2}'$, $100 \wedge 001 = 89° 0\frac{1}{2}'$, $010 \wedge 001 = 89° 26\frac{2}{3}'$.

**Forms**[1]:
*a* (100, $i$-$\bar{i}$)
*b* (010, $i$-$\breve{i}$)
*c* (001, *O*)
*n* (210, $i$-$\bar{2}'$)
*m* (110, *I′*)
*N* ($2\bar{1}0$, $'i$-$\bar{2}$)
*M* ($1\bar{1}0$, ′*I*)
*d* (401, ′4-$\bar{i}'$)

$\Delta$ ($\bar{4}01$, ′4-$\bar{i}'$)
*e* (023, $\frac{2}{3}$-$\breve{i}'$)
*h* (011, 1-$\breve{i}'$)
*f* (043, $\frac{4}{3}$-$\breve{i}'$)
*i* (021, 2-$\breve{i}'$)
*z* (083, $\frac{8}{3}$-$\breve{i}'$)
$\eta$ ($0\bar{2}3$, $'\frac{2}{3}$-$\breve{i}$)
$\chi$ ($0\bar{1}1$, ′1-$\breve{i}$)
$\phi$ ($0\bar{4}3$, $'\frac{4}{3}$-$\breve{i}$)

$\upsilon$ ($0\bar{2}1$, ′2-$\breve{i}$)
$\zeta$ ($0\bar{8}3$, $'\frac{8}{3}$-$\breve{i}$)
$\gamma$ (421, 4-$\bar{2}'$)
$\sigma$ (111, 1′)
$\omega$ (221, 2′)
$\lambda$ (343, $\frac{4}{3}$-$\frac{4}{3}'$)
*g* ($\bar{4}21$, ,4-$\bar{2}$)
*s* ($\bar{1}11$, ,1)
*o* ($\bar{2}21$, ,2)

*l* ($\bar{3}43$, ,$\frac{4}{3}$-$\frac{4}{3}$)
$\Gamma$ ($\bar{4}\bar{2}1$, 4-$\bar{2}$,)
$\Sigma$ ($\bar{1}\bar{1}1$, 1,)
$\Omega$ ($\bar{2}\bar{2}1$, 2,)
$\Lambda$ ($\bar{3}\bar{4}3$, $\frac{4}{3}$-$\frac{4}{3}$,)
*G* ($4\bar{2}1$, ′4-$\bar{2}$)
*S* ($1\bar{1}1$, ′1)
*O* ($2\bar{2}1$, ′2)
*L* ($3\bar{4}3$, $'\frac{4}{3}$-$\frac{4}{3}$)



After Schrauf.

Schrauf's lateral axes are exchanged in the above in order to bring out the close approximation to monoclinic symmetry.

$bm = 66° \ 9'$ $c\eta = 23° \ 43'$ $bo = 66° \ 0'$ $cS = 57° \ 26'$
$bM = 65° \ 3\frac{1}{2}'$ $e\eta = 47° \ 15'$ $b\Omega = 67° \ 22'$ $co = 73° \ 12\frac{1}{2}'$
$mM = 48° \ 47\frac{1}{2}'$ $b\sigma = 69° \ 53'$ $o\Omega = 46° \ 38'$ $cm = 88° \ 52'$
$cd = 79° \ 14'$ $b'S = 69° \ 30'$ $c\sigma = 56° \ 53'$ $cM = 89° \ 20'$
$ce = 23° \ 32'$ $\sigma S = 40° \ 37'$ $c\Omega = 73° \ 29\frac{1}{2}'$

Crystals small, often complex and, as explained by Schrauf, combined according to a number of twinning laws with embedded tw. lamellæ. Also in druses of crystals and in spherical aggregates.

Cleavage: macrodiagonal. H. = 3·5. G. = 3·5–3·6. Luster vitreous. Color light to dark rose-red. Transparent to translucent. Axes of elasticity sensibly parallel to crystallographic axes.

**Comp.**—$(Ca,Co,Mg)_3As_2O_8.2H_2O$ = Arsenic pentoxide 51·4, lime 28·1, cobalt protoxide 12·5, water 8·0 = 100 (Ca : Co = 3 : 1).

**Anal.**—Winkler, J. pr. Ch., **16**, 86, 1877.

| | | $As_2O_5$ | CoO | CaO | MgO | $H_2O$ |
|---|---|---|---|---|---|---|
| Daniel mine | G. = 3·56 | $\frac{2}{3}$ 52·67 | 10·29 | 25·05 | 4·10 | 8·29 = 100·40 |

Earlier analyses by Schrauf (on minute quantities), l. c., and Winkler (J. pr. Ch., **10**, **191**, 1874) gave somewhat different results. The crystals from the Rappold mine are darker in color and contain a little more cobalt with G. = 3·585; G. = 3·506 Daniel, Schrauf.

**Pyr.**—Heated to 100° becomes dark blue and splits up, but regains the red color on cooling. Fuses B.B. easily and on charcoal gives arsenical fumes; after roasting reacts for cobalt with the fluxes. Dissolves in acids.

**Obs.**—Early (1824) found at Schneeberg, Saxony, on quartz; later obtained from the same region at the Daniel and Rappold mines. Also reported from Schapbach, Baden.

Named after Gustav Rose (1798–1873).

**Ref.**—[1] Min. Mitth., 137, 1874; earlier but incomplete observations were made by Lévy and Haidinger, cf. Schrauf.

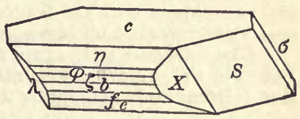
### 591. BRANDTITE. *A. E. Nordenskiöld*, Öfv. Ak. Stockh., **45**, 418, 1888.

Triclinic. In form near roselite.

**Forms**[1]:
$b$ (010, $i$-$\breve{\imath}$)
$c$ (001, $O$)
$e$ (023, $\frac{2}{3}$-$\breve{\imath}'$)
$f$ (043, $\frac{4}{3}$-$\breve{\imath}'$)
$\eta$ ($0\bar{2}3$, $'\frac{2}{3}$-$\breve{\imath}$)
$\phi$ ($0\bar{4}3$, $'\frac{4}{3}$-$\breve{\imath}$)
$\zeta$ ($0\bar{8}3$, $'\frac{8}{3}$-$\breve{\imath}$)
$\sigma$ (111, 1')
$\lambda$ (343, $\frac{4}{3}$-$\frac{4}{3}'$)
$S$ ($1\bar{1}1$, '1)
$X$ ($4\bar{3}3$, $'\frac{4}{3}$-$\frac{\bar{4}}{3}$)?

Approximate measured angles: $bc = 90° \ 35'$, $b\eta = 66° \ 55'$, $b\phi = 49° \ 46'$, $bf = 47° \ 2'$, $be = 65° \ 7'$, $bS = 69° \ 52'$.

In crystals, prismatic by development of the brachydomes, and with $c$ largely developed. Faces $c$ striated ‖ edge $c/\eta$. Twins common with $c$ as tw. pl. Crystals united in radiated groups and in rounded or reniform aggregates.



H. = 5–5·5. G. = 3·671–3·672. Luster vitreous. Colorless to white. Transparent to translucent.

**Comp.**—$Ca_2MnAs_2O_8 + 2H_2O$ or $2CaO.MnO.As_2O_5.2H_2O$ = Arsenic pentoxide 51·3, manganese protoxide 15·8, lime 24·9, water 8·0 = 100.

**Anal.**—G. Lindström, G. För. Förh., **13**, 123, 1891.

| $As_2O_5$ | $P_2O_5$ | MnO | PbO | FeO | CaO | MgO | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 50·48 | 0·05 | 14·03 | 0·96 | 0·05 | 25·07 | 0·90 | 8·09 Cl 0·04, insol. 0·04 = 99·71 |

**Pyr., etc.**—Fuses rather easily to a brown bead; in the closed tube gives off water without decrepitation; arsenical fumes on charcoal. Dissolves in hydrochloric and nitric acids.

**Obs.**—Found at the Harstig mine, near Pajsberg, Wermland, Sweden. Associated with barite, calcite, caryopilite, sarkinite, and also crystallized native lead.

Named after the Master of the Mint, Georg Brandt (d. 1768).

**Ref.**—[1] Nordenskiöld, quoted by Lindström, l. c.

**592. FAIRFIELDITE.** *G. J. Brush* and *E. S. Dana*, Am. J. Sc., **17**, 359, 1879. Leucomanganit *Sandberger*, Jb. Min., 370, 1879; **1**, 185, 1885.

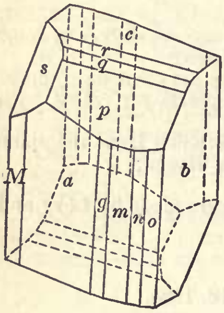
Triclinic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}2797 : 1 : 0{\cdot}1976$; $\alpha = 102^\circ\ 8\frac{2}{3}'$, $\beta = 94^\circ\ 33\frac{1}{3}'$, $\gamma = 77^\circ\ 19\frac{5}{6}'$ E. S. Dana.

$100 \wedge 010 = {*}102^\circ\ 0'$, $100 \wedge 001 = {*}88^\circ\ 0'$, $010 \wedge 001 = 78^\circ\ 33\frac{1}{3}'$.

**Forms:**
*a* (100, *i*-$\bar{i}$)
*b* (010, *i*-$\breve{i}$)
*c* (001, *O*)
*g* (320, *i*-$\frac{3}{2}$')
*m* (110, *I*')
*n* (230, *i*-$\frac{3}{2}$')
*o* (120, *i*-$\breve{2}$')
*M* (1$\bar{1}$0, '*I*)
*r* (113, $\frac{1}{3}$')
*q* (112, $\frac{1}{2}$')
*p* (111, 1')
*s* (1$\bar{4}$1, '4-$\breve{4}$

$ag = 10^\circ\ 57\frac{1}{3}'$ $aM = 14^\circ\ 45'$ $cm = 84^\circ\ 39'$ $bp = {*}78^\circ\ 30'$
$am = 16^\circ\ 31'$ $cr = 12^\circ\ 43'$ $ap = {*}56^\circ\ 30'$ $b's = 58^\circ\ 42\frac{1}{2}'$
$an = 24^\circ\ 40'$ $cq = 18^\circ\ 31'$ $as = 51^\circ\ 17'$ $ps = 42^\circ\ 47\frac{1}{2}'$
$ao = 32^\circ\ 20'$ $cp = {*}33^\circ\ 0'$

The relation in form between fairfieldite and roselite-brandtite is not clear; the fairfieldite measurements leave much to be desired.



In prismatic crystals with *a*, *b* largely developed. Usually in foliated to lamellar crystalline aggregates; occasionally curved, foliated, or fibrous; in radiating masses.

Cleavage: *b* highly perfect; *a* less so. Fracture uneven. Brittle. H. = 3·5. G. = 3·07–3·15. Color white or greenish white to pale straw yellow. Streak white. Luster pearly to sub-adamantine; on the surface of perfect cleavage (*b*) very brilliant, resembling selenite. Transparent.

The planes of light-vibration intersect *a* in lines making angles of 40° and 50° with the obtuse edge *a*/*b*; in the latter, an optic axis is visible toward the edge named. The planes intersect *b* in lines making angles of 10° and 80° with the edge *a*/*b*, the second axis visible in this plane.

**Comp.**—A hydrous phosphate of calcium and manganese, $Ca_2MnP_2O_8 + 2H_2O$ = Phosphorus pentoxide 39·4, manganese protoxide 19·6, lime 31·0, water 10·0=100. Iron replaces a little of the manganese.

**Anal.**—1, 2. S. L. Penfield, Am. J. Sc., **17**, 359, 1879; 1, clear transparent, filling cavities in reddingite; 2, massive, somewhat friable. 3, H. L. Wells, ib., **39**, 212, 1890.

| | G. | $P_2O_5$ | MnO | FeO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ | quartz | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | | 38·39 | 15·55 | 5·62 | 28·85 | 0·73 | 0·13 | 9·98 | 1·31 | = | 100·56 |
| 2. | | 39·62 | 12·40 | 7·00 | 30·76 | 0·30 | — | 9·67 | 0·55 | = | 100·30 |
| 3. | 3·07 | 37·69 | 17·40 | 3·42 | 30·02 | — | — | 9·81 | 1·66 | = | 100 |

**Pyr., etc.**—B B. glows, blackens, and fuses at 4·15 to a dark yellowish brown mass, coloring the flame pale green. with faint reddish yellow streaks on the upper edge. Reactions for iron and manganese with the fluxes. In the closed tube gives off neutral water; turns first yellow, then dark brown, and becomes magnetic. Soluble in acids.

**Obs.**—Occurs with other manganesian phosphates in a vein of albitic granite at Branchville, Fairfield Co., Conn. Also at Rabenstein, near Zwiesel, Bavaria (*leucomanganite*). In composition fairfieldite is analogous to roselite and more closely to brandtite.

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**593. MESSELITE.** *W. Muthmann*, Zs. Kr., **17**, 93, 1889.

Triclinic. In indistinct minute tabular crystals, with *am* = 42°–43°; often in stellate aggregates.

H. = 3–3·5. Colorless to brownish. Transparent to translucent. Extinction on *a* inclined 20° to the edge *a*/*m*; an optic axis visible through *a*.

**Comp.**—$(Ca,Fe)_3P_2O_8 + 2\frac{1}{2}H_2O$ = Phosphorus pentoxide 38·3, iron protoxide 19·4, lime 30·2, water 12·1 = 100. Here Ca : Fe = 2 : 1. With $2H_2O$ the composition would correspond to brandtite and fairfieldite.

**Anal.**—Muthmann. l. c.

| $P_2O_5$ | FeO | MnO | CaO | MgO | $H_2O$ |
|---|---|---|---|---|---|
| 37·72 | 15·63 | *tr.* | 31·11 | 1·45 | 12·15 insol. 1·40 = 99·46 |

Gives off water when heated and becomes dark brown to black.

**Obs.**—Found near Messel in Hesse, in a coal mine; the crystals occur in a bituminous clay slate.

**594. REDDINGITE.** *G. J. Brush* and *E. S. Dana*, Am. J. Sc., **16**, 120, 1878; ib., **17**, 365, 1879.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·8678 : 1 : 0·9486$ E. S. Dana[1].

$100 \wedge 110 = 40° 57'$, $001 \wedge 101 = 47° 32\frac{5}{6}'$, $001 \wedge 011 = 43° 29\frac{1}{3}'$.

**Forms:** *b* (010, *i*-$\breve{i}$), *r* (112, $\frac{1}{2}$)[2], *s* (223, $\frac{2}{3}$)[2], *p* (111, 1), *t* (221, 2)[2], *q* (212, 1-$\bar{2}$).

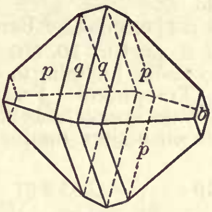
| | | | |
|---|---|---|---|
| $rr' = 52° 34'$ | $ss''' = 54° 8\frac{1}{2}'$ | $tt'' = 141° 53'$ | $bp = 57° 22'$ |
| $rr'' = 71° 47'$ | $pp' = {}^*76° 50'$ | $tt''' = 76° 33\frac{1}{2}'$ | $bq = 72° 15'$ |
| $rr''' = 45° 12'$ | $pp'' = {}^*110° 43'$ | $qq' = 89° 17'$ | $ps = 11° 23'$ |
| $ss' = 63° 15\frac{1}{2}'$ | $pp''' = 65° 16'$ | $qq'' = 99° 59'$ | $pr = 19° 28'$ |
| $ss'' = 87° 57'$ | $tt' = 91° 6'$ | $qq''' = 35° 30'$ | $pt = 15° 35'$ |

Homœomorphous with scorodite and strengite.

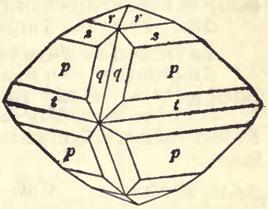
Habit octahedral; crystals often in parallel groupings. Also granular massive.

Cleavage distinct in one direction. Fracture uneven. Brittle. H. = 3–3·5. G. = 3·102. Luster vitreous to subresinous. Color pinkish white or pale rose-pink to yellowish white, surface sometimes dark reddish brown from alteration. Translucent to transparent.

1.



2.



**Comp.**—Hydrous phosphate of manganese, $Mn_3P_2O_8 + 3H_2O$ = Phosphorus pentoxide 34·7, manganese protoxide 52·1, water 13·2 = 100. Iron replaces part of the manganese; in anal. 3, Mn : Fe = 2 : 1.

**Anal.**—1, 2, H. L. Wells, quoted by Brush and Dana; 1, after deducting 12·08 p. c. quartz; 2, after deducting 4·42 p. c. quartz. 3, Id., ib., **39**, 212, 1890.

| | $P_2O_5$ | FeO | MnO | CaO | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. | 34·52 | 5·43 | 46·29 | 0·78 | 0·31 | 13·08 | = 100·41 |
| 2. | 35·16 | 7·89 | 43·22 | 0·71 | — | 12·27 | = 99·25 |
| 3. | 34·90 | 17·13 | 34·51 | 0·63 | — | 13·18 | quartz 0·13 = 104·48 |

**Pyr., etc.**—In the closed tube, first whitens, then turns yellow, and finally brown, but does not become magnetic. Fuses in the naked lamp-flame. B.B. colors the flame pale green, and fuses easily to a blackish brown non-magnetic globule. Reacts for manganese and iron with the fluxes. Soluble in acids.

**Obs.**—Occurs sparingly at Branchville, Fairfield Co., Conn., intimately associated with fillowite, fairfieldite, dickinsonite, in a vein of albitic granite. Black octahedral crystals, pseudomorphs after reddingite, are also found. Named from Redding, the name of the town in which the locality is situated.

In crystalline form, reddingite is closely related to scorodite and strengite, but differs from them in composition, containing but three equivalents of water, and having the metals in the protoxide state.

**Ref.**—[1] L. c., 1878. [2] Id., Am. J. Sc., **39**, 211, 1890; the symbols for *r* and *t* are given incorrectly.

**595. PICROPHARMACOLITE.** *Stromeyer*, Gilb. Ann., **61**, 185, 1819.

In aggregates of small spherical, botryoidal forms with radiating foliated structure. Luster feeble pearly. Color white. Opaque.

**Comp.**—$R_3As_2O_8 + 6H_2O$, with R = Ca : Mg = 5 : 1; this requires: Arsenic pentoxide 46·2, lime 28·1, magnesia 4·0, water 21·7 = 100.

**Anal.**—1, Stromeyer, l. c. 2, Frenzel, Jb. Min., 786, 1873. 3-5, Genth, Am. J. Sc., **40**, 204, 1890. The material of anal. 5 was dried over $H_2SO_4$ one month.

| | G. | $As_2O_5$ | CaO | MgO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|
| 1. Riechelsdorf | | 46·97 | 24·65 | 3·22 | 23·98 | CoO 1·00 | = 99·82 |
| 2. Freiberg | | 46·93 | 25·77 | 3·73 | 24·01[a] | | = 100·44 |
| 3. Joplin | 2·583 | $\frac{2}{3}$ 47·60 | 22·42 | 6·64 | 23·11[b] | | = 99·77 |
| 4. " | | 47·74 | 19·64 | 8·41 | 24·58 | | = |
| 5. " | | 50·56 | 17·09 | 11·54 | 20·35 | | = |

[a] At 100° loss 13 p. c. [b] Do. 11·6.

**Obs.**—From Riechelsdorf aud from Freiberg. At Joplin, Mo.
The name alludes to the magnesia present, from πικρός, *bitter*.

**596. TRICHALCITE.** Trichalcit *Herm.*, J. pr. Ch., **73**, 212, 1858.

In radiated groups, columnar; also in dendritic forms.

H. = 2·5. Luster silky. Color verdigris-green.

**Comp.**—$Cu_3As_2O_8 + 5H_2O$ = Arsenic pentoxide 41·3, cupric oxide 42·6, water 16·1 = 100.

**Anal.**—Hermann, l. c.

| $As_2O_5$ | $P_2O_5$ | CuO | $H_2O$ | |
|---|---|---|---|---|
| 38·73 | 0·67 | 44·19 | 16·41 | = 100 |

**Pyr., etc.**—Heated decrepitates, yields much water, and becomes dark brown. B.B. on charcoal fuses in the outer flame to a pearl, and in the inner yields a bead of copper. Dissolves easily in cold hydrochloric acid.

**Obs.**—From the Turginsk copper mine, or Berezov, on tetrahedrite. Resembles tyrolite.

LAVENDULAN *Breithaupt*, J. pr. Ch., **10**, 505, 1837. Lavendulite.

Amorphous, with a greasy luster, inclining to vitreous. H. = 2·5–3. G. = 3·014 Br. Color lavender-blue. Streak paler. Translucent. Fracture conchoidal.

Contains, according to Plattner, arsenic, cobalt, nickel, and copper. Goldsmith (Proc. Acad. Philad., 192, 1877) obtained on an impure sample from Chili, after deducting impurities (11·6 insol.):

| $As_2O_5$ | CuO | CoO | NiO | $H_2O$ | |
|---|---|---|---|---|---|
| 46·89 | 40·10 | 2·51 | 1·35 | 9·13 | = 99·98 |

The formula arrived at is $R_3As_2O_8.3H_2O$, but the material was too impure to make the conclusion very definite. B.B. fuses easily. Soluble in warm hydrochloric acid.

Occurs with cobalt and other ores at Annaberg, Saxony, as the result of their alteration. Similarly with cobalt ores from Chili.

CHLOROTILE. Chlorotil *Frenzel*, Min. Mitth., 42, 1875; Jb. Min., 517, 1875.

In minute capillary crystals of prismatic habit (orthorhombic), also fibrous and massive; soft. Color in the mass pale green to emerald-green, microscopic crystals colorless. Transparent. Composition asserted to be $Cu_3As_2O_8 + 6H_2O$ = Arsenic pentoxide 39·9, cupric oxide 41·3, water 18·8 = 100. An approximate analysis gave: $As_2O_5$ 41, CuO 41, $H_2O$ 18 = 100. Occurs with aragonite and wapplerite, at Schneeberg, and with quartz and scheelite at Zinnwald.

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## **Vivianite Group.** Monoclinic.

**597. VIVIANITE.** Bloa Järnjord, Naturligit Berlinerblätt, Calx Martis phlogisto juncta, etc., *Cronst.*, 182, 1758. Cæruleum Berolinense nativum *Born.*, Lithoph., **1**, 136, 1772. Ocre martiale bleue, Bleu de Prusse natif, *de Lisle*, **3**, 295, 1783. Natürliche Berlinerblau, Phosphorsaurer Eisen, *Klapr.*, Crell's Ann., **1**, 390, 1784. Eisenblau, Blaueisenerde, *Germ.* Vivianit (fr. Cornwall) *Wern.*, Letztes Min. Syst., 41, 1817; Breith., Hoffm. Min., **4** b, 146, 1817. Phosphate of Iron, Blue Iron Earth. Fer phosphaté, Fer azuré, *Fr.* Eisenglimmer *Mohs*, Min., 212, 1824. Eisen-Phyllit *Breith.*, Char., 26, 1823. Glaukosiderit *Glocker*, Handb., 857, 1831. Mullicite *Thoms.*, Min., **1**, 452, 1836. Anglarite *Berthier*, Ann. Mines, **12**, 303, 1837.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 0·74975 : 1 : 0·70153$; $\beta = 75° 34\frac{1}{4}' = 001 \wedge 100$ Rath[1].

$100 \wedge 110 = 35° 59'$, $001 \wedge \bar{1}01 = 49° 45\frac{2}{3}'$, $001 \wedge 011 = 34° 11\frac{1}{2}'$.

**Forms**[2]:
$a$ (100, $i$-$\bar{i}$)
$b$ (010, $i$-$\grave{i}$)
$c$ (001, $O$)
$y$ (310, $i$-$\bar{3}$)
$m$ (110, $I$)
$l$ (109, $-\frac{1}{9}$-$\bar{i}$)[4]
$k$ (102, $-\frac{1}{2}$-$\bar{i}$)[4]
$n$ (101, $-$ 1-$\bar{i}$)
$d$ (401, $-$ 4-$\bar{i}$)[4]
$o$ ($\bar{1}$03, $\frac{1}{3}$ $\bar{i}$)[4]
$w$ ($\bar{1}$01. 1-$\bar{i}$)
$t$ ($\bar{2}$01, 2-$\bar{i}$)
$\epsilon$ ($\bar{7}$04, $\frac{7}{4}$-$\bar{i}$)[4]
$\delta$ ($\bar{4}$01, 4-$\bar{i}$)
$g$ (012, $\frac{1}{2}$-$\grave{i}$)[3]
$f$ (023, $\frac{2}{3}$-$\grave{i}$)[4]
$e$ (011, 1-$\grave{i}$)
$z$ (112, $-\frac{1}{2}$)
$x$ (111, $-$ 1)
$r$ ($\bar{1}$12, $\frac{1}{2}$)
$v$ ($\bar{1}$11, 1)
$\phi$ (3·5·14, $-\frac{5}{14}$-$\frac{5}{3}$)[4]
$\psi$ ($\bar{8}$36, $\frac{4}{8}$-$\frac{\grave{8}}{3}$)[4]
$\omega$ ($\bar{8}$33, $\frac{8}{3}$-$\frac{\grave{8}}{3}$)[4]
$q$ ($\bar{1}$32, $\frac{3}{2}$-$\grave{3}$)[3]
$s$ ($\bar{1}$31, 3-$\grave{3}$)[3]

$yy''' = 27^\circ\ 13'$
$mm''' = {}^*71^\circ\ 58'$
$ak = 53^\circ\ 29'$
$an = 39^\circ\ 16'$
$ad = 13^\circ\ 38'$
$a'o = 86^\circ\ 18'$
$a'w = 54^\circ\ 40'$

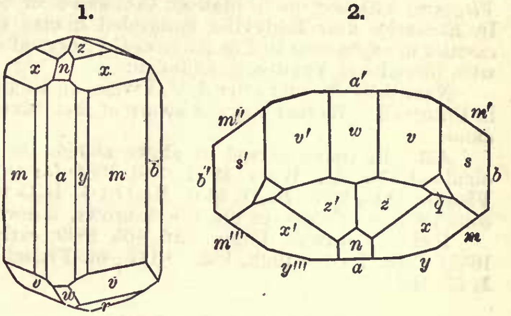
$a't = 30^\circ\ 50'$
$a'\delta = 15^\circ\ 30'$
$gg' = 37^\circ\ 31\tfrac{1}{2}'$
$ff' = 48^\circ\ 44'$
$ee' = 68^\circ\ 23'$
$mc = 78^\circ\ 22'$
$mz = 51^\circ\ 28'$

$mx = 35^\circ\ 48'$
$m'r = 68^\circ\ 58'$
$m'v = {}^*45^\circ\ 44'$
$az = 55^\circ\ 3'$
$ag = 76^\circ\ 21'$
$ax = 44^\circ\ 57'$
$ae = 78^\circ\ 6'$

$a'r = 77^\circ\ 58'$
$a'v = 59^\circ\ 52'$
$zz' = 31^\circ\ 28'$
$xx' = 47^\circ\ 53'$
$rr' = 37^\circ\ 47'$
$vv' = {}^*59^\circ\ 34'$

Crystals prismatic, sometimes flattened ‖ *a*; prismatic faces vertically striated. Crystals often in stellate groups. Often reniform and globular. Structure divergent, fibrous, or earthy; also incrusting.

Cleavage: *b* highly perfect; *a* in traces; also fracture$^s$ fibrous nearly $\perp \dot{c}$. Flexible in thin laminæ; sectile. H. = 1·5–2. G. = 2·58–2·68. Luster, *b* pearly or metallic pearly; other faces vitreous. Colorless when unaltered, blue to green, deepening on exposure. Streak colorless to bluish white, soon changing to indigo-blue; color of the dry powder often liver-brown. Transparent to translucent; becoming opaque on exposure. Pleochroism strong.



Figs. 1, 2, Cornwall, Rath.

Optically +. Ax. pl. and $Bx_o \perp b$. $Bx_{a.r} \wedge \dot{c} = 61^\circ\ 22'$. $Bx_{a.y} \wedge \dot{c} = 61^\circ\ 28'$. $Bx_{a.bl} \wedge \dot{c} = 61^\circ\ 36'$. Dispersion $\rho < v$ small, also horizontal inconsiderable. Axial angles, Dx.

$2H_{a.r} = 80^\circ\ 26'$ $\therefore\ 2E_r = 142^\circ\ 22'$ $2H_{o.r} = 121^\circ\ 19'$ $\therefore\ 2V_r = 73^\circ\ 4'$ $\beta_r = 1{\cdot}590$
$2H_{a.y} = 80^\circ\ 33'$ $\therefore\ 2E_y = 143^\circ\ 14'$ $2H_{o.y} = 121^\circ\ 10'$ $\therefore\ 2V_y = 73^\circ\ 10'$ $\beta_y = 1{\cdot}592$
$2H_{a.v} = 80^\circ\ 54'$ $\therefore\ 2E_v = 146^\circ\ 46'$ $2H_{o.v} = 120^\circ\ 52'$ $\therefore\ 2V_v = 73^\circ\ 26'$ $\beta_v = 1{\cdot}604$

**Comp.**—Hydrous ferrous phosphate, $Fe_3P_2O_8 + 8H_2O$ = Phosphorus pentoxide 28·3, iron protoxide 43·0, water 28·7 = 100.

Many analyses show the presence of iron sesquioxide due to alteration; see 5th Ed., p. 557.

Colorless crystals from Delaware gave Fisher (Am. J. Sc., 9, 84, 1850): $P_2O_5$ 27·17, FeO 44·10, $H_2O$ 27·95, $SiO_2$ 0·10 = 99·32.

Pale bluish green crystals from Cornwall (measured by Rath, above) gave Flight 1·13 $Fe_2O_3$; a dark blue variety contained 9·17 $Fe_2O_3$ and dark brown crystals 5·08 $Fe_2O_3$, Ch. News, **22**, 260, 1870.

A peculiar variety of vivianite has been described by W. L. Dudley (Am. J. Sc., **40**, 120, 1890) forming "blue roots" embedded in clay some two feet below the water surface near Eddyville, Ky. The roots were from ½ to 2 cm. thick and 6 to 12 in length, and the woody fiber had been nearly replaced by the vivianite. An analysis of material purified by washing and decantation and dried for twelve hours over sulphuric acid gave:

| $P_2O_5$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | CaO | MgO | $H_2O$(243°) | $H_2O$(100°) | insol. |
|---|---|---|---|---|---|---|---|---|
| 27·71 | 17·74 | 9·35 | 24·58 | 0·59 | 0·43 | 7·24 | 10·59 | 1·84 = 100·07 |

**Pyr., etc.**—In the closed tube yields neutral water, whitens, and exfoliates. B.B. fuses at 1·5, coloring the flame bluish green, to a grayish black magnetic globule. With the fluxes reacts for iron. Soluble in hydrochloric acid.

**Obs.**—Occurs associated with pyrrhotite and pyrite in copper and tin veins; sometimes in narrow veins with gold, traversing gray-wacke; both friable and crystallized in beds of clay, and sometimes associated with limonite, or bog iron ore; often in cavities of fossils or buried bones.

At St. Agnes in Cornwall transparent indigo crystals have been found, 1 inch in diameter and 2 in. long, in pyrrhotite; at Wheal Falmouth, and near St. Just; in Devonshire, near Tavistock; at Bodenmais and the gold mines of Verespatak in Transylvania, in crystals; on the promontory of Kerch in the Black Sea, in large indistinct crystals in the interior of shells. The earthy variety, sometimes called *blue-iron earth* or *native Prussian blue* (*Fer azuré*), occurs in Greenland, Syria, Carinthia, Cornwall, etc. The friable varieties in bog iron ore in several peat swamps in the Shetland Isles, at Ballagh in the Isle of Man, accompanying sometimes the horns of the elk and deer, and near an old slaughter-house in Edinburgh. At Cransac, France, in crystals formed after the burning of a coal mine; at Anglar, a massive form (*anglarite*).

In N. America, it occurs in *N. York*, at Harlem, in crystals accompanying stilbite and feldspar in fissures in gneiss In *New Jersey*, at Imleytown, in dark blue crystals; at Allentown, Monmouth Co., in considerable abundance, both crystallized, in nodules, and earthy, embedded in bog iron ore, and associated with clays; at Mullica Hill, Gloucester Co. (*mullicite*), in cylindrical masses, consisting of divergent fibers or acicular crystals; at Franklin, occasionally; it often fills the interior of belemnites and other fossils in the ferruginous sand formation. Also in *Delaware*, 4 m. W. of Cantwell's Bridge, and near Middletown, in the Green Sand, in fine large crystals which are colorless when first obtained, containing only iron protoxide; near Cape Henlopen, in Sussex Co. In *Maryland*, in the north part of Somerset and Worcester Cos. In *Virginia*, with bog ore in Stafford Co., and 8 or 10 m. from Falmouth, with gold and galena. In *Kentucky*, near Eddyville, embedded in clay (cf. above). In *California*, an earthy form in cavities in asphaltum in Los Angeles Co.; crystallized at Camptonville, Yuba Co. In *Canada*, with limonite at Vaudreuil, abundant.

Named by Werner after J. G. Vivian, an English mineralogist who discovered the specimens in Cornwall. Werner was not aware of their identity with the *Blaueisenerde* when he gave the name.

**Alt.**—Becomes altered, as above stated, through the oxidation of the iron. Tschermak obtained (Ber. Ak. Wien, **49** (1), 340, 1864) for an altered vivianite in crystals from a cabinet in Vienna: $P_2O_5$ 30·5, $Fe_2O_3$ 55·0, $Na_2O$ 1·5, $H_2O$ 14·0 = 101. G. = 2·95; luster metallic-pearly; color on face of cleavage pinchbeck-brown, elsewhere blackish brown; streak ocher-yellow.

**Ref.**—[1] Cornwall, Pogg., **136**, 405, 1869; earlier angles are incorrect. [2] Mlr., Min., p. 500, 1852; Rath, l. c. [3] Rath, l. c. [4] Dx., on French crystals, N. R., 184, 1867. [5] Mgg., Jb. Min., **1**, 53, 1884.

### 598. SYMPLESITE. *Breithaupt*, J. pr. Ch., **10**, 501, 1837.

Monoclinic. Axes $\grave{a} : \overset{\shortmid}{\bar{b}} : \grave{c} = 0·7806 : 1 : 0·6812$; $\beta = 72° 43' = 001 \wedge 100$ Krenner[1].

$100 \wedge 110 = 36° 42'$, $001 \wedge 101 = 33° 29\frac{1}{2}$, $001 \wedge 011 = 33° 2\frac{1}{2}'$.

**Forms**[1]: *a* (100, *i*-ī), *b* (010, *i*-ì), *c* (001, O); *m* (110, *I*); *r* (013, $\frac{1}{3}$-ì).

Angles: $mm''' = {}^*73° 24'$, $rr' = 24° 28'$, $br = {}^*77° 46'$, $mr = {}^*68° 56'$.

In small prismatic crystals sometimes tabular ‖ *b*; faces *m* vertically striated; in radiated spherical aggregates.

Cleavage: *b* perfect. Fracture uneven. Brittle. H. = 2·5 nearly. G. = 2·957. Luster of cleavage-face pearly; elsewhere vitreous. Color pale indigo, inclined to celandine-green; sometimes between leek- and mountain-green. Streak bluish white. Subtransparent to translucent.

Pleochroic: $\mathfrak{c}$ yellowish green to oil-green, ‖ $\mathfrak{b}$ colorless to greenish yellow, $\mathfrak{a}$ bluish green to blue. Optically −. Ax. pl. ⊥ *b* and inclined to $\grave{c} + 31° 48'$. $Bx_a \perp b$. $2H_{a.y} = 107° 28'$.

**Comp.**—Hydrous arsenate of iron, probably $Fe_3As_2O_8 + 8H_2O$ = Arsenic pentoxide 39·0, iron protoxide 36·6, water 24·4 = 100. The analysis gives $9H_2O$, which requires: Arsenic pentoxide 37·8, iron protoxide 35·5, water 26·7 = 100.

**Anal.**—Boricky, Vh. Min. Ges., **3**, 98, 1868, deducting 7·7 p. c. quartz.

| | | $As_2O_5$ | FeO | $H_2O$ | |
|---|---|---|---|---|---|
| Hüttenberg | G. = 2·964 | 37·84 | 34·73 | 27·43 | = 100 |

**Pyr., etc.**—In the closed tube yields much water; at a high temperature some arsenous acid sublimes, imparting an acid reaction to the water, and giving a black magnetic residue. B.B. in the forceps infusible, but colors the outer flame light blue (arsenic), and becomes black and magnetic. On charcoal gives a strong arsenical odor. With the fluxes reacts for iron, and gives also traces of manganese and sulphuric acid (Plattner).

**Obs.**—Occurs at Lobenstein in Voigtland, with siderite; at Hüttenberg, Carinthia; sparingly with pharmacosiderite at Pisek, Bohemia (Vrba). Also with quartz in cavities in hornstone at Felsöbánya.

Named from σύν and πλησιάζειν, *to bring together*, in allusion to its relation to other minerals.

**Ref.**—[1] [Term. Füz., 10, 83, 108, 1886] Zs. Kr., 13, 70; Jb. Min., 1, 462, ref., 1887.

**599. BOBIERRITE.** Phosphate de Magnésie tribasique et hydraté *Bobierre*, Les Mondes, 691, April 1868. Bobierrite *Dana*, Min., 595, 1868.

Monoclinic; in minute six-sided prismatic crystals, with *a* (100), *b* (010), *m* (110) and a terminal plane *c* (001)? inclined 77° to *a*. Forms crystalline agglomerations, looking like white spots in the guano in which it is embedded. Also massive.

Cleavage: clinodiagonal. Colorless to white. Optically +. Ax. pl. $\perp$ *b*. $Bx_a$ inclined 34° to *a*. $2E = 125°$ approx. Dispersion $\rho < v$ weak, Lcx.

**Comp.**—Hydrous magnesium phosphate, $Mg_3P_2O_8 + 8H_2O$ = Phosphorus pentoxide 29·5, magnesia 35·0, water 35·5 = 100.

**Anal.**—A. Lacroix, C. R., **106**, 631, 1888.

$P_2O_5$ 29·97 MgO 34·59 $H_2O$ 35·38 = 99·94

Insoluble in water, but easily soluble in acids without effervescence.

**Obs.**—From the guano of Mexillones, on the Chilian coast.

**600. HŒRNESITE.** Hörnesit *Haid.*, Vh. G. Reichs., 41, 1860; Ber. Ak. Wien, **40**, 18, 1860.

Monoclinic. In crystals resembling gypsum in habit, giving the angles: $mm''' = 73°$, $zz'(?) = 28°$ (cf. vivianite, p. 814). Also columnar; stellar-foliated.

Cleavage: clinodiagonal, perfect. H. = 1. G. = 2·474. Luster of cleavage pearly. Color snow-white. Folia transparent, flexible.

**Comp.**—Hydrous magnesium arsenate, $Mg_3As_2O_8 + 8H_2O$ = Arsenic pentoxide 46·6, magnesia 24·3, water 29·1 = 100.

**Anal.**—Hauer, quoted by Haidinger, l. c.

$As_2O_5$ 46·33 MgO 24·54 $H_2O$ 29·07 = 99·94

**Pyr., etc.**—In a glass tube gives much water. B.B. fuses easily, and on charcoal affords the odor of arsenic. Insoluble in water and easily soluble in acids.

**Obs.**—First distinguished by Kenngott in minerals from the Banat, Hungary (vicinity either of Cziklowa or Orawitza), in the Imperial Mineral Cabinet at Vienna. Occurs in a coarsely granular calcite, containing also some garnets.

Named after Dr. Hörnes, of the Imperial Cabinet.

**601. ERYTHRITE.** Kobold-Blüthe *Brückmann*, Magnalia, 161, etc., 1727. Kobolt Blomma, Flos Cobalti [the cryst.], Koboltbeslag [impure earthy], Cobalti minera colore rubro, etc., *Wall.*, Min., 234, 1747. Koboltblüte, Koboltbeschlag, Ochra Cobalti rubra, *Cronstedt*, 212, 1758. Kobaltblüthe *Germ.* Cobalt Bloom, Red Cobalt, Cobalt Ocher. Cobaltum acido arsenico mineralisatum *Bergmann*, Sciagr., 134, 1782, Opusc., **2**, 446, 1780 (first anal.). Arsenate of Cobalt. Cobalt arseniaté *Fr.* Erythrine *Beud.*, Min., **2**, 596, 1832. Rhodoise *Huot*, **1**, 313, 1841.

Monoclinic. Axes $\grave{a} : \overset{|}{b} : \grave{c} = 0·75 : 1 : 0·70$; $\beta = 75°$ approx., Brezina.[1]

**Forms**[2]: *a* (100, *i-ī*), *b* (010, *i-ì*); *m* (110, *I*), *w* ($\bar{1}01$, 1-*ī*); *r* ($\bar{1}12$, $\frac{1}{2}$), *v* ($\bar{1}11$, 1).

Angles nearly as with vivianite, measured: $m'v = 45°\ 48'$, $vw = 29°\ 43'$, $rr' = 34°\ 12'$.

Crystals prismatic and vertically striated. Also in globular and reniform shapes, having a drusy surface and a columnar structure; sometimes stellate. Also pulverulent and earthy, incrusting.

Cleavage: *b* highly perfect; *a*, *w* indistinct. Thin laminæ flexible[3] in a direction $\perp$ *b* and nearly $\perp$ *ċ*. Sectile. H. = 1·5–2·5; least on *b*. G. = 2·948. Luster of *b* pearly; other faces adamantine, inclining to vitreous; also dull and earthy. Color crimson- and peach-red, sometimes pearl-gray or greenish gray; red tints incline to blue $\perp$ *b*. Streak a little paler than the color; the dry powder deep lavender-blue. Transparent to subtranslucent.

Optically −. Ax. pl. and $Bx_a \perp b$. Axial angles, Dx.[3]:

$2H_r = 104°\ 41'$ $2H_y = 104°\ 31'$ $2H_{bl} = 102°\ 20'$

**Var.**—1. Crystallized and foliated. 2. Earthy. The latter is the *earthy cobalt bloom* (Kobaltbeschlag *Germ.*, Rhodoise *Huot.*).

**Comp.**—Hydrous cobalt arsenate, $Co_3As_2O_8 + 8H_2O$ = Arsenic pentoxide 38·4, cobalt protoxide 37·5, water 24·1 = 100. The cobalt is sometimes replaced by nickel, iron, and calcium.

**Anal.**—1–3, Kersten, Pogg., **60**, 251, 1843. 4, Lindaker, Vogl's Joach., 1857. 5, Petersen, Pogg., **134**, 86, 1868.

| | $As_2O_5$ | CoO | NiO | FeO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. Schneeberg | 38·43 | 36·52 | *tr.* | 1·01 | — | 24·10 | = 100·06 |
| 2. " G. = 2·912 | 38·30 | 33·42 | — | 4·01 | — | 24·08 | = 99·81 |
| 3. " | 38·10 | 29·19 | — | — | 8·00 | 23·90 | = 99·19 |
| 4. Joachimsthal | 36·42 | 23·75 | 11·26 | 3·51 | 0·42 | 23·52 | $SO_3$ 0·86 = 99·74 |
| 5. Wittichen | 38·10 | 30·36 | 3·71 | 3·04 | *tr.* | 24·79 | = 100 |

**Pyr., etc.**—In the closed tube yields water at a gentle heat and turns bluish; at a higher heat gives off arsenic trioxide, which condenses in crystals on the cool glass, and the residue has a dark gray or black color. B.B. in the forceps fuses at 2 to a gray bead, and colors the flame light blue (arsenic). B.B. on charcoal gives an arsenical odor, and fuses to a dark gray arsenide, which with borax gives the deep blue color characteristic of cobalt. Soluble in hydrochloric acid, giving a rose-red solution.

The *earthy cobalt bloom*, of a peach-blossom color (Kobaltbeschlag), is shown by Kersten to be cobalt bloom, with some free arsenic trioxide. He obtained, ibid., p. 262:

| | $As_2O_3$ | $As_2O_5$ | CoO | FeO | $H_2O$ | |
|---|---|---|---|---|---|---|
| 1. Schneeberg | 51·00 | 19·10 | 16·60 | 2·10 | 11·90 | NiO,$SO_3$ *tr.* = 100·70 |
| 2. Annaberg | 48·10 | 20·00 | 18·30 | — | 12·13 | NiO,CaO,$SO_3$ *tr.* = 98·53 |

**Obs.**—Occurs at Schneeberg in Saxony, in micaceous scales, stellately aggregated; in brilliant specimens, consisting of minute aggregated crystals, at Saalfeld in Thuringia; also at Riechelsdorf in Hesse; Wolfach and Wittichen in Baden; Auerbach on the Bergstrasse; Modum in Norway. The earthy peach-blossom varieties have been observed at Allemont in Dauphiné; in Cornwall, at the Botallack mine, St. Just, etc.; near Alston in Cumberland; near Killarney in Ireland. A perfectly green variety occurs at Platten in Bohemia, and sometimes red and green tinges have been observed on the same crystals.

In the U. S., in Penn., sparingly near Philadelphia. In Nevada, at Lovelock's station. In California, Los Angeles Co., and at the Kelsey mine, Compton.

Named from *ἐρυθρός, red.*

**Ref.**—[1] Min. Mitth., 19, 1872. [2] Mgg., Jb. Min., 1, 53, 1884. [3] Dx., N. R., 132, 1867, Bull. Soc. Min., 1, 76, 1878.

**602. ANNABERGITE.** Ochra Niccoli, Niccolum calciforme, *Cronst.*, Min., 218, 1758. Nickelocker. Nickelblüthe. Nickel Bloom; Nickel Ocher; Nickel Green; Arsenate of Nickel. Nickel Arseniaté. Annabergite *B. & M.*, 503, 1852. Dudgeonite *Heddle*, Min. Mag., 8, 200, 1889.

Monoclinic. In capillary crystals; also massive and disseminated.

Soft. Fracture uneven, or earthy. Color fine apple-green. Streak greenish white.

**Comp.**—Hydrous nickel arsenate, $Ni_3As_2O_8 + 8H_2O$ = Arsenic pentoxide 38·5, nickel protoxide 37·4, water 24·1 = 100.

A little cobalt protoxide (to 2·5 p. c.) is sometimes present. In dudgeonite about one-third of the nickel is replaced by calcium.

**Anal.**—1, Berthier, Ann. Ch. Phys., **13**, 52, 1820. 2, Stromeyer, Schw. J., **25**, 221, 1819. 3–5, Kersten, Pogg., **60**, 269, 1843. 6, Genth, Am. Phil. Soc., **23**, 46, 1885. 7, Heddle, l. c.

| | $As_2O_5$ | NiO | CoO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|
| 1. Allemont | 36·8 | 36·2 | 2·5 | — | 24·5 | = 100 |
| 2. Riechelsdorf | 36·97 | 37·35 | — | — | 24·32 | $Fe_2O_3$ 1·13, $SO_3$ 0·23 = 100 |
| 3. Schneeberg | 38·30 | 36·20 | 1·53 | *tr.* | 23·91 | FeO,$SO_3$ *tr.* = 99·94 |
| 4. " | 38·90 | 35·00 | *tr.* | — | 24·02 | FeO 2·21, $SO_3$ *tr.* = 100·13 |
| 5. " | 37·21 | 36·10 | *tr.* | — | 23·92 | FeO 1·10, $As_2O_3$ 0·52 = 98·85 |
| 6. Silver Cliff | 36·64 | 32·64 | 0·50 | 3·51 | 23·94 | MgO 3·74 = 100·97 |
| 7. Pibble M. | 39·33 | 25·01 | 0·76 | 9·32 | 25·01 | = 99·43 |

**Pyr., etc.**—In the closed tube gives off water and darkens in color. B.B. fuses easily, and on charcoal gives an arsenical odor and yields a metallic button, which with borax glass gives at first a cobalt-blue glass, and later the violet to reddish brown color characteristic of nickel; in R.F. it becomes gray from reduced nickel. Soluble in acids.

**Obs.**—Occurs on smaltite at Allemont in Dauphiné, and is supposed to result from the decomposition of this ore; also at Kamsdorf, near Saalfeld; at Annaberg and Schneeberg; at Riechelsdorf, and other mines of nickel ores. It has been occasionally observed associated with copper nickel in the cobalt mine at Chatham, Connecticut. In Colorado, at the Gem mine near Silver Cliff, with niccolite. In Nevada, with niccolite in Churchill Co.

Dudgeonite is from the Pibble mine in Kirkcudbrightshire, Scotland, a few miles from Creetown; named after the discoverer, Mr. Dudgeon.

**603. CABRERITE.** Wasserhaltige Nickeloxyd-Magnesia *J. H. Ferber*, B. H. Ztg., **22**, 306, 1863. Cabrerite *Dana*, Min., 561, 1868.

Monoclinic, *aw* (100 ∧ $\bar{1}$01) = 54° 20′ to 55° Dx.[1] Like erythrite in habit. Also fibrous, concentric, radiated. Reniform and granular.

Cleavage: clinodiagonal, perfect. H. = 2. G. = 2·96 Spain; 3·11 Laurium. Luster pearly on face of cleavage; silky when fibrous. Color apple-green. Translucent to transparent.

Optically −. Ax. pl. and $Bx_a \perp b$. Dispersion $\rho > v$ strong, also crossed. Axial angles, Dx.:

Spain $2H_r$ = 105° 30′–106° 32′ Laurium $2H_r$ = 110° 20′–112° 20′

**Comp.**—A hydrous arsenate of nickel and magnesium, $(Ni,Mg)_3As_2O_8 + 8H_2O$. Cobalt, iron also replace part of the nickel. If Ni : Mg = 3 : 1, the formula requires: Arsenic pentoxide 40·2, nickel protoxide 29·3, magnesia 5·3, water 25·2 = 100.

**Anal.**—1, Ferber, l. c. 2, Frenzel, Jb. Min., 682, 1874. 3, Damour, Bull. Soc. Min., **1**, 77, 1878.

| | | $As_2O_5$ | NiO | CoO | FeO | MgO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Spain | G. = 2·96 | 42·37 | 20·01 | 4·06 | — | 9·29 | 25·80 | = | 101·53 |
| 2. " | G. = 2·92 | 41·42 | 25·03 | 1·49 | — | 6·94 | 25·78 | = | 100·66 |
| 3. Laurium | G. = 3·11 | 41·40 | 28·72 | *tr.* | 2·01 | 4·64 | 23·11 | = | 99·88 |

**Pyr., etc.**—In the closed tube yields water and becomes grayish yellow. B.B. in R.F. infusible; on charcoal gives arsenical fumes.

**Obs.**—From the Sierra Cabrera, Spain, in a gangue of brown spar, which is connected with the Mountain Limestone and argillaceous schist; similarly associated at the zinc mines of Laurium, Greece. Results from the alteration of arsenides of nickel and cobalt.

**Ref.**—[1] Bull. Soc. Min., **1**, 75, 1878.

**604. KÖTTIGITE.** Zinkarseniat *Otto Köttig*, J. pr. Ch., **48**, 183, 1849; *Naumann*, ib., p. 256. Köttigite *Dana*, Min., 487, 1850.

Monoclinic, isomorphous with vivianite, *bm* = 53°, *an* (100 ∧ 101) = 39° Groth[1]. Massive, or in crusts, with crystalline surface and fibrous structure.

Cleavage: clinodiagonal, perfect. H. = 2·5–3. G. = 3·1. Luster of surface of fracture silky. Color light carmine- and peach-blossom-red. Streak reddish white. Translucent to subtranslucent. An axis of elasticity in *b* inclined 37° to *ċ*.

**Comp.**—Hydrous zinc arsenate, $Zn_3As_2O_8 + 8H_2O$ = Arsenic pentoxide 37·3, zinc oxide 39·4, water 23·3 = 100. Cobalt and nickel replace part of the zinc.

**Anal.**—Köttig, l. c.

$As_2O_5$ [37·17] ZnO 30·52 CoO 6·91 NiO 2·00 CaO *tr.* $H_2O$ 23·40 = 100

**Pyr., etc.**—In the closed tube gives much water, and at a higher temperature a faint crystalline sublimate of arsenic trioxide. B.B. fuses easily, coloring the flame blue; on charcoal in R.F. gives copious fumes of arsenic and coats the coal with zinc oxide; with soda the coating is much more marked, and is yellow while hot and white on cooling; this moistened with cobalt solution and heated in O.F. assumes a green color. With borax and salt of phosphorus gives a cobalt-blue glass.

**Obs.**—Occurs with smaltite at the cobalt mine Daniel, near Schneeberg. The color is owing partly to the arsenate of cobalt in the mineral.

**Ref.**—[1] Min.-Samml. Strassb., 166, 1878.

**605. RHABDOPHANITE.** Rhabdophane *Lettsom*, Zs. Kr., 3, 191, 1878; Proc. Cryst. Soc., 105, 1882; *L. de Boisbaudran*, C. R., 86, 1028, 1878. Scovillite *G. J. Brush* and *S. L. Penfield*, Am. J. Sc., 25, 459, 1883. Skovillit.

Massive, small mammillary, globular with indistinct fibrous structure. Also as an incrustation, botryoidal or stalactitic, with radiated fibrous structure.

Fracture uneven. H. = 3·5. G. = 3·94–4·01 scovillite. Luster greasy. Color brown, pinkish or yellowish white. Translucent. Optically uniaxial, positive, Bertrand[1]. Shows the spectroscopic absorption-bands for didymium and erbium.

**Comp.**—A hydrous phosphate of metals of the cerium and yttrium groups, $RPO_4 + H_2O$ or $R_2O_3.P_2O_5.2H_2O$. Assuming the relation of yttrium to cerium metals as 1 : 4, the percentage composition is: $P_2O_5$ 28·4, $(Y,Er)_2O_3$ 11·1, $(La,Di)_2O_3$ 53·3, $H_2O$ 7·2 = 100.

**Anal.**—1, Hartley, J. Ch. Soc., **41**, 210, 1882, as recalc. by Brush and Penfield. 2, Brush and Penfield, l. c. and ibid., **27**, 200, 1884.

| | $P_2O_5$ | $(Y,Er)_2O_3$ | $(La,Di)_2O_3$ | $H_2O$ | |
|---|---|---|---|---|---|
| 1. *Rhabdophanite* | 26·26 | 65·75 | | 7·99 | = 100 |
| 2. *Scovillite* | 29·10 | 9·93 | 53·82 | 6·86 | $Fe_2O_3$ 0·29 = 100 |

The original analysis of scovillite (Penfield) gave: $P_2O_5$ 24·94, $(Y,Er)_2O_3$ 8·51, $(La,Di)_2O_3$ 55·17, $Fe_2O_3$ 0·25, combined $H_2O$ 5·88, $H_2O$ lost at 100° 1·49, $CO_2$ 3·59 = 99·83. The authors conclude that the $CO_2$ is due to an admixed mineral having the composition $R_2O_3.3CO_2.3H_2O$, and deducting this the result above given is obtained. Hartley obtained, excluding 5·69 impurities: $P_2O_5$ 24·64, $(Ce,La,Di,Y)_2O_3$ 61·69, $H_2O$ combined 7·50, $Al_2O_3$, $Fe_2O_3$, CaO, MgO with some $P_2O_5$ 1·93, $SiO_2$ 3·76 = 99·52; another determination gave: $Ce_2O_3$ 23·19, $Y_2O_3$ 2·09.

**Pyr., etc.**—B.B. infusible. With salt of phosphorus and borax gives a rose-colored bead in both flames. Soluble in hydrochloric acid.

**Obs.**—*Rhabdophanite* is known only in a few specimens obtained from Cornwall prior to 1820; it was taken for brown sphalerite, some varieties of which it resembles rather closely. Named from *ράβδος, rod*, and *φαίνεσθαι, to appear*, in allusion to the absorption-bands seen in its spectrum.

*Scovillite* occurs sparingly in thin pinkish or yellowish incrustations on limonite and pyrolusite at the Scoville ore bed in Salisbury, Conn.

**Ref.**—[1] Bull. Soc. Min., 3, 58, 1880.

**606. CHURCHITE.** A new British mineral containing cerium, *A. H. Church*, Ch. News, **12**, 121, 1865. Churchite *C. G. Williams*, ib., 183. Hydrated cerous phosphate *Church*, J. Ch. Soc., 18, 259, 1865.

Monoclinic? In fan-like aggregations of minute crystals. Also radiated columnar.

Cleavage perfect in one direction. Fracture conchoidal. H. = 3–3·5. G. = 3·14 approx. Luster vitreous; pearly on cleavage plane. Color pale smoke-gray, tinged with flesh-red. Streak white. Transparent to translucent. Doubly refracting.

**Comp.**—A hydrous phosphate of cerium (didymium) and calcium, $RPO_4 + 2H_2O$ or $R_3P_2O_8 + 4H_2O$. If $Ce_2O_3 : CaO = 5 : 3$, the formula requires: Phosphorus pentoxide 27·5, cerium oxide 53·2, lime 5·4, water 13·9 = 100.

**Anal.**—Church, l. c.

| $P_2O_5$ | $Ce_2O_3$ | CaO | $H_2O$ | |
|---|---|---|---|---|
| 28·48 | 51·87 | 5·42 | 14·93 | F *tr.* = 100·70 |

C. G. Williams (l. c.) has proved churchite to contain didymium.

**Pyr., etc.**—B.B. in tube yields acid water, becoming opaque. In outer flame becomes reddish, and difficultly fusible. With borax in outer flame gives a bead which is orange-yellow and opaline while hot, and colorless or slightly amethystine when cold.

**Obs.**—Occurs at Cornwall, in a copper lode, as a coating one-tenth of an inch thick on quartz and argillaceous schist.

Named after Prof. A. H. Church, of Cirencester, England.

## Scorodite Group. Orthorhombic.

**607. SCORODITE.** Cupreous Arsenate of Iron. Cupro-martial Arsenate *Bourn.*, Phil. Trans., 191, 1801. Martial Arsenate of Copper. Cuivre arseniaté ferrifère *H.*, Tabl., 91, 1809. Scorodit *Breith.*, Hoffm. Handb., **4**, 2, 182, 1817. Scorodite and Néoctèse *Beud.*, **2**, 605, 607, 1832; Dx., Ann. Ch. Phys., **10**, 402, 1844. Arseniksinter, Eisensinter, *Hermann*, Bull. Soc. Imp. Nat. Moscou, **1**, 254; 1845. Kobalt-scorodit *Lippmann*, v. Hornberg, Zool. Min. Ver. Regensb., **11**, 172.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}86578 : 1 : 0{\cdot}95414$ Rath[1].
$100 \wedge 110 = 40° \ 53\tfrac{1}{6}'$, $001 \wedge 101 = 47° \ 46\tfrac{3}{4}'$, $001 \wedge 011 = 43° \ 39\tfrac{1}{3}'$.

**Forms**[2]: *c* (001, *O*) *h* (340, *i*-$\tfrac{4}{3}$)[3] *n* (201, 2-$\bar{i}$) *i* (112, $\tfrac{1}{2}$)
*a* (100, *i*-$\bar{i}$) *m* (110, *I*) *d* (120, *i*-$\breve{2}$) *e* (012, $\tfrac{1}{2}$-$\breve{i}$) *p* (111, 1)
*b* (010, *i*-$\breve{i}$) *s* (121, 2-$\breve{2}$)

*mm‴* = 81° 46′ *mi* = 53° 55′ *ii″* = 72° 10′ *pp‴* = *65° 20′
*dd′* = 60° 1′ *mp* = 34° 27′ *ii‴* = 45° 21′ *ss′* = 54° 11′
*nn′* = 131° 11½′ *ds* = 24° 24½′ *pp′* = *77° 8′ *ss″* = 131° 11′
*ee′* = 51° 0½′ *ii′* = 52° 53′ *pp″* = 111° 6′ *ss‴* = 104° 6′

1. 2. 3. 4.

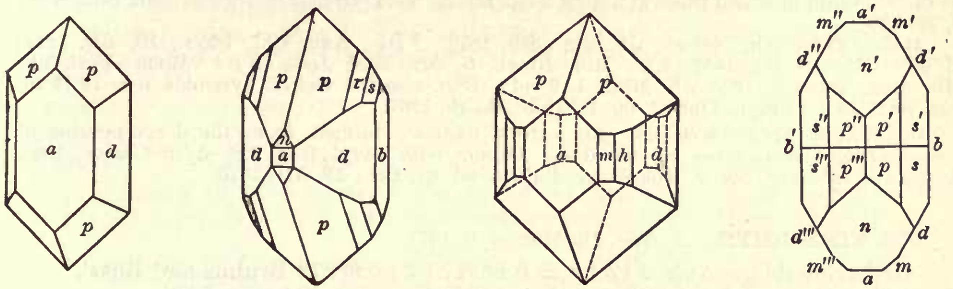


Fig. 1, Common form. 2, 3, Ural, Erem ($r = 16{\cdot}17{\cdot}16$). 4, Dernbach, after Rath.

Habit octahedral, also prismatic (*d*), less often tabular ∥ *a*. Crystals aggregated in irregular groups. Also earthy, amorphous.

Cleavage: *d* imperfect; *a*, *b* in traces. Fracture uneven. Brittle. H. = 3·5–4. G. = 3·1–3·3. Luster vitreous to subadamantine and subresinous. Color pale leek-green or liver-brown. Streak white. Subtransparent to translucent.

Optically +. Ax. pl. ∥ *a*. Bx ⊥ *c*. Ax. angles:

$2H_{a.r} = 76° \ 43\tfrac{1}{2}'$ ∴ $2E_r = 130° \ 58'$ Also (meas.) $2E_r = 115° \ 43'$ at 17° C., 116° 56′ at 76°·5
$2H_{a.y} = 76° \ 5'$ ∴ $2E_y = 129° \ 32'$
$2H_{a.bl} = 72° \ 44'$ ∴ $2E_{bl} = 122° \ 25'$ Dx.[4]

**Comp.**—Hydrous ferric arsenate, $FeAsO_4 + 2H_2O$ or $Fe_2O_3.As_2O_5.4H_2O$ = Arsenic pentoxide 49·8, iron sesquioxide 34·6, water 15·6 = 100.

**Anal.**—1–4, Damour, Ann. Ch. Phys., **10**, 412, 1844. 5, Raimondi, Min. Pérou, 228, 1878. Also 5th Ed., p. 574.

| | | $As_2O_5$ | $Fe_2O_3$ | $H_2O$ | | |
|---|---|---|---|---|---|---|
| 1. Vaulry, *green crystals* | G. = 3·11 | 50·95 | 31·89 | 15·64 | = | 98·48 |
| 2. Cornwall, *blue crystals* | | 51·06 | 32·74 | 15·68 | = | 99·48 |
| 3. Saxony, *bluish* | | 52·16 | 33·00 | 15·58 | = | 100·74 |
| 4. Brazil, *Neoctese* | G. = 3·18 | 50·96 | 33·20 | 15·70 | = | 99·86 |
| 5. Peru, *earthy* | | 50·0 | 35·7 | 14·5 | = | 100·2 |

An *Iron-sinter* (Eisensinter, Arseniksinter) from Nerchinsk, analyzed by Hermann, l. c., is an amorphous scorodite.

**Pyr., etc.**—In the closed tube yields neutral water and turns yellow. B.B. fuses easily, coloring the flame blue. B.B. on charcoal gives arsenical fumes, and with soda a black magnetic scoria. With the fluxes reacts for iron. Soluble in hydrochloric acid.

**Obs.**—Found of brown color in the granitic mountains of Schwarzenberg, in Saxony, associated with arsenopyrite; at Dernbach, Nassau; at Lölling, near Hüttenberg in Carinthia, with löllingite; at Chanteloube, near Limoges; at Nerchinsk, Siberia, in fine crystals; also as an amorphous crust or *iron-sinter* on beryl, topaz, and quartz; leek-green, in the Cornish mines, coating cavities of ferruginous quartz; at the Minas Geraes, in Brazil; in Popayan; Dist. Lucma, Peru, in an earthy form, at the gold mines of Victoria, in Australia, in quartz with arsenopyrite and gold.

Occurs in minute crystals and druses of leek-green and greenish white colors, near Edenville, N. Y., with arsenopyrite, iron-sinter, etc., in white limestone; in Cabarrus Co., N. C., on G. Luderick's farm, in aggregations of greenish white, brownish green and leek-green crystals; coating cavities of quartz and limonite with copper ores and pyrite. In Northern Alabama with arsenopyrite. In Utah, Tintic district, at the Mammoth mine on enargite associated with pharmacosiderite and various copper arsenates; at the Horn Silver mine, Utah. As a thin amorphous incrustation on the siliceous sinter of the geysers and hot springs of the Yellowstone region; thus at the Joseph Coat Springs and elsewhere (Hague, Am. J. Sc., **34**, 171, 1887); also at the Steamboat Springs, Nevada.

The cobalt-scorodite of Lippmann (l. c.) occurs in bluish crystals with quartz and hypochlorite, at Schneeberg; it has not been analyzed.

Named from *σκόροδον*, *garlic*, alluding to the odor before the blowpipe.

**Alt.**—Scorodite occurs altered to limonite.

**Artif.**—Formed in crystals like the natural mineral (G. = 3·28) by the action of arsenic acid on metallic iron in sealed tubes at a high temperature, Verneuil and Bourgeois, Bull. Soc. Min., **3**, 32, 1880.

**Ref.**—[1] Dernbach, Nassau, Jb. Min., 396, 1876. [2] Dx., Ann. Ch., Phys., **10**, 402, 1844; cf. Mlr., Min., p. 411, 1852, Kk., Min. Russl., **6**, 307, 1874, Rath, l. c. [3] Erem., Ural, Vh. Min. Ges., **20**, 185, 1885 (Jb. Min., **1**, 3 ref., 1889), also the vicinal pyramids $\mu = 19{\cdot}19{\cdot}20$, $\tau = 16{\cdot}17{\cdot}16$. [4] Propr. Opt., **1**, 60, 1857; N. R., 89, 1867.

JOGYNAITE *N. Nordenskiöld.* Au earthy mineral, formed from the decomposition of arsenopyrite, and referred to scorodite. Occurs with beryl from the Adun-Chalon Mts., Nerchinsk, Siberia. See v. Koksharov, Bull. Acad. St. Pet., **19**, 571, 1873.

### 608. STRENGITE. *A. Nies*, Jb. Min., p. 8, 1877.

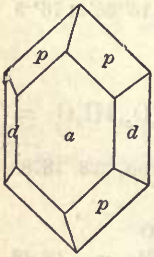
Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c} = 0{\cdot}86517 : 1 : 0{\cdot}98272$ Bruhns and Busz[1].

$100 \wedge 110 = 40° \ 52'$, $001 \wedge 101 = 48° \ 38\frac{1}{3}'$, $001 \wedge 011 = 44° \ 30'$.

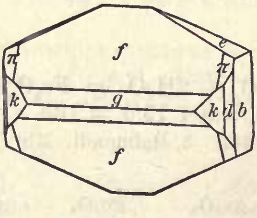
**Forms**[1]: *a* (100, $i$-$\bar{i}$), *k* (430, $i$-$\frac{4}{3}$)[2], *d* (120, $i$-$\breve{2}$); *f* (302, $\frac{3}{2}$-$\bar{i}$)[2]; *g* (805, $\frac{8}{5}$-$\bar{i}$)[2], *e* (012, $\frac{1}{2}$-$\breve{i}$)[2], *p* (111, 1), *π* (15·12·10, $\frac{3}{2}$-$\frac{5}{4}$)[2]?.

| | | | |
|---|---|---|---|
| $kk''' = 65° \ 57\frac{1}{2}'$ | $gg' = 122° \ 21\frac{1}{2}'$ | $pp' = {}^*78° \ 1\frac{1}{2}'$ | $pp''' = {}^*65° \ 59' \ 50''$ |
| $dd' = 60° \ 3'$ | $ee' = 52° \ 20'$ | $pp'' = 112° \ 41'$ | $b\pi = 62° \ 33'$ |
| $ff' = 119° \ 11'$ | $ap = 50° \ 59'$ | | |

Crystals rare; in habit and angle near scorodite; also prismatic by extension of macrodomes. Generally in spherical and botryoidal forms, aggregates with radiated fibrous structure, and drusy surface.



Eleonore M., Nies.



Virginia, Ayres.

Cleavage: *a* imperfect. H. = 3–4. G. = 2·87. Luster vitreous, brilliant. Color peach-blossom-red, carmine-red, and various other shades; sometimes nearly colorless. Streak yellowish white. Translucent to transparent. Bx $\perp \grave{c}$. Ax. angle 60° approx., Bruhns & Busz[3].

**Comp.**—Hydrous ferric phosphate, $FePO_4 + 2H_2O$ or $Fe_2O_3.P_2O_5.4H_2O$ = Phosphorus pentoxide 38·0, iron sesquioxide 42·7, water 19·3 = 100.

**Anal.**—1, Nies, l. c. 2, Koenig, Proc. Acad. Philad., 277, 1877.

| | | $P_2O_5$ | $Fe_2O_3$ | $H_2O$ | |
|---|---|---|---|---|---|
| 1. Eleonore Mine | G. = 2·87 | 37·82 | 43·65 | 19·61 | insol. 0·15 = 101·23 |
| 2. Rockbridge Co., Va. | | 39·30 | 42·30 | 19·87 | = 101·47 |

**Pyr., etc.**—B.B. fuses readily to a black shining bead, coloring the flame bluish green. Iron reaction with borax. Dissolves easily in warm hydrochloric acid; in nitric acid insoluble.

**Obs.**—Occurs with cacoxenite, at the Eleonore iron mine on the Dünsberg, near Giessen; also in colorless crystals with eleonorite, at the Rothläufchen mine, near Waldgirmes, in the same region; also the Jakobssegen mine near Bremthal in the Taunus. In distinct crystals, pink to red, in cavities in dufrenite, from Rockbridge Co., Va., sometimes like f. 1 in habit, also f. 2. Named after Prof. A. Streng, of Giessen.

**Ref.**—[1] Zs. Kr., **17**, 558, 1890. The results of Nies, l. c., were deduced from $111 \wedge \bar{1}11 = 77° 46'$, $111 \wedge 1\bar{1}1 = 64° 52'$, $120 \wedge 1\bar{2}0 = 61° 24'$.

[2] E. F. Ayres, priv. contr. The crystals examined were in part like f. 1 with also another brachypyramid, *s* in part (f. 2) prismatic ∥ axis $\bar{b}$. The last named are like the crystals figured and imperfectly described by Koenig, and formed the material of anal. 2. The suggestion, therefore, that they belonged to phosphosiderite (cf. f. 1, below) does not seem applicable unless, indeed, the latter is merely a form of strengite. The angles measured by Koenig and Ayres are as follows: $bk = 58°$ K, 57° 52′ A; $bd = 30° 29'$ A; $ff''' = 62° 35'$ K; $gg''' = 57° 40'$ K, 58° 24′ A; $b\pi = 62° 53'$ A.

[3] Cf. phosphosiderite below.

**Artif.**—Rose-red microscopic crystals having the composition of strengite have been obtained by A. de Schulten by heating a solution of $FeCl_3.6H_2O$ with phosphoric acid solution in a closed tube at 180°–190° C. They are, however, monoclinic, tabular ∥ *b* (010) with $\beta = 65°$. Extinction inclined 38° to edge *a*/*b*. Twins *a* (100) and *c* (001). Ax. plane ∥ *b* (010). C. R., **100**, 1522, 1885.

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## 609. PHOSPHOSIDERITE. *W. Bruhns* and *K. Busz*, Zs. Kr., **17**, 555, 1890.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·53302 : 1 : 0·87723$ Bruhns & Busz[1].

$100 \wedge 110 = 28° 3\frac{1}{2}'$, $001 \wedge 101 = 58° 43'$, $001 \wedge 011 = 41° 15\frac{1}{2}'$.

**Forms:**
*a* (100, $i$-$\bar{i}$)
*b* (010, $i$-$\breve{i}$)
*c* (001, *O*)
*p* (710, $i$-$\bar{7}$)
*o* (410, $i$-$\bar{4}$)
*n* (210, $i$-$\bar{2}$)
*m* (110, *I*)
*e* (101, 1-$\bar{i}$)
*g* (034, $\frac{3}{4}$-$\breve{i}$)
*h* (011, 1-$\breve{i}$)
*t* (041, 4-$\breve{i}$)
*d* (111, 1)
*i* (771, 7)

The form is not far from that of strengite (cf. ref. [1]) and the chemical composition differs only in the amount of water, but it does not seem possible to unite the two species.

$oo''' = 15° 11'$
$nn''' = 29° 51'$
$mm''' = 56° 7'$
$bm = *61° 56\frac{1}{2}'$
$ee' = 117° 26'$
$ce = *58° 43'$
$gg = 66° 41'$
$hh' = 82° 31'$
$tt' = 148° 11'$
$dd' = 102° 6'$
$dd'' = 123° 36'$
$dd''' = 48° 59'$
$cd = 61° 48'$
$ci = 85° 37'$

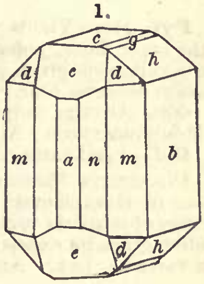
In prismatic crystals, with *b* prominent; faces mostly rough and not allowing of exact measurement.

Cleavage: *b* perfect. H. = 3·75. G. = 2·76. Color peach-blossom-red or reddish violet. Transparent.

Pleochroism distinct: $\mathfrak{c}$ nearly colorless; $\mathfrak{b}$ carmine-red; $\mathfrak{a}$ pale rose. Optically +. Ax. pl. ∥ *b*. Bx ⊥ *c*. Axial angle large. Dispersion strong, $\rho > v$.

$2K_y = 62° 55'$ $2E_y = 126° 26'$ Na $\beta_y = 1·7315$ $\therefore$ $2V_y = 62° 4'$

1.



**Comp.**—$2FePO_4 + 3\frac{1}{2}H_2O$ or $Fe_2O_3.P_2O_5.3\frac{1}{2}H_2O$ = Phosphoric pentoxide 38·9, iron sesquioxide 43·8, water 17·3 = 100.

**Anal.**—Bruhns & Busz, l. c.

$\frac{2}{3}$ $P_2O_5$ 38·85 $Fe_2O_3$ 44·30 $H_2O$ 17·26 = 100·41

**Pyr., etc.**—In the closed tube becomes yellow and opaque, giving off water without decrepitation. B.B. fuses easily to a black magnetic bead. Soluble completely in hydrochloric acid; nearly insoluble in nitric acid.

**Obs.**—Found in cavities in an iron ore (Pecheisenstein) from the Kalterborn mine, near Eiserfeld, Siegen mining district, Germany.

**Ref.**—[1] L. c. By making the cleavage face = 001 and *m* (110) = 021 Bruhns & Busz calculate the axes:

$$\breve{a} : \bar{b} : \acute{c} = 0·82285 : 1 : 0·93805,$$

which are not very far from the axes of strengite. The two minerals differ, however, in optical orientation as well as chemically.

**610. BARRANDITE.** Barrandit *v. Zepharovich*, Ber. Ak. Wien, **56** (1), 20, 1867.

In spheroidal concretions, indistinctly radiated fibrous, with the surface crystalline angular; concentric in structure.

H. = 4·5. G. = 2·576. Luster between vitreous and greasy. Color pale bluish, reddish, greenish or yellowish gray. Streak yellowish to bluish white. Translucent to opaque.

**Comp.**—$(Al,Fe)PO_4 + 2H_2O$ or $(Al,Fe)_2O_3.P_2O_5.4H_2O$. If Al : Fe = 3 : 4 the percentage composition is: Phosphorus pentoxide 40·7, alumina 12·5, iron sesquioxide 26·2, water 20·6 = 100.

**Anal.**—E. Boricky, l. c.

| $P_2O_5$ | $Al_2O_3$ | $Fe_2O_3$ | $H_2O$ |
|---|---|---|---|
| 39·68 | 12·74 | 26·58 | 21·00 = 100 |

**Pyr., etc.**—Yields water with an acid reaction. B.B. splits open and becomes darker in color; moistened with sulphuric acid colors the flame bluish green. Soluble in hot hydrochloric acid.

**Obs.**—Occurs at Cerhovic, N.N.W. of Přibram, in Bohemia, in clefts in a Lower Silurian sandstone, with cacoxenite and stilpnosiderite; the translucent globules ½ to 1½ mm. in diameter, and having within some resemblance to opal; the opaque variety without luster; sometimes a grain of limonite at center, and particles of the same as impurity.

**Alt.**—Stated to give origin by alteration to dufrenite, similar globules and fibrous crusts at the locality having the composition of the latter mineral.

**611. VARISCITE.** Variscite *Breithaupt*, J. pr. Ch., **10**, 506, 1837.

Orthorhombic. Axes $\breve{a} : \bar{b}$ = 0·648 : 1; 100 ∧ 110 = 32° 57′ Chester[1]. Observed forms: *a* (100, *i-ī*), *b* (010, *i-ĭ*), *c* (001, *O*), *m* (110, *I*); *mm‴* = *65° 54′.

Crystals prismatic, usually six-sided, but rarely distinct. Commonly in sheaf-like aggregates and incrustations with reniform surface.

H. = 4. Luster vitreous, brilliant. Color deep emerald-green, bluish green to colorless. Transparent to translucent. Indices $\gamma - \alpha = 0·0173$ Lcx.

**Comp.**—$AlPO_4 + 2H_2O$ or $Al_2O_3.P_2O_5.4H_2O$ = Phosphorus pentoxide 44·9, alumina 32·3, water 22·8 = 100.

**Anal.**—1, Petersen, Jb. Min., 357, 1871. 2, Chester, Am. J. Sc., **13**, 295, 1877.

| | | $P_2O_5$ | $Al_2O_3$ | $H_2O$ | |
|---|---|---|---|---|---|
| 1. Voigtland | G. = 2·408 | 44·05 | 31·25 | 22·85 | $Cr_2O_3,Fe_2O_3,FeO$ 1·21, CaO 0·18, MgO 0·41 [= 99·95 |
| 2. Arkansas | ⅔ | 44·35 | 31·85 | 23·80 = 100 | |

From 2 an insoluble residue of 50–70 p. c. has been deducted.

**Pyr., etc.**—Yields water in a matrass. B.B. in the forceps infusible, but becomes white; in the outer flame, colors the flame deep bluish green; with borax and salt of phosphorus forms a pale yellowish green glass; with soda fuses with effervescence, but imperfectly; with cobalt solution becomes blue.

**Obs.**—Occurs in quartz and siliceous slate at Messbach near Plauen in Saxon Voigtland. In Montgomery Co., Arkansas, on quartz. Named from Variscia (Voigtland).

**Ref.**—[1] Arkansas, Am. J. Sc., **15**, 207, 1878.

PLANERITE *Hermann*, Bull Soc. Nat. Mosc., **35** (2), 240, 1862. A mineral from the copper mines of Gumeshevsk, in the Ural. Occurs in thin subcrystalline, botryoidal layers in the cavities of a quartz rock. H. = 5; G. = 2·65. Color on fresh surface verdigris-green, passing to olive-green on exposure to the air. Luster dull. Translucent on the edges. $\gamma - \alpha = 0·0173$, like variscite, Lcx. Analysis afforded:

| $P_2O_5$ | $Al_2O_3$ | CuO | FeO | $H_2O$ |
|---|---|---|---|---|
| 33·94 | 37·48 | 3·72 | 3·52 | 20·93 = 99·59 |

Hermann regards the hydrated oxides of iron and copper as unessential, as in many other aluminous phosphates, turquois, peganite, fischerite, etc.

B.B. in tube decrepitates, yielding much neutral water. Easily soluble in borax, giving copper reaction. Only slightly attacked by acids, but easily decomposed by boiling with caustic soda. Named after Planer, director of the mines.

AMPHITHALITE. Amfithalit *Igelström*, Öfv. Ak. Stockh., **23**, 93, 1866. B. H. Ztg., **25**, 309, 1866.

Massive. H. = 6 Color milk-white. Subtranslucent. Analysis.—Igelström:

| $P_2O_5$ | $Al_2O_3$ | MgO | CaO | $H_2O$ | FeO,MnO |
|---|---|---|---|---|---|
| 30·06 | 48·50 | 1·55 | 5·76 | 12·47 | *tr.* = 98·34 |

B.B. infusible. Insoluble in acids. Occurs in the quartzyte of Horrsjöberg, Wermland, with lazulite, rutile, and cyanite. Named from ἀμφιϑαλής, *becrowned*, since it usually occurs surrounded by other beautiful minerals, though unattractive itself. Groth refers this to the doubtful berlinite ($AlPO_4 + \frac{1}{4}H_2O$?) which is mentioned on p. 847.

**612. CALLAINITE.** ? Callaina *Plin.*, **37**, 33. Turquois pt. Callais *Damour*, C. R., **59**, 936, 1864. Callainite *Dana*.

Massive. Texture wax-like.

H. = 3·5–4. G. = 2·50–2·52. Color apple-green to emerald-green, spotted or lined with whitish and bluish. Translucent.

**Comp.**—$AlPO_4 + 2\frac{1}{2}H_2O$ or $Al_2O_3.P_2O_5.5H_2O$ = Phosphorus pentoxide 42·6, alumina 30·5, water 26·9 = 100.

**Anal.**—A. Damour, l. c.

| $P_2O_5$ | $Al_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ | CaO | $H_2O$ |
|---|---|---|---|---|---|
| 42·58 | 29·57 | 1·82 | *tr.* | 0·70 | 23·62 sand 2·10 = 100·39 |

**Pyr., etc.**—When heated yields water, and becomes opaque, chocolate-brown, and friable. B.B. infusible.

**Obs.**—From a Celtic grave, near Mané-er H'roek in Lockmariaquer, in rounded pieces from the size of a flax-seed to that of a pigeon's egg, and found in the collections of the Polymathic Society of Morbihan, in western France.

Damour makes this mineral the *callais* of Pliny, and especially in view of its *green* color. But the callais was blue, and the green stone really related to it was probably the *callaina* (see p. 845). Yet, as this identity is not established, the name *callainite* is better than Pliny's name unmodified.

**613. ZEPHAROVICHITE.** *E. Boricky*, Ber. Ak. Wien, **59** (1), 593, 1869.

Crystalline to compact, horn-like in aspect. Fracture conchoidal. H. = 5·5. G. = 2·37. Color greenish, yellowish or grayish white. Translucent.

**Comp.**—$AlPO_4.3H_2O$ = Phosphorus pentoxide 40·3, alumina 29·0, water 30·7 = 100.

| | $P_2O_5$ | $Al_2O_3$ | $Fe_2O$ | CaO | MgO | $H_2O$ | quartz | |
|---|---|---|---|---|---|---|---|---|
| 1. | 35·56 | 29·77 | — | 1·07 | 0·41 | 26·70 | 5·46 | = 98·97 |
| 2. | 37·46 | 28·44 | — | 0·54 | *tr.* | 26·57 | 6·05 | = 99·06 |
| 3. | 37·80 | 29·60 | 0·86 | 1·38 | — | 28·98 | 0·46 | = 99·08 |

Nos. 1 and 2 contained intermingled wavellite, and No. 3 an earthy gibbsite. Boricky thinks the analyses prove the mineral to be essentially an aluminium phosphate with 3 molecules $H_2O$. It is, however, to be noted that this differs from callainite above only in containing 1 molecule more of water, and analysis 2, after deduction of the 6·04 of quartz, gives: $P_2O_5$ 40·28, $Al_2O_3$ 30·57, CaO 0·58, $H_2O$ 28·56, a result which approaches the figures given by Damour in his analysis of callainite. The species, therefore, must be regarded as a doubtful one.

Occurs in sandstone at Trenic in Bohemia.

Named for Prof. V. von Zepharovich (1830–1890).

GIBBSITE. A so-called gibbsite stated to have come from Richmond, Mass., and to occur with the true gibbsite (aluminium hydrate = hydrargillite, p. 254) has given Hermann, J. pr. Ch., **40**, 32, 1847; also **47**, 1, 1849:

$P_2O_5$ 37·62 $Al_2O_3$ 26·66 $H_2O$ 35·72 = 100

This corresponds nearly to $AlPO_4 + 4H_2O$, but the occurrence is not above question. The substance was called *richmondite* by Kenngott (cf. p. 255).

Genth also mentions a gibbsite of Hermann, occurring in scales on wavellite from Gen. Trimble's farm near White Horse Station, Chester Valley R. R. (locality formerly called "Steamboat"). He says it is a phosphate corresponding with peganite but containing more water.

**614. KONINCKITE.** *Cesàro*, Ann. Soc. G. Belg. Mem., **11**, 247, 1883–84.

In small spherical aggregates of radiating needles; in one case terminated by an oblique plane.

Cleavage transverse. H. = 3·5. G. = 2·3. Luster vitreous. Color and streak yellow. Transparent. Extinction parallel.

**Comp.**—$FePO_4 + 3H_2O$ or $Fe_2O_3.P_2O_5.6H_2O$ = Phosphorus pentoxide 34·6, iron sesquioxide 39·0, water 26·4 = 100.

**Anal.**—Cesàro, l. c.

$\frac{2}{3}$ $P_2O_5$ 34·8 $Fe_2O_3$ 33·8 $Al_2O_3$ 4·6 $H_2O$ 26·8 = 100

**Pyr., etc.**—B.B. fuses easily. Soluble in strong acids.

**Obs.**—Occurs with richellite at Richelle near Visé, Belgium.

Named for the Belgian geologist, L. G. de Koninck (1809–1887).

## Hydrous Phosphates, etc.—Acid Division.

$\grave{a} : \overset{1}{\bar{b}} : \grave{c}$ $\beta$

**615. Stercorite** $H(NH_4)NaPO_4 + 4H_2O$ Monoclinic $2{\cdot}8828 : 1 : 1{\cdot}8617$ 80° 42½′

$\breve{a} : \bar{b} : \grave{c}$

**616. Haidingerite** $HCaAsO_4 + H_2O$ Orthorhombic $0{\cdot}8391 : 1 : 0{\cdot}4990$

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### Pharmacolite Group. Monoclinic.

$\grave{a} : \overset{1}{\bar{b}} : \grave{c}$ $\beta$

**617. Pharmacolite** $HCaAsO_4 + 2H_2O$ $0{\cdot}6137 : 1 : 0{\cdot}3622$ 83° 13′

**618. Brushite** $HCaPO_4 + 2H_2O$ $0{\cdot}6221 : 1 : 0{\cdot}3415$ 84° 45′

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**619. Metabrushite** $2HCaPO_4 + 3H_2O$ Monoclinic

**620. Martinite** $H_2Ca_5(PO_4)_4 + \frac{1}{2}H_2O$? Rhombohedral

$\breve{a} : \bar{b} : \grave{c}$

**621. Newberyite** $HMgPO_4 + 3H_2O$ Orthorhombic $0{\cdot}9548 : 1 : 0{\cdot}9360$

$\grave{a} : \bar{b} : \grave{c}$ $\beta$

**622. Wapplerite** $HCaAsO_4 + 3\frac{1}{2}H_2O$ Monoclinic? $0{\cdot}9125 : 1 : 0{\cdot}2660$ 84° 35′

**623. Hannayite** $H_4(NH_4)_2Mg_3(PO_4)_4 + 8H_2O$ Triclinic

$\breve{a} : \bar{b} : \grave{c} = 0{\cdot}6990 : 1 : 0{\cdot}9748;\ \alpha = 122°\ 31\frac{1}{2}',\ \beta = 126°\ 46',\ \gamma = 54°\ 9'$

$\grave{a} : \overset{1}{\bar{b}} : \grave{c}$ $\beta$

**624. Hureaulite** $H_2Mn_5(PO_4)_4 + 4H_2O$ Monoclinic $1{\cdot}9192 : 1 : 0{\cdot}5245$ 84° 1′

**625. Forbesite** $H_2(Ni,Co)_2As_2O_8 + 8H_2O$?

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**615. STERCORITE.** Stercorite *Herapath*, Q. J. Ch. Soc., 1849. Microcosmic Salt. Native Salt of Phosphorus. Phosphorsalz *Germ.*

Monoclinic. Axes $\grave{a} : \overset{1}{\bar{b}} : \grave{c} = 2{\cdot}8828 : 1 : 1{\cdot}8617;\ \beta = {*}80°\ 42\frac{1}{2}' = 001 \wedge 100$ Mitscherlich[1].

$100 \wedge 110 = 70°\ 38',\ 001 \wedge 101 = 29°\ 59\frac{1}{2}',\ 001 \wedge 011 = 61°\ 26\frac{1}{2}'$.

**Forms**[1] (artif. cryst.): *a* (100, *i*-$\bar{i}$) *c* (001, *O*) *h* (310, *i*-$\bar{3}$) *m* (110, *I*) *r* (101, – 1-$\bar{i}$) *k* (201, – 2-$\bar{i}$) *f* ($\bar{1}$01, 1-$\bar{i}$) *x* ($\bar{2}$01, 2-$\bar{i}$) *n* (112, – ½) *t* ($\bar{1}$12, ½)

*hh‴* = 86° 58′ *cr* = 29° 59½′ *cx* = 58° 10′ *ct* = 45° 44′

*mm‴* =*141° 16′ *ck* = 46° 31½′ *cn* = 42° 44½′ *nn′* = 79° 46′

*am* = 70° 38′ *cf* =*35° 26′ *cm* = 86° 56′ *tt′* = 85° 9′

Artif. cryst. prismatic ‖ $\grave{c}$ with *m* prominent and terminated by *c* and the dome *f* ($\bar{1}$01), also other forms. Native mineral in crystalline masses and nodules.

H. = 2. G. = 1·615. Luster vitreous. Color white, stained yellowish brown. Transparent. Fragile. Not efflorescent. Easily soluble in hot and cold water.

**Comp.**—$HNa(NH_4)PO_4 + 4H_2O$ = Phosphorus pentoxide 34·7, soda 15·1, ammonium oxide 10·7, water 39·5 = 100.

**Anal.**—1, Herapath, l. c. 2, Raimondi, Min. Pérou, 28, 1878.

| | $P_2O_5$ | $Na_2O$ | $(NH_4)_2O$ | $H_2O$ |
|---|---|---|---|---|
| 1. Ichaboe | 34·33 | 15·75 | 7·68 | 42·24 = 100 |
| 2. Guañape | 34·54 | 14·50 | 8·48 | 42·48 = 100 |

**Pyr., etc.**—B.B. intumesces, and gives off water and ammonia, colors the flame momentarily a faint green, and fuses to a transparent colorless glass, soluble in boiling water.

**Obs.**—Found in guano at the island of Ichaboe on the west coast of Africa, and named from the Latin *stercus, dung.* Also in the guano of the Guañape Islands on the coast of Peru.

This species is identical with the *salt of phosphorus*, used as a flux in blowpipe analysis.

**Ref.**—[1] Ann. Ch. Phys., **19**, 399, 1821.

**616. HAIDINGERITE.** *Turner*, Edinb. J. Sc., **3**, 308, 1825. Diatomes Gypshaloid, *Haid.*, ib., 303, and Pogg., **5**, 182, 1827.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·83910 : 1 : 0·49895 Haidinger[1].

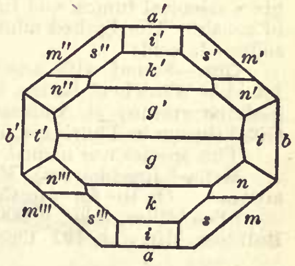
100 ∧ 110 = 40° 0′, 001 ∧ 101 = 30° 44⅙′, 001 ∧ 011 = 26° 31′.

**Forms:** *b* (010, *i*-ĭ) *g* (102, ½-ī) *i* (401, 4-ī) *s* (421, 4-2̄)
*a* (100, *i*-ī) *m* (110, *I*) *k* (201, 2-ī) *t* (011, 1-ĭ) *n* (542, $\frac{5}{2}$-$\frac{5}{4}$)

*mm‴* = *80° 0′ *ii′* = 134° 24′ *ss″* = 137° 37′ *nn″* = 121° 38′
*gg′* = 33° 7′ *tt′* = *53° 2′ *ss‴* = 42° 17′ *nn‴* = 58° 14′
*kk′* = 99° 53′ *ss′* = 118° 35′ *nn′* = 92° 55′

Mostly in minute crystals aggregated into botryoidal forms and drusy crusts.

Cleavage: *b* highly perfect. Sectile; thin laminæ slightly flexible. H. = 1·5–2·5. G. = 2·848. Luster vitreous, on cleavage face pearly. Streak white. Color white. Transparent to translucent.



Optically +. Ax. pl. ∥ *a*. $Bx_0 \perp b$. Ax. angle large. Refractive index, γ = 1·67, Dx.[2]

**Comp.**—$HCaAsO_4 + H_2O$ or $2CaO.As_2O_5.3H_2O$ = Arsenic pentoxide 58·1, lime 28·3, water 13·6 = 100.

**Pyr.**—B.B. like pharmacolite. Dissolves easily in nitric acid.

**Obs.**—The single original specimen, in the cabinet of R. P. Greg, Jr., was of uncertain origin. Later observations by Tschermak show that the locality was doubtless Joachimsthal, where it occurs with pharmacolite. Also from Wittichen and Alpirsbach, Baden (Sandberger).

Named after the Austrian mineralogist Wilhelm von Haidinger (1797–1871).

**Ref.**—[1] L. c., or Pogg., **5**, 182, 1825. [2] Dx., Bull. Soc. Min., **11**, 195, 1888.

**617. PHARMACOLITE.** Arseniksaurer Kalk (von Wittichen) *Selb*, Scherer's J., **4**, 537, 1800. Pharmakolit *Karsten*, Tab., 75, 1800. Arsenikblüthe *Wern.*, pt. Arsenate of Lime. Chaux arseniatée *Fr.* Arsenicite *Beud.*, Min., **2**, 593, 1832. Hemiprismatischer Gypshaloid, *Haid.*, Pogg., **5**, 181, 1825.

Monoclinic. Axes $\grave{a} : \bar{b} : \dot{c}$ = 0·61373 : 1 : 0·36223; β = 83° 13⅓′ = 001 ∧ 100 Schrauf[1].

100 ∧ 110 = 31° 21½′, 001 ∧ 101 = 32° 12½′, 001 ∧ 011 = 19° 47′.

**Forms[1]:** *c* (001, *O*) *m* (110, *I*) *d* (331, − 3)[4] *x* (3̄21, 3-$\frac{3}{2}$)
*b* (010, *i*-ì) *s* (310, *i*-3̄) *n* (011, 1-ì) *π* (1̄11, 1)[3]

*ss‴* = 22° 58′ *cm* = 84° 13′ *ππ′* = 36° 14′ *m′π* = 59° 19′
*mm‴* = 62° 43′ *cπ* = 36° 28′ *xx′* = 40° 56′ *sx* = 31° 3′
*nn‴* = 39° 34′ *cx* = 67° 24′ *m′x* = 47° 45′

Crystals rare, small; in habit prismatic ‖ axis $\grave{a}$. Faces *c*, *n* often striated ‖ edge *c*/*n*. Commonly in delicate silky fibers or acicular crystallizations; in stellated groups. Also botryoidal and stalactitic and sometimes massive.

Cleavage: *b* perfect. Fracture uneven. Flexible in thin laminæ. H. = 2–2·5. G. = 2·64–2·73. Luster vitreous; on *b* inclining to pearly. Color white or grayish; frequently tinged red by arsenate of cobalt. Streak white. Translucent to opaque.

Optically –. Ax. pl. and $Bx_o \perp b$. $Bx_a \wedge \grave{c} = +69° 42'$. Axial angles, Dx.[4]:

$$2H_{o.r} = 113° 24' \qquad 2H_{o.y} = 112° 20' \qquad 2H_{o.bl} = 111° 47'$$

**Comp.**—Probably $HCaAsO_4 + 2H_2O$ or $2CaO.As_2O_5.5H_2O$ = Arsenic pentoxide 53·3, lime 25·9, water 20·8 = 100.

This is the composition of artificial crystals which gave Dufet: $As_2O_5$ 52·65, CaO 26·63, $H_2O$ 20·94 = 100·22. Bull. Soc. Min., **11**, 187, 1888. These were identical in form and optical constants with the natural mineral; analyses of the latter, however, give half an equivalent more water.

**Anal.**—1, Rg., Pogg. Ann., **62**, 150, 1844. 2, Petersen, ib., **134**, 86, 1868. 3, Jannettaz, Bull. Soc. Min., **11**, 212, 1888. 4, Hatle and Tauss, Vh. G. Reichs., 226, 1887.

| | $As_2O_5$ | CaO | $H_2O$ | |
|---|---|---|---|---|
| 1. Glücksbrunn | 51·58 | 23·59 | [23·40] | CoO,FeO 1·43 = 100 |
| 2. Wittichen | 49·45 | 24·18 | [26·37] | CoO,FeO,MgO,MnO *tr.* = 100 |
| 3. St. Marie-aux-Mines G. = 2·535 | 50·54 | 23·90 | 23·80 | MgO 0·50, $Fe_2O_3$ 0·35, $SiO_2$ 0·70, |
| 4. Völlegg | 48·60 | 27·04 | 24·49 | = 100·13 [$P_2O_5$ 0·30 = 100·09 |

**Pyr., etc.**—In the closed tube yields water and becomes opaque. B.B. in O.F. fuses with intumescence to a white enamel, and colors the flame light blue (arsenic). On charcoal in R.F. gives arsenical fumes, and fuses to a semi-transparent globule, sometimes tinged blue from traces of cobalt. The ignited mineral reacts alkaline to test paper. Insoluble in water, but readily soluble in acids.

**Obs.**—Found with arsenical ores of cobalt and silver, also with arsenopyrite. Has been found at Wittichen, Baden, in crystals; at St. Marie-aux-Mines in the Vosges, in botryoidal or globular groups; at Andreasberg in the Harz, and at Riechelsdorf and Bieber in Hesse; at Glücksbrunn in Thuringia; at Joachimsthal in Bohemia; at Völlegg, Styria, with arsenopyrite.

This species was named, in allusion to its containing arsenic, from *φάρμακον, poison.*

**Ref.**—[1] Joachimsthal, Min. Mitth., 138, 1873; earlier observations by Haid., l. c., are not accurate. On the form of the artif. cryst., see Dufet, l. c.

[2] See Miller, Min., p. 506, 1852, and Schrauf, l. c. [3] Schrauf, Zs. Kr., **4**, 284, 1879. [4] Dx., Bull Soc. Min., **11**, 192, 1888; on the optical constants of the artif. cryst., see Dufet, l. c.

**618. BRUSHITE.** *G. E. Moore*, Proc. Acad. Cal., **3**, 167, 1864; Am. J. Sc., **39**, 43, 1865.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 0·6221 : 1 : 0·3415$; $\beta = {}^*84° 45' = 001 \wedge 100$ J. D. Dana[1].

$100 \wedge 110 = 31° 46\frac{2}{3}'$, $001 \wedge \bar{1}01 = 29° 55\frac{1}{2}'$, $001 \wedge 011 = 18° 46'$.

**Forms**: *b* (010, *i*-$\grave{i}$); *s* (310, *i*-$\bar{3}$), *n* (011, 1-$\grave{i}$), *l* ($\bar{3}$01, 3-$\bar{i}$) cleavage.

Angles: *bs* = *78° 20′, *ss′* = 23° 20′, *bn* = 71° 13′, *nn′* = *37° 34′, *l* ∧ edge *n*/*n′* = 62° 37′.

In small slender prisms, flattened ‖ *b*, with a rough oblique termination. Also concretionary massive, consisting of lamellar individuals, and having pearly cleavages.

Cleavage: *b* perfect; *l* ($\bar{3}$01) also perfect. H. = 2–2·5. G. = 2·208. Luster of *b* pearly, elsewhere vitreous, and in part splendent; when massive, earthy, or more or less resinous. Colorless to pale yellowish. Transparent to translucent.

**Comp.**—$HCaPO_4 + 2H_2O$ or $2CaO.P_2O_5.5H_2O$ = Phosphorus pentoxide 41·3, lime 32·5, water 26·2 = 100.

**Anal.**—1, 2, Moore, l. c. 3, Julien, Am. J. Sc., **40**, 369, 1865.

|  | $P_2O_5$ | CaO | $H_2O$ |  |
|---|---|---|---|---|
| 1. Aves I. | 41·50 | 32·65 | 26·33 | = 100·48 |
| 2. " | 41·32 | 32·73 | 26·40 | = 100·45 |
| 3. Sombrero | 39·95 | 32·11 | 25·95 | $Al_2O_3,Fe_2O_3$ 0·33, $SO_3$ 0·78, hygrosc. 1·23 = 100·35 |

**Pyr., etc.**—Heated in a closed tube whitens, and at an incipient red heat gives off water. B.B. in the platinum forceps fuses easily with intumescence, tingeing the flame green; the button crystalline with brilliant facets on cooling. Dissolves readily in dilute acids.

**Obs.**—Occurs on the rock guano of Aves Island and Sombrero in the Caribbean Sea, in groups and crusts consisting of delicate and mostly transparent crystals. Named after Prof. G. J. Brush of New Haven.

**Ref.**—[1] Am. J. Sc., **39**, 45, 1865; the position is changed to correspond to pharmacolite (q.v.), as suggested by Dufet, Bull. Soc. Min., **11**, 187, 1888.

### 619. METABRUSHITE. *A. A. Julien*, Am. J. Sc., **40**, 371, 1865.

Zeugite *Julien*, ib., p. 373. Ornithite *Julien*, ib., p. 377.

Monoclinic. In imperfect crystals with *a* (100, *i-ī*), *b* (010, *i-ì*), *o* (101, − 1-*ī*). Faces *a* broad and even, but dull, *b*, *o* deeply furrowed and rounding into one another; crystals sometimes flattened ‖ *b*. Angle *ao* = 38°, but varying. J. D. D.

Cleavage: *b* perfect. Brittle. H. = 2·5–3. G. = 2·288, 2·356, 2·362. Luster feeble, sometimes resinous on fracture; on *b* pearly. Color pale yellow, buff, to nearly white; streak uncolored. Translucent to transparent.

**Comp.**—$2HCaPO_4 + 3H_2O$ or $2CaO.P_2O_5.4H_2O$ = Phosphorus pentoxide 43·6, lime 34·3, water 22·1 = 100.

**Anal.**—Julien, l. c.

|  | $P_2O_5$ | CaO | $H_2O$ | MgO | $Al_2O_3,Fe_2O_3$ | $SO_3$ |
|---|---|---|---|---|---|---|
| ½ | 42·72 | 32·98 | 21·83 | 0·52 | 0·79 | 0·05 hygr. 1·50 = 100·39 |

The water iucluded some organic matter.

**Pyr., etc.**—Same as for brushite.

**Obs.**—From the island of Sombrero, West Indies, coating cavities in guano and the coral rock, the latter altered by filtrations from the overlying guano. The crystals are sometimes 1 inch long and ¼ inch broad.

**Alt.**—The crystals of metabrushite from Sombrero are often hollow from the removal of the interior, and otherwise altered. Julien describes the following varieties:

1. H. = 3·25. G. = 2·971. The crust of the hollow crystals thin, and surfaces within and without often coated by minute rhombs of calcite; the *zeugite* of Julien. 2. Crust rather thicker, without a glittering surface of calcite rhombs. 3. G. = 2·988–3·030; in narrow blades sometimes an inch long; the crust thick, the crystals being nearly or quite solid. Zeugite is named from ζευγιτης, *yoked together*, because of its relation to metabrushite and ornithite. Cf. martinite, beyond.

4. *Ornithite* of Julien, from Sombrero (l. c., p. 377), appears also to be altered metabrushite, its crystals presenting the same forms and habit, but usually quite small and very thin parallel to the orthodiagonal; also sometimes thin parallel to the clinodiagonal, and acute rhombic in section; angle 100 ∧ 101 = about 38°; H = 2·5. The analysis given was made on only one-tenth of a gram, and the results are hence unavoidably doubtful.

Analyses of varieties 1, 3, 4, afforded Julien (the water including some organic matter):

|  |  | $P_2O_5$ | CaO | $H_2O$ | MgO | $Fe_2O_3,Al_2O_3$ | $SO_3$ | $CO_2$ | F | NaCl |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Var. 1. *Zeugite* | ⅔ | 46·55 | 44·21 | 3·02 | 3·59 | 0·66 | 0·19 | 0·24 | *tr.* | 1·08 | = 99·54 |
| Var 3. " |  | 43·24 | 48·87 | 3·98 | 0·56 | 1·02 | 0·18 | 1·74 | *tr.* | ? | = 99·59 |
| Var. 4. *Ornithite* |  | 40·14 | 45·77 | 9·45 | *tr.* | 4·62 | — | — | — | — | = 99·98 |

In 1, oxygen ratio for $P_2O_5$ : CaO (impurities excluded) = 2·95 : 1·56, and as noted beyond the composition is near that of martinite.

Ornithite corresponds nearly to the formula $Ca_3P_2O_8 + 2H_2O$.

There occur also, with the above, hemispherical stellated groups of white crystals, as altered ornithite, which Julien has not analyzed, but supposed to be the same compound *minus* the water. One crystal of the so-called ornithite had on its edges and surface microscopic tufts of acicular crystals.

**620. MARTINITE.** *Kloos* [Sammlg. G. Reichsmus. Leiden, 1], Jb. Min., 1, 41 ref., 1888.

Rhombohedral. As an aggregation of minute rhombohedrons (0·05 mm.) with plane angles of 75° and 105°, filling cavities in pseudomorphous crystals of gypsum. G. = 2·894. Luster vitreous. Color white or slight yellowish. Transparent.

**Comp.**—$H_2Ca_5(PO_4)_4.\frac{1}{2}H_2O$ or $5CaO.P_2O_5.\frac{3}{2}H_2O$ = Phosphorus pentoxide 48·1, lime 47·3, water 4·6 = 100.

**Anal.**—Kloos, l. c.

| $P_2O_5$ | CaO | $H_2O$ | |
|---|---|---|---|
| 47·67 | 46·78 | 4·52 | insol. 0·20, organ. 0·75 = 99·92 |
| 47·87 | 47·63 | 5·46 | = 100·96 |

**Pyr., etc.**—B.B. burns white and falls to pieces without melting. Dissolves in dilute acid without effervescence.

**Obs.**—Found in the phosphorite deposits derived from guano on Table Mt., near St. Barbara, on the south shore of the island Curaçoa, West Indies.

Martinite seems to be nearly identical with the zeugite of Julien.

**621. NEWBERYITE.** *G. vom Rath*, Ber. nied. Ges., p. 5, Jan. 13, 1879.

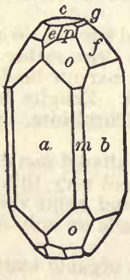
Orthorhombic. Axes $\breve{a} : \bar{b} : \breve{c}$ = 0·95482 : 1 : 0·93601 Schmidt[1].

100 ∧ 110 = 43° 40′ 34″, 001 ∧ 101 = 44° 25′ 48″, 001 ∧ 011 = 43° 6′ 25″.

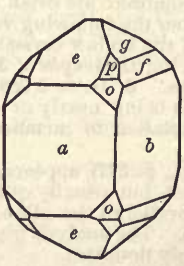
**Forms**[2]:
*a* (100, $i$-$\bar{i}$)
*b* (010, $i$-$\breve{i}$)
*c* (001, $O$)
*l* ($\bar{2}$10, $i$-$\bar{2}$)
*v* (320, $i$-$\bar{\frac{3}{2}}$)
*n* (750, $i$-$\bar{\frac{7}{5}}$)
*t* (430, $i$-$\bar{\frac{4}{3}}$)
*m* (110, $I$)
*e* (102, $\frac{1}{2}$-$\bar{i}$)
*d* (101, 1-$\bar{i}$)
*q* (302, $\frac{3}{2}$-$\bar{i}$)
*g* (011, 1-$\breve{i}$)
*f* (021, 2-$\breve{i}$)
*p* (112, $\frac{1}{2}$)
*h* (223, $\frac{2}{3}$)
*o* (111, 1)
*s* (722, $\frac{7}{2}$-$\bar{\frac{7}{2}}$)
*r* (211, 2-$\bar{2}$)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *ll‴* | = 51° 3′ | *qq′* | = 111° 34′ | *co* | = 53° 35′ | *ao* | = *54° 24′ 32″ |
| *mm″* | = 87° 21′ | *gg′* | = 86° 13′ | *cr* | = 65° 17′ | *pp‴* | = 45° 35′ |
| *a*‿ | = *63° 53′ 18″ | *ff′* | = 123° 47′ | *pp′* | = 47° 53′ | *hh‴* | = 55° 10′ |
| *ee′* | = 52° 13′ | *cp* | = 34° 7½′ | *hh′* | = 58° 1′ | *oo″* | = 67° 31′ |
| *dd′* | = 88° 52′ | *ch* | = 42° 6′ | *oo′* | = 71° 11′ | *rr‴* | = 46° 5′ |

1.



2.



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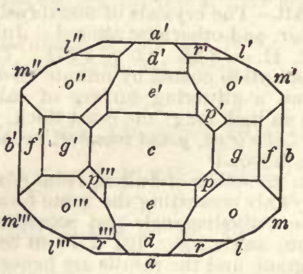


Figs. 1–3, after Schmidt.

Crystals often large (to 1 sq. in.), tabular ∥ *a*.

Cleavage: *b* perfect; *c* imperfect. H. = 3–3·5. G. = 2·10. Luster vitreous. Color white. Optically +. Ax. pl. ∥ *b*. Bx ⊥ *c*. Axial angles, Schmidt:

For Na $2E = 70° 20′$ $2H_a = 46° 24′$ $2H_o = 145° 56′$ ∴ $2V_a = 44° 47′$ $\beta = 1·5196$
Also $2E_r = 69° 47′$ $2H_{a.r} = 46° 12′$ $2H_{o.r} = 147° 25′$

**Comp.**—Hydrous phosphate of magnesium $HMgPO_4 + 3H_2O$ or $2MgO.P_2O_5.7H_2O$ = Phosphorus pentoxide 40·8, magnesia 23·0, water 36·2 = 100.

**Anal.**—1, MacIvor, quoted by Rath, l. c. 2, Id., Ch. News, **55**, 216, 1887.

| | $P_2O_5$ | $MgO$($MnO$ *tr.*) | $H_2O$[a] | |
|---|---|---|---|---|
| 1. Skipton Caves | 41·25 | [23·02] | 35·73 | = 100 |
| 2. " " | 40·73 | 22·37 | [35·84] | FeO 0·85, MnO 0·21 = 100 |

[a] Expelled at 170°, none at 100°.

Easily soluble in cold nitric and hydrochloric acids.

**Obs.**—From the guano of the Skipton Caves near Ballarat, Victoria; also from the guano of Mexillones, Chili.

Named after Mr. J. C. Newbery of Melbourne.

**Ref.**—[1] Chili, Zs. Kr., **7**, 26, 1882; these results vary but little from those of vom Rath. [2] All on Chili crystals, Schmidt; observed by Rath on Victoria crystals *a b c e f o*.

### 622. WAPPLERITE. *Frenzel*, Min. Mitth., 279, 1874.

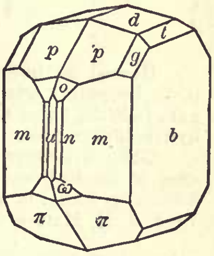
Monoclinic (or triclinic?). Axes $\breve{a} : \bar{b} : \grave{c} = 0·9125 : 1 : 0·2660$; $\beta = 84° 35' = 001 \wedge 100$ Schrauf[1].

$100 \wedge 110 = 42° 15\frac{1}{6}'$, $001 \wedge 101 = 15° 46\frac{1}{3}'$, $001 \wedge 011 = 14° 50'$.

**Forms:**
*a* (100, *i*-$\bar{i}$)
*b* (010, *i*-$\grave{i}$)
*n* (210, *i*-$\bar{2}$)
*m* (110, *I*)
*l* (120, *i*-$\grave{2}$)
*d* (011, 1-$\grave{i}$)
*t* (031, 3-$\grave{i}$)
*o* (411, − 4-$\bar{4}$)
*p* (211, − 2-$\bar{2}$)
*ω* ($\bar{4}$11, 4-$\bar{4}$)
*π* ($\bar{2}$11, 2-$\bar{2}$)
*g* (231, − 3-$\frac{3}{2}$)
*e* (251, − 5-$\frac{5}{2}$)
*γ* ($\bar{2}$31, 3-$\frac{3}{2}$)

Also *ψ* ($\bar{1}\bar{0}$·0·1, 10-$\bar{i}$).

$nn''' = 48° 51'$
$mm''' = 84° 30'$
$ll' = 57° 39\frac{1}{2}'$
$dd' = 29° 40'$
$tt' = 76° 56'$
$oo' = 18° 43\frac{1}{2}'$
$\gamma p' = 24° 48'$
$gg' = 66° 50'$
$\omega\omega' = 20° 31\frac{1}{2}'$
$\pi\pi' = 26° 52'$
$ao = 39° 15\frac{1}{2}'$
$ap = 56° 40'$
$a'\omega = 43° 52'$
$a'\pi = 64° 37\frac{1}{2}'$



After Schrauf.

In small highly modified crystals, with monoclinic symmetry. Also in incrustations sometimes crystalline, or globular, sometimes glassy, with a reniform surface.

Cleavage: *b*. H. = 2–2·5. G. = 2·48. Luster strongly vitreous. Colorless to white. Transparent to translucent. Ax. pl. in a section ‖ *b* inclined 69½° to edge *bm*, 13½° to *bp*, 15° to *bd*. $Bx_a$ normal, or nearly so, to *b*. 2E = 55°. Dispersion $\rho < v$, also crossed.

**Comp.**—$HCaAsO_4 + 3\frac{1}{2}H_2O$ or $2CaO.As_2O_5.8H_2O$ = Arsenic pentoxide 47·4, lime 23·0, water 29·6, = 100. The calcium is replaced in part by magnesium.

**Anal.**—Frenzel, l. c.

| $As_2O_5$ | $CaO$ | $MgO$ | $H_2O$ | |
|---|---|---|---|---|
| 47·70 | 14·19 | 8·29 | 29·40 | = 99·58 |
| 47·69 | 15·60 | 7·35 | 29·49 | = 100·13 |

5 equivalents of water (19 p. c.) go off at 100°, the remainder at 360°.

**Obs.**—Found with pharmacolite at Joachimsthal; also at Schneeberg. Named after Herrn Wappler of the Freiberg Mineralien-Niederlage.

**Ref.**—[1] Jb. Min., 290, 1875, and later Zs. Kr., 4, 281, 1880. It may yet prove that wapplerite belongs to the monoclinic system, from which it deviates but little, if at all. The triclinic axial ratio and angles deduced by Schrauf (l. c., 1880) are as follows:

$$\breve{a} : \bar{b} : \grave{c} = 0·90089 : 1 : 0·26159;\quad \alpha = 90° 13' 55'',\quad \beta = 95° 20',\quad \gamma = 90° 10' 35''.$$

RÖSSLERITE *R. Blum* [JB. Wett. Ges. Hanau, 32, 1861], Jb. Min., 334, 1861.

Described as occurring with pharmacolite and erythrite in the Kupferschiefer at Bieber, Hesse, in thin crystalline plates with columnar or fibrous structure. One cleavage. H. = 2–3. Luster vitreous or dull. Colorless or white. An analysis by Delffs gave:

$As_2O_5$ 40·16 $MgO$ 14·22 $CaO$ *tr.* $H_2O$ 45·62 = 100

This conforms to the formula $HMgAsO_4 + 7H_2O$. Named after Dr. K. Rössler.

A mineral referred here by Tschermak (Ber. Ak. Wien, **56** (1), 828, 1867) occurring in monoclinic crystals at Joachimsthal and Kremnitz is made by Schrauf (Jb. Min., 290. 1875) an altered form of wapplerite. This may be true of the original mineral also. An analysis gave Tschermak: $As_2O_5$ 49·1, MgO 17·0, $H_2O$ 34·7 = 100·8.

**623. HANNAYITE.** *Ulrich, vom Rath*, Ber. nied. Ges., p. 11, Jan. 7, 1878; p. 5, Jan. 13 1879.

Triclinic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·6990 : 1 : 0·9748$; $\alpha = 122° 31\frac{1}{2}'$, $\beta = 126° 46\frac{1}{6}'$, $\gamma = 54° 9'$ Rath.

100 ∧ 010 = 112° 58¼′, 100 ∧ 001 = *65° 28′, 010 ∧ 001 = 73° 14′.

After Rath.

**Forms:** *a* (100, *i-ī*), *c* (001, *O*); *m* (110, *I′*), *l* (130, *i-3̆′*) cleavage, *M* (1$\bar{1}$0, ′*I*); ω ($\bar{1}\bar{3}$3, 1-3,).

Angles: *am* = *39° 32′, *mM* = *65° 26′, *cm* = *50° 50′, *cω* = 52° 20′, *aω* = *70° 24′.

In small and slender prismatic crystals, vertically striated. Cleavage: *c*, *m*, *M*, *l*. G. = 1·893. Color yellowish.

**Comp.**—A hydrous phosphate of magnesium and ammonium, $Mg_3P_2O_8.2H_2(NH_4)PO_4+8H_2O$ or $(NH_4)_2O.3MgO.2P_2O_5.10H_2O$ = Phosphorus pentoxide 44·4, magnesia 18·7, ammon. ox. 5·6, water 22·5 = 100.

**Anal.**—1, MacIvor, quoted by Rath, l. c. 2, Id., Ch. News, **55**, 216, 1887.

| | $P_2O_5$ | MgO | $(NH_4)_2O$ | $H_2O$ | |
|---|---|---|---|---|---|
| 1. | $\frac{2}{3}$ 45·70 | 18·90 | 8·09 | 28·20 | = 100·89 |
| 2 | 44·71 | 18·54 | 8·10 | [28·25] | FeO 0·31, MnO 0·09 = 100 |

Heated 36 hours at 100° undergoes no change; between 100° and 110° or 115° loses 21·08 p. c., becoming opaque; heated over a Bunsen flame loses the remainder of the water and the ammonia (36·48 = total loss). The remainder fuses, but dissolves only in part in concentrated hydrochloric acid.

**Obs.**—Discovered by MacIvor of Melbourne in the bat guano which forms deposits 30 feet deep in the Skipton basaltic caves 30 miles s.w. of Ballarat, Victoria, and recognized as new by Ulrich, as stated in a letter to vom Rath. Occurs with struvite and newberyite. Named after Prof. J. B. Hannay, of Manchester, England.

**624. HUREAULITE.** *Alluaud*, Vauquelin, Ann. Ch. Phys., **30**, 302, 1825; *Alluaud*, Ann. d. Sc. Nat., 8, 349, 1826. *Dufrénoy*, Ann. Ch. Phys., **41**, 338, 1829; *Des Cloizeaux* and *Damour*, ibid., **53**, 293, 1858.

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c} = 1·9192 : 1 : 0·5245$; $\beta = {*}84° 1'$ = 001 ∧ 100 E. S. Dana[1].

100 ∧ 110 = *62° 21′, 001 ∧ 101 = 14° 48′·2, 001 ∧ 011 = 27° 32′·9.

| | | | | |
|---|---|---|---|---|
| **Forms:** | *c* (001, *O*) | β ($\bar{5}$01, 5-ī) | ϵ ($\bar{2}$21, 2) | *z* ($\bar{6}$21, 6-3̄) |
| *a* (100, *i-ī*) | *m* (110, *I*) | *p* (223, − ⅔) | *k* ($\bar{5}$11, 5-5) | *l* ($\bar{8}$41, 8̄-2) |
| *b* (010, *i-ì*) | α ($\bar{4}$01, 4-ī) | δ (111, − 1) | | |

See also below, ref. [1], for planes on figs. 3, 4.

| | | | |
|---|---|---|---|
| *mm‴* = 124° 42′ | *cm* = 87° 14′ | *a′l* = 47° 59′ | *m′ϵ* = 41° 29′ |
| *cα* = 50° 49′ | *cϵ* = 51° 17′ | *pp′* = 37° 9′ | *m′l* = 25° 13′ |
| *a′α* = 45° 10′ | *ap* = 74° 47½′ | *δδ′* = 52° 14½′ | *m′k* = 51° 9′ |
| *cp* = 21° 3′ | *aδ* = 71° 25′ | *kk′* = 35° 58′ | *m′α* = *70° 54′ |
| *cδ* = 29° 46′ | *a′k* = 41° 40′ | *ll′* = 84° 15′ | |

In short prismatic crystals, sometimes tabular ‖ *a*. Faces *a*, *m* striated; also ϵ ‖ edge *m*/ϵ, and δ ‖ edge δ/*m*. In Branchville crystals zone *m l k a* striated ‖ intersection-edges. Crystals isolated or grouped, the groups sometimes mammillary, or fascicled as in stilbite. Also massive, compact, scaly, or imperfectly fibrous.

Cleavage: *a* rather perfect. H. = 5. G. = 3·185, yellow, and 3·198, reddish, Damour; 3·149 Branchville. Luster vitreous, somewhat greasy, bright. Color orange-red, brownish orange, rose-violet, and pale rose, grayish, nearly colorless. Streak nearly white. Transparent to translucent.

Optically −. Ax. pl. $\perp b$. Bx $\perp b$; $Bx_o \wedge \dot{c} = +75°$ or $\mathfrak{c}a = 15°$ for red; $Bx_o \wedge \dot{c} = 76°$ or $\mathfrak{c}a = 14°$ for blue. Dispersion $\rho < v$ large; crossed distinct (1°).

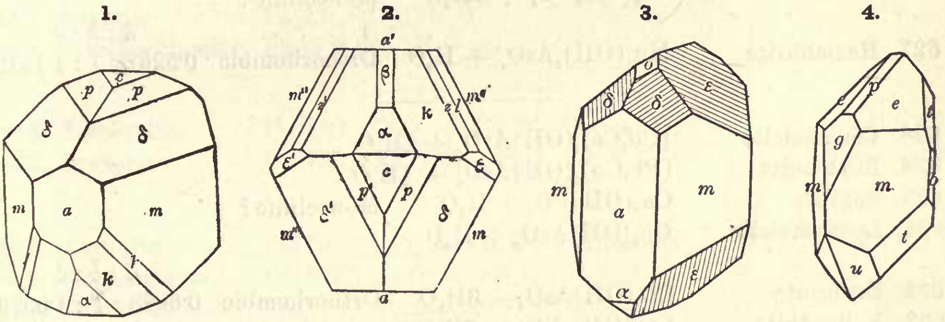
Limoges $2H_{a.r} = 88° 52'$ ∴ $2E_r = 173° 52'$ $2H_y = 86° 22'$ $2H_{bl} = 87° 17'$

Other trials gave $2H_{a.r} = 84° 51'$, $85° 55'$, etc. The angle diminishes 6° 34′ between 41°·5 and 121° C., Dx.

**Var.**—The (*a*) brownish orange or yellowish, (*b*) the rose-violet, and (*c*) the pale rose, are three varieties occurring at Limoges, differing somewhat in their crystalline planes. The orange is the most common.

**Comp.**—$H_2Mn_5(PO_4)_4 + 4H_2O$ or $5MnO.2P_2O_5.5H_2O$ = Phosphorus pentoxide 39·0, manganese protoxide 48·6, water 12·4 = 100.

**Anal.**—1, Dufrénoy, l. c., 1829. 2–4, Damour, l. c., 1858. 5, H. L. Wells, Am. J. Sc., **39**, 210, 1890.



Figs. 1, 2, Branchville. 3, 4, Limoges, Dx.

| | G. | $P_2O_5$ | MnO | FeO | CaO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|
| 1. Limoges | | 38·00 | 32·85 | 11·10 | — | 18·00 | | = 99·95 |
| 2. " *yellow* | 3·185 | 37·96 | 41·15 | 8·10 | — | 12·35 | quartz 0·35 | = 99·91 |
| 3. " " | | 38·20 | 42·04 | 6·75 | — | 12·00 | " 0·50 | = 99·49 |
| 4. " *reddish* | 3·198 | 37·83 | 41·80 | 8·73 | — | 11·60 | " 0·30 | = 100·26 |
| 5. Branchville | 3·149 | 38·36 | 42·29 | 4·56 | 0·94 | 12·25 | " 1·76 | = 100·11 |

**Pyr., etc.**—In the closed tube gives water. B.B. fuses to an orange-yellow or reddish yellow crystalline pearl, brown in the outer flame, then becomes black, and the flame is colored green. Reactions of manganese and iron. Easily soluble in acids.

**Obs.**—Found in cavities of triphylite or its altered form heterosite, in granite, at Limoges, commune of Huréaux, France. Probably at Michelsdorf, Silesia, with sarcopside (Websky).

In the U. States, at Branchville, Conn., in a vein of albitic granite, immediately associated with lithiophilite, also fairfieldite, dickinsonite, etc.

**Ref.**—[1] Branchville, Conn., Am. J. Sc., **39**, 207, 1890.

As described by Dx., the Limoges crystals conform to two types: Type I, f. 4, with *b* (010), *p* (001), *m* (110); also *g* (301), *e* (011), *u* $(\bar{3}\bar{1}1)$, *t* $(\bar{3}41)$. Again, II, f. 3, with *a* (100), *m* (110); also *o* (105), $\alpha$ $(\bar{1}5\cdot0\cdot8)$, $\delta$ (435), *k* $(\overline{19}\cdot5\cdot8)$, *x* $(\overline{11}\cdot9\cdot10)$, $\epsilon$ $(\bar{9}\cdot11\cdot10)$.

The axial ratio and calculated angles are: $\grave{a} : \bar{b} : \acute{c} = 1·6977 : 1 : 0·8887$; $\beta = 89° 27' = 001 \wedge 100$. $mm''' = 119° 0'$; $po = 5° 58'$, $pg = 57° 7'$; $p\alpha = 44° 44'$, $pm = 89° 43'$, $ee' = 83° 15'$, $a\delta = 69° 17'$, $a'\epsilon = 71° 44'$, $p\epsilon = 47° 28'$, $\delta\delta' = 52° 13'$; $\epsilon\epsilon' = 83° 11'$, $uu' = 51° 14'$; $pt = 75° 47'$, $tt' = 124° 55'$, $bt = 27° 32'$.

Referred to the axial ratio above accepted, the forms of Dx., type I, receive the following probable symbols: $b = 010$, $p = \bar{1}03$, $m = 110$, $e = \bar{1}53$, $u = \overline{12}\cdot3\cdot2$?, $t = 661$?. Those of type II become: $a = 100$, $m = 110$, $o = 001$, $\alpha = \bar{4}01$, $\delta = 111$, $k = \bar{5}11$, $x = 532$?, $\epsilon = \bar{2}21$.

The angles of Dx. differ from those of Branchville chiefly in the prismatic zone. Type II conforms most nearly to the Branchville crystals, and referred to their axial ratio the anomalously complex symbols become simple. The relations of the other type are less certain. The Limoges crystals obviously need further examination.

**625. FORBESITE.** Hydrous Bibasic Arsenate of Nickel and Cobalt *D. Forbes*, Phil. Mag., 25, 103, 1863. Forbesit *Kenngott*, Ueb., 1862–65, 46, 1868.

Structure fibro-crystalline.

H. = 2·5. G. = 3·086. Luster dull to silky or resinous. Color grayish white.

**Comp.**—$H_2(Ni,Co)_2As_2O_8 + 8H_2O$ = Arsenic pentoxide 42·5, nickel protoxide 18·4, cobalt protoxide 9·2, water 29·9 = 100.

**Anal.**—Forbes, l. c.

$As_2O_5$ 44·05 NiO 19·71 CoO 9·24 $H_2O$ 26·98 = 99·98

**Pyr.**—B.B. in the closed tube yields water, becoming darker; on charcoal fuses imperfectly, evolves arsenic fumes, leaving metallic globules of an arsenide of nickel and cobalt. With fluxes gives reactions for nickel and cobalt.

**Obs.**—Occurs in the desert of Atacama in veins in a decomposed dioryte. A few yards below the surface it passes into chloanthite, from which mineral it appears to have been derived.

## Hydrous Phosphates, etc.—Basic Division.

| | | | | | |
|---|---|---|---|---|---|
| 626. | **Isoclasite** | $Ca_2(OH)PO_4 + 2H_2O$ | Monoclinic? | | |
| | | | | $\breve{a} : \bar{b} : \dot{c}$ | |
| 627. | **Hemafibrite** | $Mn_3(OH)_3AsO_4 + H_2O$ | Orthorhombic | 0·5261 : 1 : 1·1510 | |

| | | | | | |
|---|---|---|---|---|---|
| 628. | **Conichalcite** | $(Cu,Ca)_2(OH)AsO_4 + \frac{1}{4}H_2O$ | | | |
| 629. | **Bayldonite** | $(Pb,Cu)_2(OH)AsO_4 + \frac{1}{2}H_2O$ | | | |
| 630. | **Tagilite** | $Cu_2(OH)PO_4 + H_2O$ | Monoclinic? | | |
| 631. | **Leucochalcite** | $Cu_2(OH)AsO_4 + H_2O$ | | | |
| | | | | $\breve{a} : \bar{b} : \dot{c}$ | |
| 632. | **Euchroite** | $Cu_2(OH)AsO_4 + 3H_2O$ | Orthorhombic | 0·6088 : 1 : 1·0379 | |
| 633. | **Volborthite** | $Cu_3(OH)_3VO_4 + 6H_2O$? | | | |
| 634. | **Cornwallite** | $Cu_6(OH)_4As_2O_8 + H_2O$ | | | |
| 635. | **Tyrolite** | $Cu_5(OH)_4As_2O_8 + 7H_2O$ | Orthorhombic | $\breve{a} : \bar{b}$ = 0·9325 : 1 | |
| 636. | **Chalcophyllite** | $Cu_7(OH)_8As_2O_8 + 10H_2O$? | Rhombohedral | $\dot{c}$ = 2·5538 | |
| 637. | **Veszelyite** | $(Cu,Zn)_7(OH)_8(As,P)_2O_8 + 5H_2O$ | Monoclinic or Triclinic | | |
| | | | | $\grave{a} : \bar{b} : \dot{c}$ | β |
| 638. | **Ludlamite** | $\overset{\text{II}}{Fe}_7(OH)_2(PO_4)_4 + 8H_2O$ | Monoclinic | 2·2520 : 1 : 1·9819 | 79° 27′ |
| | | | | $\breve{a} : \bar{b} : \dot{c}$ | |
| 639. | **Wavellite** | $Al_3(OH)_3(PO_4)_2 + 4\frac{1}{2}H_2O$ | Orthorhombic | 0·5049 : 1 : 0·3751 | |
| 640. | **Fischerite** | $Al_2(OH)_3PO_4 + 2\frac{1}{2}H_2O$ | Orthorhombic | $\breve{a} : \bar{b}$ = 0·5937 : 1 | |
| 641. | **Peganite** | $Al_2(OH)_3PO_4 + 1\frac{1}{2}H_2O$ | Orthorhombic | $\breve{a} : \bar{b}$ = 0·499 : 1 | |
| 642. | **Turquois** | $Al_2(OH)_3PO_4 + H_2O$<br>(with $HCuPO_4 + 1\frac{1}{2}H_2O$) | | | |
| 643. | **Sphærite** | $Al_5(OH)_9(PO_4)_2 + 3\frac{1}{2}H_2O$ | | | |
| 644. | **Liskeardite** | $(Al,Fe)_3(OH)_6AsO_4 + 5H_2O$ | | | |
| 645. | **Evansite** | $Al_3(OH)_6PO_4 + 6H_2O$ | | | |
| 646. | **Pharmacosiderite** | $Fe_4(OH)_3(AsO_4)_3 + 6H_2O$ | Isometric; tetrahedral | | |
| 647. | **Cacoxenite** | $Fe_2(OH)_3PO_4 + 4\frac{1}{2}H_2O$ | | | |
| | | | | $\grave{a} : \bar{b} : \dot{c}$ | β |
| 648. | **Beraunite**<br>Eleonorite | $Fe_3(OH)_3(PO_4)_2 + 2\frac{1}{2}H_2O$ | Monoclinic | 2·7538 : 1 : 4·0165 | 41° 33′ |

| | | | | $\breve{a} : \bar{b} : \acute{c}$ |
|---|---|---|---|---|
| 649. | **Childrenite** | $(Fe,Mn)Al(OH)_2PO_4 + 2H_2O$ | Orth. | 0·7780 : 1 : 0·5258 |
| 650. | **Eosphorite** | $(Mn,Fe)Al(OH)_2PO_4 + 2H_2O$ | " | 0·7768 : 1 : 0·5150 |

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| | | | | |
|---|---|---|---|---|
| 651. | **Mazapilite** | $Ca_3Fe_2(FeO)_2(OH)_2(AsO_4)_4 + 5H_2O$ | Orthorhombic | 0·8617 : 1 : 0·9980 |
| 652. | **Calcioferrite** | $Ca_3Fe_3(OH)_3(PO_4)_4 + 8H_2O$ | Monoclinic | |
| 653. | **Borickite** | $CaFe_4(OH)_8(PO_4)_2 + 4H_2O$? | | |
| 654. | **Liroconite** | $Cu_9Al_4(OH)_{15}(AsO_4)_5 + 20H_2O$ | Monoclinic | $\grave{a} : \bar{b} : \acute{c} = 1\cdot3191 : 1 : 1\cdot6808$ $\beta = 88° 33'$ |
| 655. | **Chenevixite** | $Cu_2(FeO)_2As_2O_8 + 3H_2O$? | | |
| | Henwoodite | | | |
| 656. | **Chalcosiderite** | $Cu\overset{III}{Fe}_5P_4O_{20}.8H_2O$ | Triclinic | $\breve{a} : \bar{b} : \acute{c} := 0\cdot7910 : 1 : 0\cdot6051$; $\alpha = 92° 58'$, $\beta = 93° 30'$, $\gamma = 107° 41'$ |
| 657. | **Goyazite** | $Ca_3Al_{10}P_2O_{23}.9H_2O$ | | |
| 658. | **Plumbogummite** | $PbAl_4P_2O_{12}.9H_2O$ pt. | | |

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| | | | | |
|---|---|---|---|---|
| 659. | **Torbernite** | $Cu(UO_2)_2P_2O_8 + 8H_2O$ | Tetragonal | $\acute{c} = 2\cdot9361$ |
| 660. | **Zeunerite** | $Cu(UO_2)_2As_2O_8 + 8H_2O$ | " | $\acute{c} = 2\cdot9125$ |

| | | | | $\breve{a} : \bar{b} : \acute{c}$ |
|---|---|---|---|---|
| 661. | **Autunite** | $Ca(UO_2)_2P_2O_8 + 8H_2O$ | Orthorhombic | 0·9875 : 1 : 2·8517 |
| 662. | **Uranospinite** | $Ca(UO_2)_2As_2O_8 + 8H_2O$ | " | |
| 663. | **Uranocircite** | $Ba(UO_2)_2P_2O_8 + 8H_2O$ | " | |
| 664. | **Phosphuranylite** | $(UO_2)_3(PO_4)_2 + 6H_2O$ | | |
| 665. | **Trögerite** | $(UO_2)_3(AsO_4)_2 + 12H_2O$ | | |
| 666. | **Walpurgite** | $Bi_{10}(UO_2)_3(OH)_{24}(AsO_4)_4$ | | |
| 667. | **Rhagite** | $Bi_{10}(OH)_{18}(AsO_4)_4$ | | |
| | | $5Bi_2O_3.2As_2O_5 + 9H_2O$ | | |
| 668. | **Mixite** | $Cu_{10}Bi(OH)_8(AsO_4)_5 + 7H_2O$ | | |

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**626. ISOCLASITE.** Isoklas *Sandberger*, J. pr. Ch., **2**, 125, 1870.

Monoclinic? In minute crystals with dull faces. Also columnar.

Cleavage: clinodiagonal, perfect. H. = 1·5. G. = 2·92. Luster vitreous to pearly. Colorless to snow-white.

**Comp.**—$Ca_3P_2O_8.Ca(OH)_2.4H_2O$ or $4CaO.P_2O_5.5H_2O$ = Phosphorus pentoxide 31·2, lime 49·1, water 19·7 = 100.

**Anal.**—Sandberger, l. c.

$P_2O_5$ 29·90 CaO 49·51 $H_2O$ 18·53 (ign.) $H_2O$ 2·06 (at 100°) = 100

**Pyr., etc.**—In the closed tube gives off neutral water. B.B. the fresh mineral glows and fuses. Soluble in hydrochloric acid.

**Obs.**—Found with hornstone and brown-spar on specimens from Joachimsthal, obtained eighty years ago, and now in the Würzburg Museum.

Altered crystals yielded: $P_2O_5$ 34·00, CaO 1·00, MgO 17·30, $Na_2O$ 9·80, $Fe_2O_3,Al_2O_3$ 0·36, $H_2O$ 9·22 (ign.), $H_2O$ 24·26 (100°), insol. 0·18 = 96·12.

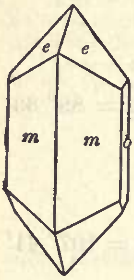
Named from *ἴσος, equal*, and *κλάσις, fracture*.

**627. HEMAFIBRITE.** Aimafibrit *L. J. Igelström*, Öfv. Ak. Stockh., **41**, No. 4, 86, 1884. Hämafibrite.

Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c} = 0{\cdot}5261 : 1 : 1{\cdot}1510$ H. Sjögren[1].
$100 \wedge 110 = 27° 45'$, $001 \wedge 101 = 65° 26\frac{1}{6}'$, $001 \wedge 011 = 49° 1'$.

**Forms**[1]: *b* (010, *i-ĭ*), *m* (110, *I*), *e*(122, 1-$\breve{2}$).

Angles: *mm'''* = *55° 30', *ee'* = 71° 19', *ee''* = 115° 36', *ee'''* = *75° 40', *be* = 52° 10', *me* = 36° 44'. The form approximates closely to that of scorodite, strengite, and reddingite.



Crystals prismatic; commonly in spherical radiated groups with fibrous structure.

Cleavage: *b* distinct; *m* less so. Fracture uneven. Brittle. H. = 3. G. = 3·50–3·65 A. Sj. Luster vitreous on crystalline faces, greasy on the fracture. Color brownish red to garnet-red, soon becoming brownish black to black. Streak brick-red. Transparent to translucent.

Optically +. Ax. pl. ∥ *a*. Bx ⊥ *c*. 2E = 70° approx. Dispersion $\rho > v$.

**Comp.**—$Mn_3As_2O_8.3Mn(OH)_2 + 2H_2O$ or $6MnO.As_2O_5.5H_2O$ = Arsenic pentoxide 30·93, manganese protoxide 57·0, water 12·1 = 100.

**Anal.**—1, A. Sjögren, Zs. Kr., **10**, 129, 1885. 2, C. H. Lundström, ibid.

| | $As_2O_5$ | MnO | FeO | $H_2O$ | |
|---|---|---|---|---|---|
| 1. Nordmark | 30·76 | 57·94 | 0·79 | 12·01 | = 101·50 |
| 2. " | 30·88 | 58·02 | 0·25 | 12·01 | MgO 0·41 = 101·57 |

An earlier but incorrect analysis with somewhat different results is given by Igelström, l. c.

**Pyr.**—B.B. fuses easily to a black slaggy bead. On charcoal yields arsenical fumes. Gives off water in the closed tube, and becomes black. Soluble in hydrochloric acid.

**Obs.**—Occurs with other manganese minerals at the Moss mine, Nordmark, Sweden; it is easily decomposed on exposure and goes over into a black foliated mineral. Named from αἷμα, *blood*, and Latin *fibra, fiber*, in allusion to its red color and also to the fibrous structure.

**Ref.**—[1] G. För. Förh., **7**, 386, 1884, and Zs. Kr., **10**, 126, 1885. Cf. also Btd., Bull. Soc. Min., **7**, 124, 1884.

**628. CONICHALCITE.** Konichalcit *Breithaupt* and *Fritzsche*, Pogg., **77**, 139, 1849.

Reniform and massive, resembling malachite.

Fracture splintery. Brittle. H. = 4·5. G. = 4·123. Color pistachio-green, inclining to emerald-green; streak the same. Subtranslucent.

**Comp.**—Perhaps $(Cu,Ca)_3As_2O_8.(Cu,Ca)(OH)_2 + \frac{1}{2}H_2O$ or $4(Cu,Ca)O.As_2O_5.1\frac{1}{2}H_2O$ = Arsenic pentoxide 43·6, cupric oxide 30·1, lime 21·2, water 5·1 = 100. Here Cu : Ca = 1 : 1.

The original mineral also contains phosphorus and in small amount vanadium replacing the arsenic. These are absent in the Utah variety, which also contains zinc and further gives the ratio RO : $As_2O_5 : H_2O$ = 4 : 9·44 : 1·64.

**Anal.**—1–3, Fritzsche, l. c. 4, Hillebrand, Proc. Col. Sc. Soc., **1**, 114, 1884.

| | $As_2O_5$ | $P_2O_5$ | $V_2O_5$ | CuO | CaO | ZnO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Spain | 30·68 | [8·81] | 1·78 | 31·76 | 21·36 | — | 5·61 | = 100 |
| 2. " | 32·41 | — | | 31·60 | 21·82 | | 5·30 | |
| 3. " | *undet.* | 9·10 | | *undet.* | 22·10 | | 5·56 | [$CO_2$ 0·97], quartz 0·90 = 100 |
| 4. Utah | 39·94 | 0·14 | — | 28·68 | 19·79 | 2 86 | 5·52 | $Fe_2O_3$ 0·36, MgO 0·54, Ag 0·30, |

**Pyr., etc.**—In the closed tube decrepitates, gives water and turns black. In the forceps fuses, and colors the flame at first emerald-green, but after a time light blue adjacent to the assay. On charcoal fuses with deflagration to a red slag-like mass, which gives an alkaline reaction to test paper, and with soda gives a globule of copper. On charcoal, with salt of phosphorus and metallic lead, the Spanish mineral yields a glass which is dark yellow while hot and chrome-green on cooling (vanadium).

**Obs.**—From Hinajosa de Cordova, in Andalusia, Spain. Also from the American Eagle mine, Tintic district, Utah, where it occurs with other copper arsenates, derived from the alteration of enargite.

Named from κονία, *powder*, and χαλκός, *lime*.

**629. BAYLDONITE.** *A. H. Church*, J. Ch. Soc., **18**, 265, 1865.

In minute mammillary concretions, with a drusy surface. Structure often somewhat reticulated.

Fracture subconchoidal, uneven. H.$=$ 4·5. G.$=$ 5·35. Luster strong resinous Color grass-green to blackish green. Streak siskin- to apple-green. Subtranslucent.

**Comp.**—$(Pb,Cu)_3As_2O_8.(Pb,Cu)(OH)_2 + H_2O$ or $4(Pb,Cu)O.As_2O_5.2H_2O$, with Pb : Cu $= 1 : 3 =$ Arsenic pentoxide 31·7, cupric oxide 32·7, lead protoxide 30·6, water 5·0 $=$ 100.

**Anal.**—Church, l. c.

$As_2O_5$ 31·76 CuO 30·88 PbO 30·13 $H_2O$ 4·58 $Fe_2O_3$, CaO, and loss 2·65 $=$ 100

**Pyr., etc.**—B.B. gives off water and becomes black. On charcoal fuses to a black bead, deflagrates, giving off arsenical fumes, and leaves a white metallic bead of lead and copper. With borax in outer flame gives a blue bead. Difficultly soluble in nitric acid.

**Obs.**—Occurs in Cornwall. Named after Dr. John Bayldon.

**630. TAGILITE.** Tagilith (fr. N. Tagilsk) *Hermann*, J. pr. Ch., **37**, 184, 1846; (fr. Ullersreuth) *Breith.*, B. H. Ztg., **24**, 309, 1865.

Monoclinic, but like liroconite in habit of crystals, Breith. Also in reniform or spheroidal concretions. Structure fibrous; also earthy.

Cleavage: brachydiagonal, distinct. Fracture uneven. Brittle. H. $=$ 3–4. G. $=$ 4·076 Breith. Luster vitreous. Color verdigris- to emerald-green. Streak verdigris-green. Subtranslucent.

**Comp.**—$Cu_3P_2O_8.Cu(OH)_2 + 2H_2O$ or $4CuO.P_2O_5.3H_2O$ $=$ Phosphorus pentoxide 27·7, cupric oxide 61·8, water 10·5 $=$ 100.

**Anal.**—1, Hermann, l. c., including a little limonite. 2, Field, Ch. Gaz., **17**, 225, June 15, 1859.

| | $P_2O$ | CuO | $H_2O$ | |
|---|---|---|---|---|
| 1. Ural | 26·44 | 61·29 | 10·77 | $Fe_2O_3$ 1·50 $=$ 100 |
| 2. Coquimbo | 27·42 | 61·70 | 10·25 | $=$ 99·37 |

**Pyr.**—Like libethenite, p. 786.

**Obs.**—Occurs at Nizhni Tagilsk in the Ural, on limonite; at the Arme Hilfe mine, Ullersreuth, in minute crystals and reniform groups or masses, on limonite, with quartz; in S. America, at the Mercedes mine, Coquimbo, fibrous on limonite.

Hermann's *tagilite* was in reniform concretions, with H. $=$ 3, G. $=$ 3·5, and color emerald- to mountain-green; and had the composition mentioned. The other characters in the above description (excepting the anal. by Field) are from Breithaupt, in an account of the Ullersreuth ore, which he refers to tagilite, but which has not been analyzed and may perhaps not be that species.

**631. LEUCOCHALCITE.** Leucochalcit *Sandberger*, *Petersen*, Jb. Min., **1**, 263, 1881.

In very slender, needle-like crystals. Nearly white, with tinge of green. Luster silky.

**Comp.**—Probably $Cu_3As_2O_8.Cu(OH)_2 + 2H_2O$ or $4CuO.As_2O_5.3H_2O$ $=$ Arsenic pentoxide 42·7, cupric oxide 47·2, water 10·0 $=$ 100.

**Anal.**—Petersen.

$As_2O_5$ [37·89] $P_2O_5$ 1·60 CuO 47·10 CaO 1·56 MgO 2·28 ign.* 9·57 = 100

* $H_2O,CO_2$ *tr.*

**Pyr., etc.**—Becomes first green on ignition, and finally fuses to a black glass.

**Obs.**—Occurs as a delicate coating with malachite and calcite at the Wilhelmine mine in the Spessart, Germany.

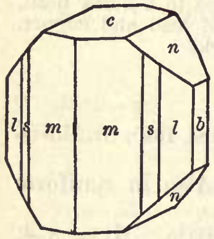
**632. EUCHROITE.** Euchroit *Breithaupt*, Char., 172, 266, 1823.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·6088 : 1 : 1·0379$ Haidinger[1].
$100 \wedge 110 = 31° 20'$, $001 \wedge 101 = 59° 36\frac{1}{3}'$, $001 \wedge 011 = 46° 4'$.

**Forms**[1]: *b* (010, *i*-*ì*), *c* (001, *O*); *m* (110, *I*), *s* (230, *i*-$\frac{3}{2}$), *l* (120, *i*-$\breve{2}$); *d* (102, $\frac{1}{2}$-$\bar{i}$)[2], *e* (101, 1-$\bar{i}$)[2], *n* (011, 1-$\breve{i}$).

Angles: *mm'''* = *62° 40', *ss'* = 95° 12', *ll'* = 78° 47½', *dd'* = 80° 52', *ee'* = 119° 13', *nn'* = *92° 8'.

Habit prismatic; faces *msl* striated vertically.



Cleavage: *m*, *n* (011) in traces. Fracture small conchoidal to uneven. Rather brittle. H. = 3·5–4. G. = 3·389. Luster vitreous. Color bright emerald- or leek-green. Transparent to translucent. Optically +. Ax. pl. ‖ *a*. Bx ⊥ *c*. Axial angles:

2E = 61° 11' at 17° C. and 56° 8' at 86° C., Dx.[3]

**Comp.**—$Cu_3As_2O_8.Cu(OH)_2 + 6H_2O$ or $4CuO.As_2O_5.7H_2O$ = Arsenic pentoxide 34·2, cupric oxide 47·1, water 18·7 = 100.

Analyses agree closely, see 5th Ed., p. 566. Wöhler obtained: $As_2O_5$ 33·22, CuO 48·09, $H_2O$ 18·39 = 99·70, Lieb. Ann., **51**, 285, 1844.

**Pyr., etc.**—In the closed tube gives more water, but has otherwise the same reactions as olivenite.

**Obs.**—Occurs in quartzose mica slate at Libethen in Hungary, in crystals of considerable size, having much resemblance to dioptase.

Named from εὔχροα, *beautiful color.*

**Alt.**—Tschermak suggests that olivenite may be euchroite altered by the loss of water, he finding crystals of olivenite projecting from the holes of cavernous euchroite, Ber. Ak. Wien, **51**, 129.

**Ref.**—[1] Ed. J. Sc., **2**, 133, 1825, or Pogg., **5**, 165, 1825; also Dx., Ann. Ch. Phys., **13**, 423, 1845. [2] Solly, Proc. Cambridge Phil. Soc., **4**, 6, 1883. [3] Propr. Opt., **2**, 30, 1859, N. R., 57, 1867.

**633. VOLBORTHITE.** *Hess*, Bull. Ac. St. Pet., **4**, 1838, and J. pr. Ch., **14**, 52, 1838. Knauffite. Vanadate of Copper. Vanadinsaures Kupfer.

In small six-sided tables, often aggregated in globular forms.

Cleavage: in one direction very perfect. H. = 3–3·5. G. = 3·55 Credner. Luster pearly to vitreous. Color olive-green, citron-yellow. Streak clear yellowish green, nearly yellow. Thin splinters translucent.

**Comp.**—A hydrous vanadate of copper, barium, and calcium; perhaps $(Cu,Ca,Ba)_3(OH)_3VO_4 + 6H_2O$ = Vanadium pentoxide 19·6, cupric oxide 38·4, lime 6·8, baryta 6·2, water 29·0 = 100.

**Anal.**—1, 2, Genth, Am. Phil. Soc. Philad., **17**, 122, 1877; 1*a*, 2*a*, the same, after deduction of impurities (Rg., Min. Ch. Erg., 263, 1886).

| | $V_2O_5$ | CuO | BaO | CaO | MgO | $H_2O$ | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ |
|---|---|---|---|---|---|---|---|---|---|
| **1.** | 13·62 | 34·04 | 4·29 | 4·29 | 3·01 | [33·15] | 1·38 | 4·45 | 1·77 = 100 |
| **2.** | 13·59 | 38·01 | 4·30 | 4·49 | 1·42 | [31·60] | 1·36 | 4·78 | 0·45 = 100 |
| 1*a*. | 14·74 | 36·84 | 4·64 | 4·64 | 3·26 | 35·88 | — | — | — = 100 |
| 2*a*. | 14·55 | 40·70 | 4·60 | 4·80 | 1·52 | 33·83 | — | — | — = 100 |

The material analyzed consisted of about 85 p. c. of insoluble gangue, the analysis of the remainder is given in 1 and 2; in 1*a*, 2*a*, the corresponding results after the deduction of the impurities are given. Calciovolborthite or Kalkvolborthit, p. 790, has a very different composition.

**Pyr., etc.**—B.B. on charcoal fuses easily to a black bead, which in the inner flame becomes blackish gray. With soda on charcoal yields copper; with borax and salt of phosphorus reactions for copper. Fused with soda in the platinum spoon, the mass yields on treatment with water a solution which, acidulated with hydrochloric acid and boiled, gives an emerald-green solution, and this diluted with water becomes blue; Kbl.

**Obs.**—From Sisersk and Nizhni Tagilsk in the Ural, where it was found by Dr. A. Volborth, after whom it was named; and from several mines of the Permian formation in the government of Perm, especially at the Alexandrov mine in the Motovilich District.

**634. CORNWALLITE.** Cornwallit *Zippe*, Abh. Böhm. Ges. Prag, 1846.

Massive.

Fracture conchoidal. H. = 4·5. G. = 4·16–4·17. Color emerald-green to dark verdigris-green.

**Comp.**—$Cu_3As_2O_8.2Cu(OH)_2 + H_2O$ or $5CuO.As_2O_5.3H_2O$ = Arsenic pentoxide 33·8, cupric oxide 58·2, water 7·9 = 100.

**Anal.**—Church, J. Ch. Soc., **21**, 276, 1868.

| | $As_2O_5$ | $P_2O_5$ | CuO | $H_2O$ | |
|---|---|---|---|---|---|
| G. = 4·17 | 30·47 $\frac{4}{4}$ | 2·71 | 59·95 $\frac{7}{7}$ | 8·23 | = 101·36 |

An earlier analysis by Lerch (5th Ed., p. 569) gave 13 p. c. $H_2O$.

**Pyr., etc.**—In the matrass yields water. B.B. on charcoal gives arsenical fumes, and a bead of copper enveloped in a brittle crust.

**Obs.**—From Cornwall, occurring in small botryoidal or disseminated individuals on olivenite. Resembles malachite, but differs from it in not effervescing with acids.

**635. TYROLITE.** Kupferschaum *Wern.*, Hoffm. Min., **3**, 180, 1816, Letzt. Min. Syst., 19, 50, 1817. Kupaphrite *Shep.*, Min., **1**, 294, 1835. Tirolit *Haid.*, Handb., 509, 1845.

Orthorhombic. Axes $\breve{a} : \bar{b}$ = 0·9325 : 1, E. S. Dana[1]. In thin crystals, tabular ‖ *c*, and elongated ‖ $\bar{b}$, the free extremity bounded by the forms: *b* (010, $i$-$\breve{i}$), *m* (110, *I*), *l* (120, $i$-$\breve{2}$). Angles: $mm''' = {}^*86°$, $am = 43°$, $ll' = 56° \ 24'$, $bl = 28° \ 12'$.

Distinct crystals rare, usually grouped in fan-shaped forms and closely foliated aggregates. Also reniform, massive; structure radiate foliaceous, surface drusy.

Cleavage: *c* highly perfect, micaceous. Very sectile. Thin laminæ flexible. H. = 1–1·5. G. = 3·02–3·098. Luster: *c* pearly; other faces vitreous. Color pale apple-green and verdigris-green, inclining to sky-blue. Streak a little paler. Translucent to subtranslucent. Optically −. Ax. pl. ‖ *b*. Bx ⊥ *c*. Axial angle large.

**Comp.**—Perhaps $Cu_3As_2O_8.2Cu(OH)_2 + 7H_2O$ or $5CuO.As_2O_5.9H_2O$ = Arsenic pentoxide 29·2, cupric oxide 50·2, water 20·6 = 100.

Kobell's analysis, quoted below, gives 13·65 $CaCO_3$, present apparently as an impurity; it is also stated (N.-Z. Min., 540, 1885) that Frenzel found 13 p. c. $CaCO_3$ in the Schneeberg mineral. Further, recent careful analyses by Hillebrand on material seemingly faultless show no carbonic acid, but, on the other hand, some sulphuric acid which is not to be explained as due to admixed gypsum; the exact composition is hence complex and as yet uncertain.

**Anal.**—1, 2, Hillebrand, Am. J. Sc., **35**, 300, 1888; from 2, 1·25 p. c. gangue has been deducted. 3, R. Pearce, Proc. Col. Soc., **2**, 135, 150, 1886. 4, Kbl., Pogg., **18**, 253, 1830. 5, Church, J. Ch. Soc., **26**, 108, 1873.

| | G. | $As_3O_5$ | CuO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|
| 1. Utah | 3·27 | $\frac{2}{2}$ 28·78 | 45·22 | 6·84 | 17·26 | ZnO 0·04, MgO 0·05, $SO_3$?, $P_2O_5$ *tr.* = 98·19 |
| 2. " | | 26·22 | 46·38 | 6·69 | 17·57 | ZnO *tr.*, MgO 0·04, $P_2O_5$ *tr.*, $SO_3$ 2·27 = 99·17 |
| 3. " | | 27·87 | 42·60 | 9·10 | 16·23 | $Fe_2O_3$, $Al_2O_3$ 0·97, $SO_3$ 2·45 = 99·22 |
| | | | | $CaCO_3$ | | |
| 4. Falkenstein | | 25·01 | 43·88 | 13·65 | 17·46 | = 100 |
| 5. Libethen (?) | 3·162 | 29·29 | 50·06 | 11·92 | [8·73] | = 100 |

It is not clear that anal. 5 belongs here.

**Pyr., etc.**—In the closed tube decrepitates and yields much water. B.B. in the forceps fuses to a steel-gray globule. On charcoal gives off arsenical fumes, and fuses quietly without deflagration to a slaggy mass, which in R.F. yields globules of copper. Soluble in nitric acid, in some cases with effervescence. Soluble in ammonia, yielding a blue solution and a white residue of calcium carbonate.

**Obs.**—Usually occurs in the cavities of calamine, calcite, or quartz, accompanied by other ores of copper, appearing in small aggregated and diverging fibrous groups of a pale green color, and possessing a delicate silky luster. Has been observed in the Banat; at Posing and Libethen in Hungary; Nerchinsk in Siberia; Falkenstein and Schwatz in Tyrol; Saalfeld in Thuringia; Riechelsdorf in Hesse; Schneeberg in the Erzgebirge; in Zechstein-dolomite near Bieber.

In the U. States, in the Tintic district, Utah, at the Mammoth mine with chalcophyllite and other related species.

**Ref.**—[1] E. S. Dana, Utah, Am. J. Sc., **39**, 273, 1890.

**636. CHALCOPHYLLITE.** Cuivre arseniaté lamelliforme *H.*, Tr., 1801; *Vauquelin*, J. Mines, **10**, 562, 1801. Blättriges Olivenerz, Kupferglimmer, *Karst.*, Hoff's Mag., **1**, 543, 1801; Ludwig's Werner, 180, 1803. Copper Mica *Jameson*, Min., 1820. Kupferphyllit *Breith.*, Char., 42, 1832. Erinite *Beud.*, Tr., **2**, 598, 1832. *Dmr.-Dx.*, Ann. Ch., Phys., **13**, 420, 1845. Chalkophyllit *Breith.*, Handb., 149, 1847. Tamarite *B. & M.*, Min., 1852.

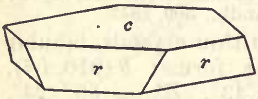
Rhombohedral. Axis $\dot{c} = 2{\cdot}5538$; $0001 \wedge 10\bar{1}1 = 71° \; 16'$ Des Cloizeaux[1].

**Forms**[2]: *c* (0001, *O*); *m* ($10\bar{1}0$, *I*); *w* ($10\bar{1}6$, $\frac{1}{6}$)[3], *v* ($10\bar{1}2$, $\frac{1}{2}$), *r* ($10\bar{1}1$, *R*), *d* ($01\bar{1}3$, $\frac{1}{3}$)[3], *e* ($01\bar{1}2$, $-\frac{1}{2}$).

Angles: *cw* = 26° 10½′, *cv* = 55° 51′, *cr* = 71° 16′, *cd* = 44° 30½′, *ce* = 55° 51′, *ww′* = 44° 55′ *rr′* = *110° 12′, *dd′* = 74° 45½′, *ee′* = 91° 34′.

Usually in six-sided tabular crystals; faces *c* sometimes triangularly striated. Also foliated massive, and in druses.

1.



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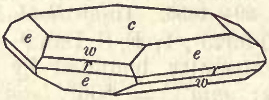


Fig. 1, simple form. 2, Utah, Washington.

Cleavage: *c* highly perfect; *r* in traces. H. = 2. G. = 2·4–2·66; 2·435 Cornwall, Hermann; 2·659 ib, Damour. Luster of *c* pearly; of other faces vitreous or subadamantine. Color emerald- or grass-green to verdigris-green. Streak somewhat paler than the color. Transparent to translucent. Optically −.

**Comp.**—A highly basic arsenate of copper; formula uncertain, anal. 2 gives: $7CuO.As_2O_5.14H_2O$; anal. 4 gives approx.: $9CuO.Al_2O_3.2As_2O_5.27H_2O$ (Rg.).

**Anal.**—1, Hermann, J. pr. Ch , **33**, 294, 1844. 2, 3, Damour, Ann. Ch. Phys., **13**, 413, 1845. 4, Church. J. Ch. Soc., **23**, 168, 1870.

| | | G. | $As_2O_5$ | $P_2O_5$ | CuO | $H_2O$ | $Al_2O_3$ | |
|---|---|---|---|---|---|---|---|---|
| 1. | Cornwall | 2·435 | 17·51[a] | *undet.* | 44·45 | 31·19 | 3·93[a] | FeO 2·92 = 100 |
| 2. | " | 2·659 | 19·35 | 1·29 | 52·92 | 23·94 | 1·80 | = 99·30 |
| 3. | " | " | 21·27 | 1·56 | 52·30 | 22·58 | 2·13 | = 99·84 |
| 4. | " | 2·44 | $\frac{2}{2}$ 15·54 | — | 46·14 | [31·75][b] | 5·97 | $Fe_2O_3$ 0·60 = 100 |

[a] With $P_2O_5$ [b] At 100°, 14·06 p. c.

**Pyr., etc.**—In the closed tube decrepitates, yields much water, and gives a residue of olive-green scales. In other respects like olivenite. Soluble in nitric acid, and in ammonia.

**Obs.**—The copper mines of Tingtang, Wheal Gorland, and Wheal Unity, near Redruth, are its principal localities in Cornwall. Occurs also crystallized in iron ore at Sayda in Saxony; in minute crystals at Herrengrund in Hungary; Moldawa in the Banat. Nizhni Tagilsk in the Ural, but rare.

In the U. States, in the Tintic district, Utah, at the Mammoth mine, with clinoclasite and other related species derived from enargite.

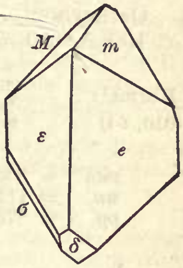
**Alt.**—Found altered to chrysocolla.

**Ref.**—[1] Ann. Ch. Phys., **13**, 420, 1845 (called by him erinite). [2] See Miller, l. c. [3] H. S. Washington, Utah, Am. J. Sc., **35**, 303, 1888.

**637. VESZELYITE.** *Schrauf*, Anz. Akad. Wien, 135, 1874; Zs. Kr., **4**, 31, 1879.

Monoclinic (or triclinic?). Form as in figure.

Measured angles, Schrauf[1]: $mM = 84° 47'$, $e\epsilon = 70° 43'–51'$, inclination edge $e/\epsilon$ to $m/M = 76° 10'$; also $me = 57° 19'$, $m\epsilon = 104° 3'$, $Me = 104° 16'$.



Incrusting, consisting of a granular aggregate of indistinct crystalline individuals. Occasionally in distinct crystals, combinations of the prism and brachydome.

H. = 3·5–4. G. = 3·531. Color and streak greenish blue.

**Comp.**—A hydrous phospho-arsenate of copper and zinc; perhaps (Rg.) $7RO.(P,As)_2O_5.9H_2O$ = ($R = Zn : Cu = 2 : 3$, $As : P = 2 : 3$), requiring: Arsenic pentoxide 10·2, phosphorus pentoxide 9·5, cupric oxide 37·5, zinc oxide 24·8, water 18·1 = 100.

**Anal.**—Schrauf (on 0·1 gr.).

| $As_2O_5$ | $P_2O_5$ | CuO | ZnO | $H_2O$ |
|---|---|---|---|---|
| 10·41 | 9·01 | 37·34 | 25·20 | 17·05 = 99·01 |

**Obs.**—Occurs as an incrustation on granite, and on limonite, at Morawitza, in the Banat.

Named after the mining engineer Veszelyi.

**Ref.**—[1] L. c., Schrauf's letters are retained, $m = 011$, $e = 110$, also $\delta$ ($\bar{2}01$) and $\sigma$ ($\bar{1}21$) rare. Schrauf gives a triclinic axial system (with which the angles do not wholly agree), but it obviously makes small claim to exactness.

**638. LUDLAMITE.** *N. S. Maskelyne* and *F. Field*, Phil. Mag., 3, 52, 135, 525, 1877.

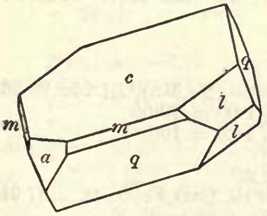
Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 2·2520 : 1 : 1·9819$; $\beta = {}^*79° 27' = 001 \wedge 100$ Maskelyne.

$100 \wedge 110 = {}^*65° 41\frac{1}{2}'$, $001 \wedge \bar{1}01 = 45° 53'$, $001 \wedge 011 = 62° 49\frac{5}{6}'$.

Forms:
a (100, i-ī)
c (001, O)
m (110, I)
t (201, − 2-ī)
d ($\bar{1}$01, 1-ī)
k ($\bar{2}$01, 2-ī)
l (011, 1-ì)
r (112, − ½)
p (111, − 1)
q ($\bar{1}$11, 1)

$mm''' = 131° 23'$ $ll' = 125° 40'$ $cq = 68° 31'$ $rr' = 79° 52'$
$ct = 52° 37\frac{1}{2}'$ $cr = 44° 36\frac{1}{2}'$ $ap = 64° 2'$ $pp' = 106° 46'$
$cd = 45° 53'$ $cp = 61° 25\frac{1}{2}'$ $al = 85° 12'$ $qq' = {}^*116° 31\frac{1}{2}'$
$ck = 68° 37'$ $cm = 85° 41'$ $a'q = 72° 17'$

Crystals small, tabular ‖ *c*. Faces *c*, *q* striated or furrowed ‖ edge *c*/*q*.



Cleavage: *c* highly perfect; *a* distinct. H. = 3–4. G. = 3·12. Luster vitreous, brilliant. Color bright green. Streak greenish white. Transparent. Optically +. Ax. pl. ‖ *b*. $Bx_a \wedge \grave{c} = -67° 5'$. Dispersion $\rho > v$ small; of bisectrices nearly zero.

$2H_a = 97° 50'$ $2H_o = 119°$ $\therefore 2V = 82° 22'$

**Comp.**—$2Fe_3P_2O_8.Fe(OH)_2 + 8H_2O$ or $7FeO.2P_2O_5.9H_2O$ = Phosphorus pentoxide 29·9, iron protoxide 53·0, water 17·1 = 100.

**Anal.**—Flight, l. c.

| $P_2O_5$ | FeO | $H_2O$ |
|---|---|---|
| 30·11 | 52·76 | 16·98 = 99·85 |

**Pyr., etc.**—B.B. colors the flame pale green, and leaves a black residue. In the closed tube decrepitates violently, becomes dark blue, and gives off water. Soluble in dilute hydrochloric and sulphuric acids.

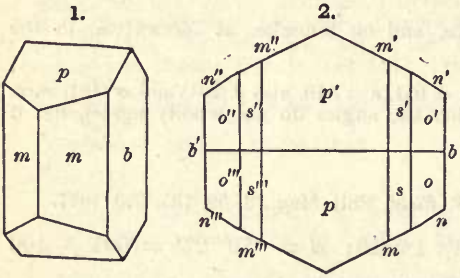
**Obs.**—Occurs with siderite, vivianite, pyrite, at the Wheal Jane mine, near Truro, Cornwall. Probably also from Stösgen near Linz on the Rhine. Named after Mr. Ludlam, of London.

**639. WAVELLITE.** Wavellite *Babbington*, Davy's Mem. in Phil. Tr., 162, 1805. Hydrargillite *Davy*, ib., 155, 162. Devonite *Thomson*. Strahliger Hydrargillit (= columnar var. of Diaspore) *Hausm.*, Handb., 443, 1813. Lasionit *Fuchs*, Schw. J., **18**, 288, 1816, **24**, 121. Striegisau *Breith.*, Schw. J., **62**, 379, 1831. Thonerdephosphat *Germ.* Alumine phosphatée *Fr.* Subphosphate of Alumina. Kapnicit *Kenng.*, Ueb., 1855, 1856–57.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}50489 : 1 : 0{\cdot}37514$ Senff[1].
$100 \wedge 110 = 26° 47\frac{1}{3}'$, $001 \wedge 101 = 36° 36\frac{3}{4}'$, $001 \wedge 011 = 20° 33\frac{3}{4}'$.

**Forms**[1]:
*b* (010, *i*-$\bar{i}$)
*q* (13·1·0, *i*-$\bar{13}$)?
*m* (110, *I*)
*n* (340, *i*-$\frac{4}{3}$)
*p* (101, 1-$\bar{i}$)
*s* (111, 1)
*o* (121, 2-$\breve{2}$)
*r* (5·11·6, $\frac{11}{6}$-$\breve{\frac{11}{5}}$)[2]

| | | | |
|---|---|---|---|
| $mm''' = {*}53° 34\frac{2}{3}'$ | $ss' = 69° 39'$ | $oo' = 61° 27'$ | $bs = 73° 14\frac{1}{2}'$ |
| $nn' = 112° 6'$ | $ss'' = 79° 33'$ | $oo'' = 93° 7'$ | $bo = 58° 56\frac{1}{2}'$ |
| $pp' = {*}73° 13\frac{1}{2}'$ | $ss''' = 33° 31'$ | $oo''' = 62° 7'$ | |



Figs. 1, simple form. 2, after Senff.

Distinct crystals rare; faces *m* striated vertically. Usually in aggregates, hemispherical or globular with crystalline surface, and having a radiated structure.

Cleavage: *p* and *b* rather perfect (Senff). Fracture uneven to subconchoidal. Brittle. H. = 3·25–4. G. = 2·337, 2·316. Luster vitreous, inclining to pearly and resinous. Color white, passing into yellow, green, gray, brown, and black. Streak white. Translucent. Optically +. Ax. pl. ∥ *a*. Bx ⊥ *c*. Dispersion $\rho > v$ small (oil). $\gamma - \alpha = 0{\cdot}025$ Lcx. Axial angles (Donnegal) Dx.

$2H_{a.r} = 75° 22'$ ∴ $2E_r = 127° 18'$ $2H_{o.r} = 114° 31'$ ∴ $2V_r = 72° 1'$ $\beta_r = 1{\cdot}524$
$2H_{a.y} = 75° 8'$ ∴ $2E_y = 127° 2'$ $2H_{o.y} = 114° 45'$ ∴ $2V_y = 71° 48'$ $\beta_y = 1{\cdot}526$
$2H_{a.bl} = 74° 29'$ ∴ $2E_{bl} = 126° 52'$ $2H_{o.bl} = 115° 20'$ ∴ $2V_{bl} = 71° 14'$ $\beta_{bl} = 1{\cdot}536$

**Comp.**—$4AlPO_4.2Al(OH)_3 + 9H_2O$ or $3Al_2O_3.2P_2O_5.12H_2O$ = Phosphorus pentoxide 35·2, alumina 38·0, water 26·8 = 100. Fluorine is sometimes present, up to 2 p. c.

**Anal.**—1, Berzelius, Schw. J., **27**, 63, 1819. 2, Erdmann, ib., **69**, 154, 1833. 3, Hermann, J. pr. Ch., **33**, 288, 1844. 4, Städeler, Lieb. Ann., **109**, 305, 1859. 5, Pisani, C. R., **75**, 79, 1872. 6, Church, J. Ch. Soc., **26**, 110, 1873. 7, Genth, Am. J. Sc., **23**, 423, 1857. 8, E. F. Smith, Am. Ch. J., **5**, 273, 1883. Also 5th Ed., 576.

| | | $P_2O_5$ | $Al_2O_3$ | $H_2O$ | F | |
|---|---|---|---|---|---|---|
| 1. Devonshire | | 33·40 | 35·35 | 26·80 | 2·06[a] | CaO 0·50, $(Fe,Mn)_2O_3$ 1·25 = 99·36 |
| 2. Striegis, *blue* | | 34·06 | 36·60 | 27·40 | *tr.* | $Fe_2O_3$ 1·00 = 99·06 |
| 3. Zbirow | | 34·29 | 36·39 | 26·34 | 1·78[a] | $Fe_2O_3$ 1·20 = 100 |
| 4. Hungary, *Kapnicite* | G. = 2·356 | 35·49 | 39·59 | [24·92] | — | = 100 |
| 5. Montebras | G. = 2·33 | 34·30 | 38·25 | 26·60 | 2·27 | = 101·42 |
| 6. Cork | | 32·00 | 37·18 | 26·45[b] | 2·09 | $SiO_2$ 0·19, CaO, $Fe_2O_3$ *tr.* = 97·91 |
| 7. Chester Co., Penn. | | 34·68 | 36·67 | 28·29 | *tr.* | limonite 0·22 = 99·86 |
| 8. Upper Milford, Penn. | | 34·14 | 36·66 | 28·32 | *tr.* | limonite 0·60 = 99·72 |

[a] HF. [b] Dried at 100°; at 100° loses 2·28 p. c. $H_2O$, at 200° 22·14, the rest at a red heat.

**Pyr., etc.**—In the closed tube gives off much water, the last portions of which react acid and color Brazil-wood paper yellow (fluorine), and also etch the tube. B.B. in the forceps swells up and splits frequently into fine acicular particles, which are infusible, but color the flame pale green; moistened with sulphuric acid the green becomes more intense. Gives a blue with cobalt solution. Some varieties react for iron and manganese with the fluxes. Heated with sulphuric acid gives off fumes of hydrofluoric acid, which etch glass. Soluble in hydrochloric acid, and also in caustic potash.

**Obs.**—Wavellite was first discovered in a tender clay slate near Barnstaple, in Devonshire, by Dr. Wavel. It has since been found at Clonmel and Cork, Ireland; in the Shiant Isles of Scotland; with the amblygonite of Montebras, France; at Zbirow and Zajecov in Bohemia; at Frankenberg and Langenstriegis, Saxony; Dünsberg near Giessen, Hesse Darmstadt; on brown iron ore in the Jura limestone at Amberg in Bavaria (the *lasionite* of Fuchs); in a manganese mine at Weinbach near Weilburg in Nassau (Genth); at Villa Rica, Minas Geraes, Brazil. *Kapnicite* is from Kapnik, Hungary.

In the United States reported as found near Saxton's River, Bellows Falls, N. H.; also at the slate quarries of York Co., Pa., near the Susquehanna; at Silver Hill mine, Davidson Co., N. C., with actinolite, pyrite, and native silver; at White Horse Station, Chester Valley R. R., Pa., in a bed of limonite, abundant in stalactitic forms, part drusy with rhombic crystals, and often coated with a pearly scaly mineral yet undetermined; at Magnet Cove, Arkansas, in fine stellate radiations of a light green to deep green color.

Named after Dr. Wavel, the discoverer. The species was considered a variety of diaspore by D'Aubuisson, Bournon, Hausmann, and some other early mineralogists, and placed next to diaspore by Werner in 1817; while Jameson arranged it in 1816 among the zeolites.

**Ref.**—[1] Pogg., 18, 474, 1830. [2] Dx., Montebras, Ann. Ch. Phys., **27**, 405, 1872.

LIME-WAVELLITE. Kalkwavellit *Kosmann*, Zs. G. Ges., **21**, 799, 1869. An impure wavellite found as the cement of a phosphorite breccia at Dehrn and Ahlbach. Supposed to contain lime as an essential ingredient, but doubtful. See App. I, p. 9, 1872. An analysis (deducting 15 p. c. impurities) gave:

$P_2O_5$ 28·39 $Al_2O_3$ 35·65 CaO 14·86 $H_2O$ 21·09 = 99·99

**640. FISCHERITE.** *Shchurovski, Hermann*, J. pr. Ch., **33**, 285, 1844.

Orthorhombic. Axes $\breve{a} : \bar{b} = 0·5937 : 1$; 100 ∧ 110 = 30° 44′ Koksharov[1].

**Forms:** *b* (010, *i*-$\breve{i}$), *c* (001, *O*), *m* (110, *I*); with also *g* (120, *i*-$\breve{2}$).

Angles: *mm‴* = *61° 28′, *gg′* = 80° 8′.

Crystals small, often six-sided prisms (*m*, *b*), also in scales, and in acicular crystals grouped in druses in radiating form; also in crusts.

H. = 5. G. = 2·46. Luster vitreous. Color grass-green to olive-green, and verdigris-green. Translucent. Optically +. Ax. pl. ∥ *a*. Bx ⊥ *c*. Axial angles variable, Dx.[2]

$2H_{a.r} = 66° 23'$ ∴ $2E_r = 106° 45'$ $2H_{o.r} = 130° 56'$ also $2H_{o.r} = 124° 58'$ $\beta_r = 1·50–1·56$
$2H_{a.y} = 66° 4'$ ∴ $2E_y = 106° 18'$ $2H_{o.y} = 131° 0'$

**Comp.**—$AlPO_4.Al(OH)_3 + 2\frac{1}{2}H_2O$ or $2Al_2O_3.P_2O_5.8H_2O$ = Phosphorus pentoxide 29·9, alumina 41·6, water 29·4 = 100.

**Anal.**—Hermann, l. c.

| $P_2O_5$ | $Al_2O_3$ | $H_2O$ | |
|---|---|---|---|
| 29·03 | 38·47 | 27·50 | CuO 0·80, $Fe_2O_3,Mn_2O_3$ 1·20, gangue 3·00 = 100 |

**Pyr., etc.**—B.B. becomes white, and clouded; yields much water, but no fluorine. Soluble in sulphuric acid.

**Obs.**—From Nizhni Tagilsk in the Ural, where it occurs in veins in a ferruginous sandstone and clay slate. Also reported as occurring in a botryoidal, enamel-like form at Roman-Gladna, Hungary (Földt. Közl., **12**, 179, 1882).

Named after Fischer v. Waldheim of Moscow.

**Ref.**—[1] Min. Russl., **1**, 31, 1853. [2] Dx., Vh. Min. Ges., **9**, 32, 1874.

**641. PEGANITE.** Peganit *Breithaupt*, Schw. J., **60**, 308, 1830.

Orthorhombic. Axes $\breve{a} : \bar{b} = 0·499 : 1$; 100 ∧ 110 = 26½° approx., Breith.

**Forms:** *c* (001, *O*), *b* (010, *i*-$\breve{i}$), *m* (110, *I*), *r* (121, 2-$\breve{2}$).

Crystals prismatic, indistinct; usually in aggregates, passing into incrustations.

Cleavage: *b*, *c*, *m*, all indistinct. Fracture uneven to subconchoidal. Brittle. H. = 3–3·5. G. = 2·492–2·501. Luster greasy to vitreous. Color deep green, greenish gray, greenish white. Streak white.

**Comp.**—$AlPO_4.Al(OH)_3 + 1\frac{1}{2}H_2O$ or $2Al_2O_3.P_2O_5.6H_2O$ = Phosphorus pentoxide 31·3, alumina 44·9, water 23·8 = 100.

**Anal.**—1, Hermann, J. pr. Ch., **33**, 287, 1844. 2, Lichtenberger, Jb. Min., 819, 1872. 3, Frenzel, ibid.

| | $P_2O_5$ | $Al_2O_3$ | $H_2O$ | |
|---|---|---|---|---|
| 1. Striegis | 30·49 | 44·49 | 22·82 | $CuO, Fe_2O_3$, gangue 2·20 = 100 |
| 2. Portugal G. = 2·46 | 36·14 | 38·90 | 23·14 | CuO 0·64, BaO 0·43 = 99·25 |
| 3. " " | 34·33 | 39·62 | 23·53 | CuO 0·83, BaO 0·39 = 98·70 |

**Pyr., etc.**—In the closed tube yields water, and assumes a violet or rose color. B.B. cracks open, becomes violet, but does not fuse. Gives but a faint copper reaction, but in other respects like turquois. The powdered mineral gives a fine blue with cobalt solution.

**Obs.**—Occurs in crusts, consisting of small prismatic crystals, at Striegis, near Freiberg, Saxony. Also at Nobrya near Albergharia Velha in Portugal.

Named from *πήγανον, an herb*, in allusion to the color.

**642. TURQUOIS.** ? Callais, ? Callaina, *Plin.*, 37, 56, 33. Firuzegi *Pers.* Turques, Turquois pt., of the 16th century and later (Turques, Fabyan's Chronicle). Türkis pt. *Germ.*, Turchesa *Ital.*, Turquoise *Fr.* Turquoise *J. B. Tavernier*, Voy. en Turquie, en Persie, etc., Paris, 1678. Turchine *Bocconi*, Museo di Fisica, etc., 278, 1697. Orientalischer Türkis *Demetrius Agaphi*, *N. Nord.* Beytr., **5**, 261, *Pallas*, ib., 265. Turquois orientale, Calaite, Agaphite, Johnite, *G. Fischer*, Mém. Soc. Imp. N. Moscou, **1**, 1806; also his Onomasticon Min. Mus. Imp. Moscou, 1811, and Essai sur la Turquoise, Moscou, 1816, of which Abstr. in Ann. Phil., **14**, 406, 1819; *John*, Mem. Soc. Imp. N. Moscou, 1, 1806, Schw. J., **3**, 93, 1807 (with analyses and assertion that it is no *Odontolite*). Hydrargillite pt. *Hausm.*, Handb., 444, 1813. Turquoise de vieille roche (in distinction from Odontolite, or T. de nouvelle roche, called also Occidental Turquois). Kallait, Kalait, *Germ.* Turchesia *Ital.* Turquesa *Span.* Turquoise.

Massive; amorphous or cryptocrystalline. Reniform, stalactitic, or incrusting. In thin seams and disseminated grains. Also in rolled masses.

Cleavage none. Fracture small conchoidal. Rather brittle. H. = 6. G = 2·6–2·83; 2·621, Hermann. Luster somewhat waxy, feeble. Color sky-blue, bluish green to apple-green, and greenish gray. Streak white or greenish. Feebly subtranslucent to opaque.

**Comp.**—A hydrous phosphate of aluminium colored by a copper compound, $AlPO_4.Al(OH)_3 + H_2O$ or $2Al_2O_3.P_2O_5.5H_2O$ = Phosphorus pentoxide 32·6, alumina 46·8, water 20·6 = 100. The copper salt present probably has the composition $2CuO.P_2O_5.4H_2O$ Clarke.

**Anal.**—1, Hermann, J. pr. Ch., **33**, 282, 1844, deducting impurities, Rg., Min. Ch., 337, 1860. 2, Church, Ch. News, **10**, 290, 1864. 3, Frenzel, Min. Mitth., **5**, 184, 1883. 4, Nicolayev, Kk., Min. Russl., **9**, 86, 1886. 5, Moore, Zs. Kr., **10**, 240, 1885. 6–8, Clarke, Am. J. Sc., **32**, 211, 1886.

| | G. | $P_2O_5$ | $Al_2O_3$ | $H_2O$ | CuO | $Fe_2O_3$ | CaO | |
|---|---|---|---|---|---|---|---|---|
| 1. Oriental, *blue* | 2·62 | 28·90 | 47·45 | 18·18 | 2·02 | 1·10 | 1·85 | MnO 0·50 = 100 |
| 2. Persia | 2·75 | 32·86 | 40·19 | 19·34 | 5·27 | 2·21[a] | — | MnO 0·36 = 100·23 |
| 3. Sinai | 2·70 | $\frac{2}{2}$ 28·40 | 38·61 | 20·69 | 3·32 | — | 3·95 | MgO 0·15, $SiO_2$ 4·37,<br>[$SO_3$ 0·66 = 100·15 |
| 4. Karkaralinsk | 2·887 | 34·42 | [35·79] | 18·60 | 7·67 | 3·52 | — | = 100 |
| 5. California, *pseud.* | 2·86 | 33·21 | 35·98 | 19·98 | 7·80 | 2·99 | — | = 99·96 |
| 6. N. Mexico, *bright blue* | | 31·96 | 39·53[b] | 19·80 | 6·30 | — | 0·13 | $SiO_2$ 1·15 = 98·87 |
| 7. " *pale blue* | 2·805 | 32·86 | 36·88 | 19·60 | 7·51 | 2·40 | 0·38 | $SiO_2$ 0·16 = 99·79 |
| 8. " *dark green* | | 28·63 | 37·88 | 18·49 | 6·56 | 4·07 | *und.* | $SiO_2$ 4·20 = 99·83 |

[a] FeO. [b] Includes some $Fe_2O_3$

**Pyr., etc.**—In the closed tube decrepitates, yields water, and turns brown or black. B.B. in the forceps becomes brown and assumes a glassy appearance, but does not fuse; colors the flame green; moistened with hydrochloric acid the color is at first blue (copper chloride). With the sodium test gives hydrogen phosphide. With borax and salt of phosphorus gives beads in O.F. which are yellowish green while hot and pure green on cooling. With salt of phosphorus and tin on charcoal gives an opaque red bead (copper). Soluble in hydrochloric acid.

**Obs.**—The highly prized oriental turquois occurs in narrow seams (2 to 4 or even 6 mm. in thickness) or in irregular patches in the brecciated portions of a porphyritic trachyte and the surrounding clay slate in Persia, not far from Nishâpûr, Khorassan (cf. Schindler, Vh. G. Reichs., 93, 1884, Rec. G. Surv. India, **17**, 132, 1884); the exact locality is stated to be on the southern slopes of the Mt. Ali-Mirsa, N.W. of the village Madèn. Also in the Megara Valley, Sinai, with limonite in seams in porphyry; a greenish blue variety comes from the Karkaralinsk (Kirgeshi Steppes), Semipalatinsk, Siberia. Also in the Kara-Tube Mts. in Turkestan, 50 versts from Samarkand with limonite, etc., in seams in a siliceous clay slate; the locality has been worked at some unknown time in the past. An impure variety is found at Steine in Silesia, and at Oelsnitz in Saxony.

In the U. States, occurs in the Los Cerillos Mts., 20 m. S.E. of Santa Fé, New Mexico, in a trachytic rock, a locality long mined by the Mexicans and in recent years reopened and extensively worked. It has afforded some fine gems. Cf. Blake, Am. J. Sc., **25**, 227, 1858; **25**, 197, 1883; Silliman, ib., **22**, 67, 1881; Clarke and Diller, l. c.; also Kunz, Gems, etc., of the U. S., 1890.

Found also in the Burro Mts., Grant Co., N. M., southwest of Silver City (Snow, Am. J. Sc., **41**, 511, 1891); at the Holy Cross Mt., Colorado. A pale green turquois occurs in the Sierra Nevada, five miles north of Columbus, Nevada; a kind pseudomorphous after apatite at Taylor's ranch, Chowchillas river, in Fresno Co., California (Zeph. & Moore, l. c.).

Domeyko (Min., 3d Ed.) refers here an earthy cupriferous aluminium phosphate from San Lorenzo, Chili (5th Ed., p. 587).

On the microscopic structure of turquois, see Bkg., Zs. Kr., **2**, 163, 1878, **3**, 81, 1879.

Natural turquois of inferior color is often artificially treated to give it the tint desired. Moreover, many stones which are of a fine blue when first found retain the color only so long as they are kept moist, and when dry they fade, become a dirty green, and are of little value. Much of the turquois (not artificial) used in jewelry in former centuries, as well as the present, and that described in the early works on minerals, was *bone-turquois* (called also *odontolite*, from *ὀδούς, tooth*), which is fossil-bone, or tooth, colored by a phosphate of iron. Its organic origin becomes manifest under a microscope. Moreover, true turquois, when decomposed by hydrochloric acid, gives a fine blue color with ammonia, which is not true of the odontolite.

The *Callais* of Pliny is generally regarded as turquois, and probably rightly so. But all he says of it is, "Callais sapphirum imitatur. candidior et litoroso mari similis," resembling sapphire (that is, *lapis-lazuli*) in color, but paler, and like the sea toward the shore; indicating a greenish blue tint and degree of opacity corresponding well enough with much turquois.

The *Callaina* also of Pliny (to which he devotes a long chapter) is referred to this species, and with even better reason. It was a stone of a pale green color, and was obtained, according to him, amid inaccessible rocks in the countries that lie at the back of India, near Mt. Caucasus, etc. He also states that it was remarkable for its size, and was full of holes and foreign substances, which it is difficult to reconcile with the true turquois. But he speaks in the next sentence of a kind from Carmania (a district of Persia) as of better quality and clearer, and this may have been real turquois. He says that no stones were more easily imitated, which is very true of turquois. He also remarks that the beauty of the Callaina is greatly heightened by a setting of gold, the contrast peculiarly befitting it.

Pliny also speaks of another stone called *Callaica* (**37**, 56), and says of it: "Callaicam vocant e turbido callaino; ferunt pluris conjunctis semper inveniri;" it is so called because it is a turbid callaina, and they are found together. He also remarks that the stone called "*Augetis* (**37**, 54) multis non alia videtur quam callaina," by many is thought to be nothing but callaina. (See further CALLAINITE, p. 825).

The *Persian smaragdus*, or emerald, alluded to by Pliny (**37**, 18, citing from Democritus), as "without transparency, agreeable and uniform in color, satisfying the vision without allowing it to penetrate it," may have been turquois; yet, as with most of Pliny's descriptions (owing to his mixing different things of similar aspect), when all the other characters given are weighed they leave doubt.

It is probable that the turquois—oriental and occidental—was as commonly used in Persia as a gem in ancient times as now. The name *turquois* (or turquoise) is French in form, and means *Turkish*, a *Turkish gem*, the gem having come into Europe through Turkey.

W. P. Blake (l. c., and ib., **25**, 197, 1883) regards the bluish green turquois of Los Cerillos as the *chalchihuitl* of the *Mexicans;* he proposes the mineralogical name *chalchuite.* By others this Mexican stone is referred to jade (p. 371), also by others to emerald.

### 643. SPHÆRITE. Sphärit *v. Zepharovich*, Ber. Ak. Wien, **56** (1), 24, 1867.

In globular concretions with a drusy faceted surface, without a distinct fibrous or concentric structure.

Cleavage distinct in one direction. H. = 4. G. = 2·536. Luster greasy-vitreous, glimmering. Color light gray, bluish; also reddish from mixture with hematite. Translucent.

**Comp.**—Perhaps $4AlPO_4.6Al(OH)_3 + 7H_2O$ or $5Al_2O_2.2P_2O_5.16H_2O$ = Phosphorus pentoxide 26·3, alumina 47·1, water 26·5 = 100.

**Anal.**—1, Boricky (l. c.); 1*a*, same, with $SiO_2$, CaO, MgO, and some $P_2O_5$ (for these bases) excluded:

| | | $P_2O_5$ | $Al_2O_2$ | MgO | CaO | $H_2O$ | $SiO_2$ | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | $\frac{2}{2}$ | 28·58 | 42·36 | 2·60 | 1·41 | 24·03 | 0·87 | = | 99·85 |
| 1*a*. | | 26·80 | 46·71 | — | — | 26·49 | — | = | 100 |

**Pyr., etc.**—Yields water. B.B. is infusible, and colors the flame bluish green. With cobalt solution a fine blue.

**Obs.**—Occurs lining cavities or seams in hematite, at Zajecov, north of St. Benigna, Bohemia, in Lower Silurian schists, along with wavellite.

**Alt.**—Becomes opaque white, dull, and earthy by alteration.

**644. LISKEARDITE.** *Maskelyne*, Nature, **18**, 426, Aug. 15, 1878.

Massive; in thin incrusting layers, with uniform fibrous structure. Color white, with a slight blue or greenish blue tint.

**Comp.**—$(Al,Fe)AsO_4.2(Al,Fe)(OH)_3 + 5H_2O$ or $3(Al,Fe)_2O_3.As_2O_5.16H_2O$ = Arsenic pentoxide 27·1, alumina 30·9, iron sesquioxide 8·1, water 33·9 = 100.

**Anal.**—W. Flight, J. Ch. Soc., **43**, 140, 1883.

| $As_2O_5$ | $Al_2O_3$ | $Fe_2O_3$ | $H_2O$ | |
|---|---|---|---|---|
| 26·96 | 28·23 | 7·64 | 34·05[a] | CuO 1·03, CaO 0·72, $SO_3$ 1·11 = 99·74 |

[a] Loss at ordinary temp., 4·35 p.c.; at 100°, 10·96 ($6H_2O$); at 120°, 5·55 ($3H_2O$); at 140°–190°, 8·22, and with lead oxide, 4·97 ($7H_2O$).

**Obs.**—Occurs in crusts one-fourth of an inch thick as a coating of cavities or incrustation on quartz or other minerals; accompanying species are scorodite, arsenopyrite, chalcopyrite, pyrite, earthy chlorite; from Liskeard, Cornwall.

**645. EVANSITE.** *D. Forbes*, Phil. Mag., **28**, 341, 1864.

Massive; reniform or botryoidal.

Fracture subconchoidal. H. = 3·5–4. G. = 1·939. Luster vitreous or resinous; internally waxy. Colorless, or milk-white; sometimes tinged with yellow or blue. Streak white. Translucent, subtranslucent.

**Comp.**—$2AlPO_4.4Al(OH)_3 + 12H_2O$ or $3Al_2O_3.P_2O_5.18H_2O$ = Phosphorus pentoxide 18·4, alumina 39·6, water 42·0 = 100.

**Anal.**—Forbes, l.c.

$\frac{8}{3}$ $P_2O_5$ 19·05 $Al_2O_3$ 39·31 $H_2O$ 39·95 insol. 1·41 = 99·72

**Pyr., etc.**—B.B. in closed tube yields neutral water, decrepitates, leaving milk-white powder. Infusible. Moistened with sulphuric acid colors the flame green. On charcoal with cobalt solution gives intense blue. With fluxes trace of iron. Soluble in sulphuric, nitric, and hydrochloric acids. Fluorine not detected.

**Obs.**—Occurs at Zsetcznik, Hungary, as reniform or globular concretions on limonite.

Brought in 1855 from Hungary, by Brooke Evans, of Birmingham, England, after whom it was named. It was labeled allophane.

A mineral occurring in a small fissure in the Yoredale Rocks, Ratcliffe Wood, Macclesfield, is referred here by A. S. Woodward. The loss on ignition was 40 p. c. Min. Mag., **5**, 333, 1883.

CŒRULEOLACTITE. Coeruleolactin *T. Petersen*, Jb. Min., 353, 1871.

Crypto-crystalline to micro-crystalline. Fracture uneven to conchoidal. H. = 5. G. = 2·552–2·593. Color milk-white passing into light copper-blue. Streak white.

Composition, perhaps $3Al_2O_3.2P_2O_5.10H_2O$ = Phosphorus pentoxide 36·9, alumina 39·7, water 23·4 = 100.

Anal.—1, Petersen; 1*a*, obtained from 1 after excluding 10 p. c. impurities. 2, Genth, Min. Rep. Penn., 143, 1875.

| | $P_2O_5$ | $Al_2O_3$ | $H_2O$ | CuO | |
|---|---|---|---|---|---|
| 1. Nassau | 36·33 | 35·11 | 21·23 | 1·40 | $Fe_2O_3$ 0·93, CaO 2·41, MgO 0·20, |
| 1*a*. " | 37·04 | 39·34 | 23·62 | — | = 100 [$SiO_2$ 1·82, ZnO, F *tr.* = 99·43 |
| 2. Chester Co., Pa. G. = 2·696 | 36·31 | 38·27 | 21·70 | 4·25 | insol. 0·54 = 101·07 |

B.B. decrepitates, infusible, on charcoal turns reddish gray. With cobalt solution gives a deep blue. Moistened with sulphuric acid colors the flame green. With the fluxes gives a faint reaction for copper. Soluble in mineral acids, also in fixed caustic alkalies.

From the Rindsberg Mine near Katzenellnbogen, Nassau. A similar mineral occurs with wavellite at General Trimble's iron mine, East Whiteland Township, Chester Co., Penn.

An aluminium phosphate, referred here with some question by Wibel, has been noted as forming with 25 p. c. carbonaceous matter, the substance of an ancient fabric dug up at Forsthaus-Perlberg. Jb. Min., 1, 209 ref., 1890.

TARANAKITE *Hector* [Jurors' Rep. N. Z. Ex., 423, 1865]. *Cox*, Trans. N. Z. Inst., **15**, 385, 1882.

Massive, resembling wavellite. Soft. Color yellowish white. Anal.—Hector, l. c.

| $P_2O_5$ | $Al_2O_3$ | FeO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 35·05 | 21·43 | 4 45 | 0·55 | 4·20 | *tr.* | 33·06 | Cl 0·46, $SO_3$ *tr.*, insol. 0·80 = 100 |

Of the water 15·46 p.c. is lost at 100°, and 17·60 more at a red heat. B.B. fuses readily. From Sugar Loaves, Taranaki, New Zealand.

BERLINITE *C. W. Blomstrand*, Öfv. Ak. Stockh., **25**, 198, 1868. TROLLEITE, ibid., p. 199. AUGELITE, ibid., p. 199. ATTACOLITE, ibid., p. 201.

These are aluminium phosphates from the iron mine of Westanå, Scania, Sweden. They need further study to show that they are all independent species. The characters given are as follows:

BERLINITE. Compact massive, no cleavage, resembles quartz. H. = 6. G. = 2·64. Luster vitreous. Colorless to grayish or pale rose-red. Translucent. Analysis:

$\frac{3}{3}$ $P_2O_5$ 54·84 $Al_2O_3$ 40·27 $Fe_2O_3$ 0·26 $H_2O$ 4·14 = 99·51

This corresponds to $2Al_2O_3.2P_2O_5.H_2O$. B.B. whitens without fusing. Hardly attacked by acids. Named after Prof. N. H. Berlin, of the University of Lund.

TROLLEITE. Compact, with indistinct cleavage. Fracture even to conchoidal. H. = 5·5. G. = 3·10. Luster more or less vitreous. Color pale green. Analysis:

$\frac{3}{3}$ $P_2O_5$ 46·72 $Al_2O_3$ 43·26 $Fe_2O_3$ 2·75 CaO 0·97 $H_2O$ 6·23 = 99·93

This corresponds to $4Al_2O_3.3P_2O_5.3H_2O$. Scarcely attacked by acids. Named after the Swedish chemist H. G. Trolle-Wachtmeister.

AUGELITE. Massive. Cleavage distinct in three directions. G. = 2·77. Luster of cleavage surface strongly pearly. Pale red, also colorless. Analysis:

$P_2O_5$ 35·04 $Al_2O_3$ 49·15 $Fe_2O_3$ 0·89 MnO 0·31 CaO 1·09 $H_2O$ 12·85 = 99·33

This corresponds to $2Al_2O_3.P_2O_5.3H_2O$. Yields much water in the glass tube. B.B. infusible. Scarcely affected by acids. Named from αὐγή, *luster.*

ATTACOLITE. Massive, indistinctly crystalline. H. = 5. G. = 3·09. Color pale red. Analysis:

$\frac{2}{2}$ $P_2O_5$ 36·06 $Al_2O_3$ 29·75 $Fe_2O_3$ 3·98 MnO 8·02 MgO 0·33 CaO 13·19 $Na_2O$ 0·45 $H_2O$ 6·90 = 98·68

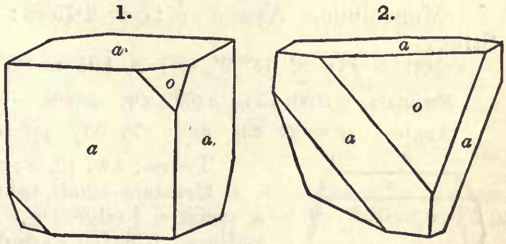
8·6 p. c. $SiO_2$ has been deducted; the formula is doubtful. B.B. fuses easily, and, when more heated, with intumescence, to a brownish yellow glass. With soda a strong manganese reaction. Very incompletely decomposed by acids. Named from ἀττακεὑς, *salmon*, alluding to the color.

**646. PHARMACOSIDERITE.** ?Fer minéralisé par l'acide arsenique *Proust*, Ann. Chem., **1**, 195, 1790; Arsenicated Iron Ore *Kirwan*, **2**, 189, 1796. Olivenerz, Arseniksaures Eisen in Würfeln kryst. (f. Carharrack) *Klapr.*, Schrift. Ges. nat. Fr. Berl., 1, 161, 1786, Beitr., 3, 194, 1802; Würfelerz, var. of Olivenerz, *Lenz*, 2, 18, 151, 1794. Würfelerz *Karsten*, Tab., 66, 1808. Cube Ore. Pharmakosiderit *Hausm.*, Handb., 1065, 1813.

Isometric: tetrahedral. Observed forms:

*a* (100, *i-i*) *d* (110, *i*) *o* (111, + 1) ω (40·1·1, 40-40)[1]

Commonly in cubes with faces sometimes striated ‖ edge *a*/*o*, or replaced by the vicinal trapezohedron ω; also tetrahedral. Rarely granular.



Figs. 1, 2, Utah, Pearce.

Cleavage: *a* imperfect. Fracture uneven. Rather sectile. H. = 2·5. G. = 2·9–3. Luster adamantine to greasy, not very distinct. Color olive-green, passing into yellowish brown, bordering sometimes upon hyacinth-red and blackish brown; also passing into grass-green, emerald-green, and honey-yellow. Streak green to brown, yellow, pale. Subtransparent to subtranslucent. Pyroelectric. Shows anomalous double refraction.[2]

**Comp.**—Perhaps $6FeAsO_4.2Fe(OH)_3 + 12H_2O$ or $4Fe_2O_3.3As_2O_5.15H_2O$ **(Rg.)** = Arsenic pentoxide 43·1, iron sesquioxide 40·0, water 16·9 = 100.

**Anal.**—Berzelius, Ak. H. Stockh., 354, 1824.

| $As_2O_5$ | $P_2O_5$ | $Fe_2O_3$ | CuO | $H_2O$ |
|---|---|---|---|---|
| 37·82 | 2·53 | 39·20 | 0·65 | 18·61 gangue 1·76 = 100·57 |

**Pyr., etc.**—Same as for scorodite.

**Obs.**—Formerly obtained at the mines of Wheal Gorland, Wheal Unity, and Carharrack, in Cornwall, coating cavities in quartz, with ores of copper; found in quartz at Burdle Gill in Cumberland, in small brilliant crystals; in minute tetrahedral crystals at Wheal Jane; also in Australia; at St. Leonard and Garonne, Dept. du Var, in France; at Schneeberg and Schwarzenberg in Saxony; at Königsberg, near Schemnitz, Hungary, and on the Sandberg; in cubic crystals (G. 2·873 Vrba) at Pisek, Bohemia.

In Utah, at the Mammoth mine, Tintic district, in straw-yellow to pale green crystals (f. 1, 2) on a ferruginous quartz with scorodite and various copper arsenates derived from enargite.

Named from φάρμακον, *poison* (in allusion to the arsenic present), and σίδηρος, *iron*.

Proust first announced the existence of an arsenate of iron, from greenish white concretionary specimens found in Spain; but from his meager description its identity with this species cannot be made certain.

**Alt.**—Has been observed altered to psilomelane, limonite, hematite.

**Ref.**—[1] Phillips, vicinal to the cube; this approximate symbol is suggested by Naumann, Lehrb. Kryst., **1**, 113, 1829. [2] Btd., Bull. Soc. Min., **4**, 256, 1881.

**647. CACOXENITE.** Kakoxen *J. Steinmann*, Vortr. Böhm. Ges., Prag, 1825. Cacoxene.

Occurs in radiated tufts of a yellow or brownish yellow color.

H. = 3–4. G. = 3·38. Becomes brown on exposure.

**Comp.**—$FePO_4.Fe(OH)_3 + 4\frac{1}{2}H_2O$ or $2Fe_2O_3.P_2O_5.12H_2O$ = Phosphorus pentoxide 20·9, iron sesquioxide 47·2, water 31·9 = 100.

The above corresponds to anal 1; anal. 2, 3, give somewhat different results.

**Anal.**—1, 2, Hauer, Jb. G. Reichs., **5**, 67, 1854; after deducting insoluble matter. 3, Nies, Jb. Min., **1**, 108, 1881.

| | $P_2O_5$ | $Fe_2O_3$ | $H_2O$ |
|---|---|---|---|
| 1. Hrbek mine | 19·63 | 47·64 | 32·73 = 100 |
| 2. " | 25·71 | 41·46 | 32·83 = 100 |
| 3. Eleonore mine G. = 2·4 | 26·17 | 40·35 | 30·59 $Al_2O_3$ 2·89 = 100 |

**Pyr., etc.**—Yields water, with trace of fluorine. Fuses on the edges to a black shining slag, and colors the outer flame bluish green. Reactions for iron. Soluble in hydrochloric acid.

**Obs.**—Occurs at the Hrbek mine, near St. Benigna in Bohemia, along with earthy limonite, dufrenite, etc. Stated by Zepharovich to be sometimes derived from the alteration of *barrandite.* Also at the Eleonore mine on the Dünsberg, near Giessen.

In the U. States, at Noblis mine, Lancaster Co., Penn., on limonite; reported with the martite of the Lake Superior mining region.

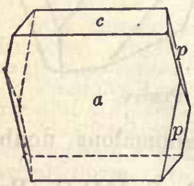
**648. BERAUNITE.** *Breithaupt*, Handb., 156, 1841, B. H. Ztg., 402, 1853. Eleonorite *Nies*, Ber. Oberhess. Ges., **19**, 111, 1880; *Streng*, Jb. Min., **1**, 102, 1881.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c}$ = 2·7538 : 1 : 4·0165; $\beta$ = *48° 33′ = 001 ∧ 100 Streng.

100 ∧ 110 = 64° 9′, 001 ∧ $\bar{1}01$ = 88° 11½′, 001 ∧ 011 = 71° 37½′.

**Forms**[1]: *a* (100, *i-ī*), *c* (001, *O*); *x* (*h0l*, − *m-ī*), *p* ($\bar{1}11$, 1).

Angles: *cp* = 89° 23, *ap* = *75° 36′, *pp′* = 140° 4′, *pp‴* = *39° 56.



Twins: tw. pl. *a*; sometimes penetration-twins.

Crystals small, tabular ‖ *a*, resembling some lazulite; faces *a* striated ‖ edge *c/a*. Commonly united in druses and in radiated foliated globules and crusts.

Cleavage: *a* distinct. Luster vitreous, on *a* inclining to pearly. Color reddish brown to dark hyacinth-red. Strongly pleochroic; red-brown ‖ axis *b*, pale yellow in a transverse direction. Streak yellow. Bisectrix nearly ⊥ *a*.

**Var.**—1 *Beraunite* in small foliated aggregates; also in monoclinic crystals with *c, b, m, p* (111); cleavage *b, c* (Boricky).

2. *Eleonorite* in crystals (cf. fig.) with angles as above. Its identity with beraunite can hardly be questioned, though not absolutely proved. Cf. Bertrand (Bull. Soc. Min., **4**, 88, 1881), who states that they are alike in angles, pleochroism, and optical characters.

**Comp.**—Perhaps $2FePO_4.Fe(OH)_3 + 2\frac{1}{2}H_2O$ or $3Fe_2O_3.2P_2O_5.8H_2O$ = Phosphorus pentoxide 31·3, iron sesquioxide 52·8, water 15·9 = 100.

Boricky calculates for the St. Benigna beraunite, $5Fe_2O_3.3P_2O_3.12H_2O$ = Phosphorus pentoxide 29·6, iron sesquioxide 55·4, water 15·0 = 100.

**Anal.**—1, Tschermak, Ber. Ak. Wien, **49** (1), 341, 1864. 2, 3, Boricky, ib., **56** (1), 11, 1867. 4, Frenzel, Jb. Min., 23, 1873. 5, Streng, crystals, l. c. 6, Id., radiated coating on limonite, l. c. 7, Koenig, Proc. Acad. Philad., 139, 1888, and Zs. Kr., **17**, 91, 1889.

| | | $P_2O_5$ | $Fe_2O_3$ | $H_2O$ | |
|---|---|---|---|---|---|
| *Beraunite.* | | | | | |
| 1. St. Benigna | | 30·5 | 55·0 | 14·0 | $Na_2O$ 1·5 = 101 |
| 2. " | | 30·2 | 55·8 | 15·1 | $Mn_2O_3,Na_2O$ *tr.* = 101·1 |
| 3. " | | 28·99 | 55·98 | 14·41 | $Mn_2O_3,Na_2O$ *tr.* = 99·38 |
| 4. Scheibenberg | G. = 2·983 | 28·65 | 54·50 | 16·55 | = 99·70 |
| *Eleonorite.* | | | | | |
| 5. Waldgirmes, *cryst.* | | 31·88 | 51·94 | 16·37 | = 100·19 |
| 6. " *radiat.* | | 31·78 | 52·05 | 16·56 | = 100·39 |
| 7. Sevier Co., Ark. | G. = 2·949 | 30·93 | 49·60 | 14·81[a] | $Al_2O_3$ 4·50 = 99·84 |

[a] Expelled at 250° C.

**Pyr.**—B.B. fuses easily to a black bead metallic in appearance, crystalline on cooling. Easily soluble in hydrochloric acid.

**Obs.**—*Beraunite* is from the Hrbek mine, St. Benigna, near Beraun, in Bohemia; reported also from Wheal Jane, near Truro, England, by Greg, associated with pure and altered vivianite; from Scheibenberg, Saxony.

*Eleonorite* occurs on limonite at the Eleonore mine on the Dünsberg, near Giessen, and at the Rothläufchen mine near Waldgirmes, in the same region. Also occurs (anal. 7) with dufrenite in Sevier Co., Arkansas, in rosettes of foliated crystals of a blood-red color.

GLOBOSITE *Breithaupt*, B. H. Ztg., **24**, 321, 1865. A mineral occurring at the Arme Hilfe mine near Hirschberg, in small globular concretions. H. = 5–5·5. G. = 2·825–2·827. Luster greasy to adamantine. Color wax-yellow to yellowish gray. Streak white. Brittle. Analysis, Fritzsche:

| $P_2O_5$ | $As_2O_5$ | $SiO_2$ | $Fe_2O_3$ | CuO | MgO | CaO | |
|---|---|---|---|---|---|---|---|
| 28·89 | *tr.* | 0·24 | 40·86 | 0·48 | 2·40 | 2·40 | $H_2O$ and F 23·94 = 99·21 |

B.B. in tube yields water; by stronger heat gives the fluorine reaction, depositing a ring of silica, and leaving a red residue not magnetic, but giving with fluxes the reaction for iron. Slowly soluble in hydrochloric acid. It occurs as above with massive and pulverulent limonite; also in the cobalt mine of Schneeberg in Saxony, with quartz and hypochlorite.

PICITE *A. Nies*, Ber. Oberhess. Ges., **19**, p. 112, 1880. *A. Streng*, Jb. Min., **1**, 116, 1881.

Amorphous; in thin coatings, or in small stalactitic and spherical forms. Fracture subconchoidal. H. = 3–4. G. = 2·83. Color dark brown. Streak yellow. Luster vitreous to greasy. Translucent. Anisotropic. Analysis.—Nies, deducting 2·10 p. c. insol.:

| $P_2O_5$ | $Fe_2O_3$ | $Al_2O_3$ | $H_2O$ |
|---|---|---|---|
| 24·47 | 46·50 | 1·00 | 28·03 = 100 |

From the Eleonore mine, on the Dünsberg, and the Rothläufchen mine, near Waldgirmes, in the neighborhood of Giessen. Closely related, as shown by Nies, to the *Picites resinaceus* of Breithaupt (Handb. Min., **3**, 897, 1847), and to a phosphate mentioned by Boricky (Ber. Ak. Wien, **56** (1), 16, 1867) as occurring at the Hrbek mine, St. Benigna, Bohemia.

DELVAUXITE. Delvauxene *Dumont*, L'Institut, 121, 1839, *Delvaux*, Bull. Ac. Belg., 147, 1838. Delvauxit *Haid.*, Handb., 512, 1845.

A hydrated ferric phosphate from Berneau, near Visé, Belgium, with 40 to 50 p. c. water. Color yellowish brown to brownish black or reddish; G. = 1·85. Anal.—1, 2, Dumont, l. c. 3, Delvaux, l. c.

| | $P_2O_5$ | $Fe_2O_3$ | $H_2O$ |
|---|---|---|---|
| 1. | 16·04 | 34·20 | 49·76 = 100 |
| 2. | 16·57 | 36·62 | 46·81 = 100 |
| 3. | 18·20 | 40·44 | 41·13 = 99·77 |

Dumont's analyses give $2Fe_2O_3.P_2O_5.24H_2O$. The mineral is characterized as a *wet dufrenite* by Church, Ch. News, **10**, 157, 1864, who found that it lost 20·33 p. c. over sulphuric acid, and nearly 6 p. c. more on heating to 100° C.; the total percentage of water having been found to be 37·23, whence the essential water is only 10–11 p. c. He detected a trace of lime.

Delvauxite sometimes occurs at Visé in the form of gypsum (Cesàro), cf. also Jorissen, Mem. Soc. G. Belg., **6**, 38, 1879, who gives the formula $5Fe_2O_3.2P_2O_5.15H_2O$ or $26H_2O$ if the water lost at ordinary temperatures is included. A similar hydrated ferric phosphate has been noted at Pisek, Bohemia (G. = 2·789), cf. Vrba, Zs. Kr., **15**, 206, 1888.

### 649, 650. CHILDRENITE—EOSPHORITE.

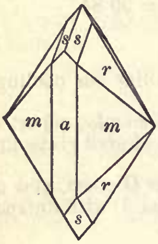
**649. Childrenite.** *Lévy*, Brandes J., **16**, 274, 1823.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·77801 : 1 : 0·52575$ Miller[1].
100 ∧ 110 = 37° 53′, 001 ∧ 101 = 34° 3′, 001 ∧ 011 = 27° 44′.

**Forms:** *a* (100, *i-ī*), *b* (010, *i-ĭ*); *m* (110, *I*); *p* (111, 1), *s* (121, 2-2̆), *r* (131, 3-3̆).

*mm‴* = *75° 46′
*mp* = 49° 26′
*ap* = 59° 7′
*as* = 65° 2′
*ar* = 70° 7′
*pp′* = 61° 46′
*ss′* = 49° 56½′
*rr′* = 39° 47′
*pp″* = 81° 8′
*ss″* = 102° 41′
*rr″* = 119° 32′
*rr*ⁱᵛ = *60° 28′
*pp‴* = 47° 5′
*ss‴* = 82° 7½′
*rr‴* = 105° 9′
*br* = 37° 25′
*bs* = 48° 56′
*bp* = 66° 28′

1.



2.

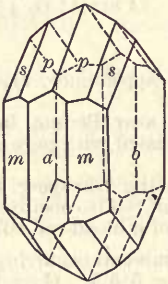


Fig. 1, Tavistock, after Mlr.
2, Hebron, Me., Cooke.

Habit pyramidal, form sometimes a double six-sided pyramid, comb. of *sm* or *rsm*; also prismatic. Faces *r*, *s* striated ∥ edge *s/s‴*; also *m* vertically. Only known in crystals.

Cleavage: *a* imperfect. Fracture uneven. H. = 4·5–5. G. = 3·18–3·24. Luster vitreous to resinous. Color yellowish white, pale yellowish brown, brownish black. Streak white to yellowish. Translucent.

Optically –. Ax. pl. ∥ *a*. Bx ⊥ *b*. Ax. angles variable, Dx.[2]:

$2E_r = 75° 22′$ $2E_y = 74° 25′$ $2E_{bl} = 71° 30′$

**650. Eosphorite.** *G. J. Brush* and *E. S. Dana*, Am. J. Sc., **16**, 35, 1878.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·77680 : 1 : 0·51501$ E. S. Dana[3].
100 ∧ 110 = 37° 50′ 25″, 001 ∧ 101 = 33° 32′ 38″, 001 ∧ 011 = 27° 14′ 57″.

**Forms:** *a* (100, *i-ī*), *b* (010, *i-ĭ*); *m* (110, *I*), *g* (120, *i-2̆*); *p* (111, 1), *q* (232, $\frac{3}{2}$-$\frac{3}{2}$), *s* (121, 2-2̆).

*mm‴* = 75° 41′
*gg′* = 65° 32′
*mp* = 49° 59′
*gs* = 39° 13½′
*pp′* = *61° 1′ 54″
*qq′* = 55° 22′
*ss′* = 49° 35′
*pp″* = 80° 2′
*qq″* = 91° 1½′
*ss″* = 101° 33′
*ss‴* = 81° 18′
*qq‴* = 65° 33′
*pp‴* = *46° 27′ 45″
*bs* = 49° 21′
*bq* = 57° 13′
*bp* = 66° 46′

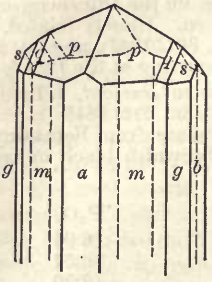
Habit prismatic, faces in zone *ab* with vertical striations. Commonly massive, cleavable to closely compact.

Cleavage: *a* nearly perfect. Fracture uneven to subconchoidal. H. =5. G.=3·11–3·145. Luster vitreous to sub-resinous; also greasy (massive). Color rose-pink, yellowish to colorless; of compact forms grayish, bluish, yellowish white. Transparent to translucent.

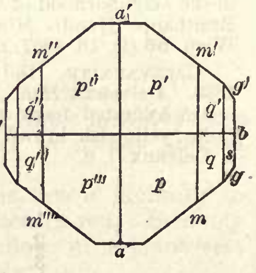
Feebly pleochroic: $\mathfrak{c}$ ($\acute{c}$) faint pink to colorless, $\mathfrak{b}$ ($\breve{a}$) deep pink, $\mathfrak{a}$ ($\bar{b}$) yellowish.

Optically –. Ax. plane ∥ *a*. Bx ⊥ *b*. Ax. angles:

1.



2.



Branchville, Conn.

$2H_{a.r} = 54° 30′$ $2H_{a.bl} = 60° 30′$

**Comp.**—In general $2AlPO_4.2(Fe,Mn)(OH)_2 + 2H_2O$ or $2RO.Al_2O_3.P_2O_5.4H_2O$.

In CHILDRENITE the iron phosphate is present chiefly; this requires: Phosphorus pentoxide 30·9, alumina 22·2, iron protoxide 31·3, water 15·6 = 100. In anal. 1, 2, Fe : Mn = 5 : 1 nearly.

In EOSPHORITE the manganese phosphate predominates, which requires: Phosphorus pentoxide 31·0, alumina 22·3, manganese protoxide 30·9, water 15·7 = 100. In anal. 3–5, Fe : Mn = 1 : 3 or 1 : 4.

**Anal.**—1, 2, S. L. Penfield, Am. J. Sc., **19**, 315, 1880. 3, Church, J. Ch. Soc. **26**, 103, 1873. 4, Penfield, Am. J. Sc., **16**, 40, 1878. 5, H. L. Wells, ibid., **16**, 41. 6, Id., ibid., **18**, 47, 1879. Also earlier Rg., Pogg. Ann., **85**, 435, 1852.

| | | G. | $P_2O_5$ | $Al_2O_3$ | FeO | MnO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| | CHILDRENITE. | | | | | | | | |
| 1. | Tavistock | | 30·19 | 21·17 | 26·54 | 4·87 | 1·21 | 15·87 | insol. 0·10 = 99·95 |
| 2. | " | | 29·98 | 21·44 | 26·20 | | | | |
| 3. | " | 3·22 | 30·65 | 15·85 | 23·45 | 7·74 | 1·03[a] | | $Fe_2O_3$ 3·51 = 99·33 |
| | EOSPHORITE. | | | | | | | | |
| 4. | Branchville | 3·134 | 31·05 | 22·19 | 7·40 | 23·51 | 0·54 | 15·60 | $Na_2O$ 0·33 = 100·62 |
| 5. | " | | 31·43 | 21·83 | 6·84 | 22·43 | 3·01 | 15·07 | = 100·61 |
| 6. | " | 3·11 | 31·39 | 21·34 | 6·62 | 22·92 | 1·48 | 15·28 | insol. 1·46 = 100·49 |

[a] MgO.

Anal. 4 was made on pure crystals; 5, on the massive mineral containing 14·41 p. c. impurities, chiefly quartz; 6, on pink massive mineral occurring in nodules in a chloritic mineral.

**Pyr., etc.**—Childrenite in the closed tube gives off neutral water. B.B. swells up into ramifications, and fuses on the edges to a black mass, coloring the flame pale green. Heated on charcoal turns black and becomes magnetic. With soda gives a reaction for manganese. With borax and salt of phosphorus reacts for iron and manganese. Soluble in hydrochloric acid.

Eosphorite in the closed tube decrepitates, whitens, gives off abundance of neutral water, and the residue turns first black, then gray, and finally liver-brown with a metallic luster, and becomes magnetic. B.B. in the forceps cracks open, sprouts and whitens, colors the flame pale green, and fuses at about 4 to a black magnetic mass. Reacts strongly for manganese.

**Obs.**—Childrenite occurs in crystals and crystalline coats, on siderite, pyrite, or quartz, and sometimes with apatite, near Tavistock, and at the George and Charlotte mine, and also at Wheal Crebor, in Devonshire; on slate at Crinnis mine in Cornwall. Crystals 1 in. long have been observed.

In U. States, at Hebron, Me., in minute hair-brown prismatic crystals, with amblygonite.

Eosphorite occurs at Branchville, Fairfield Co., Conn., in a vein of pegmatyte associated with rhodochrosite and the manganesian phosphates, lithiophilite, triploidite, dickinsonite. Also as embedded nodules (anal. 6), in a massive green chloritic mineral. The massive mineral (anal. 5, G. = 2·92–3·08) is often impure from the presence of quartz, dickinsonite, and apatite.

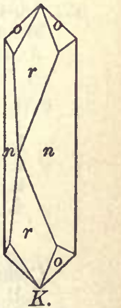
Childrenite was named after Mr. J. G. Children, an English mineralogist (1777–1852). Eosphorite from ἐωσφόρος (synonym of φωσφόρος), which means *dawn-bearing*, in allusion to the characteristic pink color.

**Ref.**—[1] Min., p. 519, 1852. Cooke obtained *ss'* = 49° 50', *ss''* = 101° 43', ∴ *ss'''* = 81° 20' Tavistock, and *ss* = 50° 30', *am* = 32° 50', ∴ *ss''* = 101° 36', *ss'''* = 80° 38' Hebron, Am. J. Sc., **36**, 258, 1863. [2] Dx., Propr. Opt., **2**, 42, 1859, N. R., 49, 1867. [3] L. c.

## 651. MAZAPILITE. *G. A. Koenig*, Proc. Acad. Philad., 192, 1888, Zs. Kr., **17**, 85, 1889.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·8617 : 1 : 0·9980 Koenig[1].

100 ∧ 110 = 40° 45', 001 ∧ 101 = 49° 11½', 001 ∧ 011 = 44° 56½'.



K.

**Forms**: *a* (100, *i-ī*), *n* (120, *i-2̆*), *r* (201, 2-ī), *d* (012, ½-ī), *o* (111, 1).

Angles: *nn'''* = *119° 45', *rr'* = 133° 18', *rr'''* = *46° 42', *dd'* = 53° 2', *oo'* = 66° 14', *oo''* = 113° 37', *oo'''* = 78° 41', *nr* = 62° 34'.

Crystals slender prismatic, 3 to 15 mm. in length; often monoclinic in development of faces.

Cleavage not observed. H. = 4·5. G. = 3·567, 3·582. Luster submetallic, dull on the fracture. Color black, on fracture surfaces deep brownish red; in thin splinters blood-red by transmitted light. Streak ocher-yellow. Subtranslucent.

**Comp.**—$Ca_3Fe_2(AsO_4)_4.2FeO(OH) + 5H_2O$ or $3CaO.2Fe_2O_3.2As_2O_5.6H_2O$ = Arsenic pentoxide 43·6, iron sesquioxide 30·3, lime 15·9, water 10·2 = 100

**Anal.**—G. A. Koenig, l. c., 1889.

| $As_2O_5$ | $Sb_2O_5$ | $P_2O_5$ | $Fe_2O_3$ | CaO | $H_2O$ |
|---|---|---|---|---|---|
| 43·60 | 0·25 | 0·14 | 30·53 | 14·82 | 9·83 = 99·17 |

About one molecule of water is expelled up to 360°; the remaining five at a red heat.

**Pyr., etc.**—Yields water in the closed tube, and at a red heat the powder becomes brick-red. B.B. fuses at 3 to a black magnetic globule, on charcoal gives the odor of arsenic and a coating of arsenic trioxide.

Soluble in warm hydrochloric acid.

**Obs.**—Occurs sparingly at the Jesus-Maria Mine in the mining district of Mazapil, Zacatecas, Mexico. The crystals are embedded in a gangue of radiated aragonite and granular calcite, with other minerals probably identified as chrysocolla and pharmacolite; also associated with silver ores.

**Ref.**—[1] L. c.; cf. also Dx., Bull. Soc. Min., **12**, 441, 1889, who makes $n = 110$, $d = 102$, $r = 041$, $o = 121$. He gives $110 \wedge 1\bar{1}0 = 60°$ and $102 \wedge \bar{1}02 = 52° \ 6'$, whence $\breve{a} : \bar{b} : \dot{c} =$ 0·57735 : 1 : 0 56443.

**652. CALCIOFERRITE.** Calcoferrit *J. R. Blum*, Jb. Min., 287, 1858.

Monoclinic? Foliated massive; in nodules.

Cleavage: very perfect, or foliated, in one direction; traces in another at right angles to the perfect one; also in another oblique to the same. Brittle. H. = 2·5. G. = 2·523–2·529 Reissig. Luster of cleavage-face pearly. Color sulphur-yellow, greenish yellow to siskin-green, yellowish, white. Streak sulphur-yellow. Thin laminæ translucent.

**Comp.**—$Ca_3Fe_2(PO_4)_4.Fe(OH)_3.8H_2O$ or $6CaO.3Fe_2O_3.4P_2O_5.19H_2O$ = Phosphorus pentoxide 32·9, iron sesquioxide 27·8, lime 19·5, water 19·8 = 100.

**Anal.**—Reissig, l. c.

$P_2O_5$ 34·01 $Fe_2O_3$ 24·34 $Al_2O_3$ 2·90 CaO 14·81 MgO 2·65 $H_2O$ 20·56 = 99·27

**Pyr., etc.**—B.B. fuses easily to a shining black magnetic globule. Easily decomposed by hydrochloric acid.

**Obs.**—In nodules in a bed of clay at Battenberg in Rhenish Bavaria. The exterior of the nodules is yellowish or reddish brown impure calcioferrite.

**653. BORICKITE.** Delvauxene (fr. Leoben) *Hauer*, Jb. G. Reichs., **5**, 68, 1854; (fr. Nenacovic) *Boricky*, Nat. Zs. Lotos, March, 1867. Borickite *Dana*, Min., 588, 1868. Boryckite.

Reniform massive. Compact, without cleavage.

H. = 3·5. G. = 2·696–2·707. Luster weak waxy. Color reddish brown. Streak the same as color. Opaque.

**Comp.**—Perhaps (Rg.) $Ca_3Fe_2(PO_4)_4.12Fe(OH)_3 + 6H_2O$. Vala and Helmhacker give for the material dried over calcium chloride, $2CaO.5Fe_2O_3.2P_2O_5.16H_2O$ or perhaps $CaO.2Fe_2O_3.P_2O_5.7H_2O$. Jb. Min., 317, 1875.

**Anal.**—1, v. Hauer, l. c. 2, Boricky, l. c.

| | | $P_2O_5$ | $Fe_2O_3$ | CaO | MgO | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. Leoben | $\frac{2}{2}$ | 20·49 | 52·29 | 8·16 | — | 19·06 = 100 |
| 2. Nenacovic | | 19·35 | 52·99 | 7·29 | 0·41 | 19·96 = 100 |

**Pyr., etc.**—Yields water. B.B. fuses easily to a black mass. Soluble in hydrochloric acid.

**Obs.**—From Leoben in Styria, and in a Lower Silurian schist at Nenacovic in Bohemia.

RICHELLITE *Cesàro* and *Desprets*, Ann. Soc. G. Belg. Mem., **10**, 36, 1883; Cesàro, **11**, 257, 1884.

Massive, compact or foliated. H. = 2–3. G. = 2. Luster greasy. Color yellow.

Anal.—1, 2, Cesàro and Desprets. 3, 4, Cesàro, l. c.

| | $P_2O_5$ | $Fe_2O_3$ | $Al_2O_3$ | CaO | $H_2O$ | | HF |
|---|---|---|---|---|---|---|---|
| 1. | 28·78 | 28·71 | 1·81 | 5·76 | 23·33[a] | 6·10[b] | 6·11 = 100·60 |
| 2. | 28·55 | — | 1·79 | 5·53 | — | — | — |
| 3. *compact* | 27·23 | 29·63 | 2·82 | 6·18 | 6·90[c] | 25·64 | 1·22 = 99·62 |
| 4. *foliated* | 25·49 | 29·67 | 3·64 | 7·19 | 9·47[c] | 23·63 | 0·96 = 100·05 |

[a] At 100°. [b] At a red heat. [c] Hygroscop.

Cesàro calculates the formula $4FeP_2O_8.Fe_2OF_2(OH)_2 + 36H_2O$.

B.B. fuses easily. Dissolves readily in acids.

Occurs with halloysite, allophane, at Richelle near Visé, Belgium.

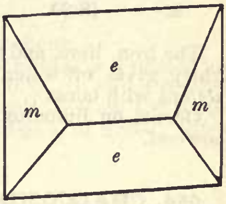
**654. LIROCONITE.** Octahedral Arseniate of Copper (fr. Cornwall) *Bourn.*, Phil. Trans., 174, 1801, Rashleigh's Brit. Min., **2**, pl. 2. 5, 11, 1802. Linsenerz *Wern.*, 1803, Ludwig's Min., **2**, 215, 1804; *Karsten*, Tab., 64, 1808. Linsenkupfer *Hausm.*, Handb., 1051, 1813. Lirokonmalachit pt. *Mohs*, Grundr., 180, 1822. Chalcophacit *Glocker*, Handb., 859, 1831.

Monoclinic. Axes $\grave{a} : \overset{|}{b} : \grave{c} = 1·3191 : 1 : 1·6808$; $\beta = 88° 32\frac{5}{6}' = 001 \wedge 100$ Des Cloizeaux[1].

$100 \wedge 110 = 52° 49\frac{1}{2}'$, $001 \wedge 101 = 50° 58\frac{2}{3}'$, $001 \wedge 011 = 59° 14\frac{1}{2}'$.

**Forms:** *m* (110, *I*); *e* (011, 1-*ĭ*).

**Angles:** $mm''' = *105° 39'$, $mm' = 74° 21'$; $ee' = *118° 29'$, $me = 46° 10'$, $m'e = *47° 24'$.



Crystals thin, resembling rhombic octahedrons, faces *m*, *e* faintly striated ‖ intersection edge. Rarely granular.

Cleavage: *m*, *e* indistinct. Fracture subconchoidal to uneven. Imperfectly sectile. H. = 2–2·5. G. = 2·882 Bournon; 2·926 Haid.; 2·985 Hermann; 2·964 Damour. Luster vitreous, inclining to resinous. Color and streak sky-blue to verdigris-green.

Optically −. Ax. pl. and $Bx_a \perp b$. $Bx_o \wedge \grave{c} = -25°$. Dispersion $\rho \wedge v$. Axial angles, Dx.[2]:

$2H_{a.r} = 77° 24\frac{2}{3}'$ ∴ $2E_r = 132° 54'$. Also $2E_r = 132° 22'$ measured.
$2H_{a.y} = 77° 18'$ ∴ $2E_y = 132° 57'$
$2H_{a.bl} = 76° 57\frac{2}{3}'$ ∴ $2E_{bl} = 133° 46'$ $2E_{bl} = 133° 57'$ measured.

**Comp.**—A hydrous arsenate of aluminium and copper, formula uncertain; the analyses correspond nearly to $Cu_6Al(AsO_4)_5.3CuAl(OH)_6.20H_2O$ or $18CuO.4Al_2O_3.5As_2O_5.55H_2O$ = Arsenic pentoxide 28·9, alumina 10·3, cupric oxide 35·9, water 24·9 = 100. Phosphorus replaces part of the arsenic.

**Anal.**—1, Hermann, J. pr. Ch., **33**, 296, 1844. 2, 3, Dmr., Ann. Ch. Phys., **13**, 414, 1845.

| | $As_2O_5$ | $P_2O_5$ | $Al_2O_3$ | CuO | $H_2O$ | |
|---|---|---|---|---|---|---|
| 1. Cornwall G. = 2·985 | 23·05 | 3·73 | 10·85 | 36·38 | 25·01 | $Fe_2O_3$ 0·98 = 100 |
| 2. " G. = 2·964 | 22·22 | 3·49 | 9·68 | 37·18 | 25·49 | = 98·06 |
| 3. " | 22·40 | 3·24 | 10·09 | 37·40 | 25·44 | = 98·57 |

**Pyr., etc.**—In the closed tube gives much water and turns olive-green. B.B. cracks open, but does not decrepitate; fuses less readily than olivenite to a dark gray slag; on charcoal cracks open, deflagrates, and gives reactions like olivenite. Soluble in nitric acid.

**Obs.**—Crystals occasionally an inch in diameter; usually quite small. With various ores of copper, pyrite, and quartz, at Wheal Gorland, Wheal Muttrell, and Wheal Unity, in Cornwall; also in minute crystals at Herrengrund in Hungary; and in Voigtland.

Named from λειρός, *pale*, and κονία, *powder*.

**Ref.**—[1] Propr. Opt., **2**, 71, 1859. [2] L. c., and N. R., 144, 1867.

**655. CHENEVIXITE.** *Adam, F. Pisani*, C. R., **62**, 690, 1866.

Massive to compact.

Fracture subconchoidal. H. = 3·5–4·5. G. = 3·93 approx. Luster vitreous. Color dark green, olive-green to greenish yellow Streak yellowish green.

**Comp.**—Somewhat uncertain, perhaps (Groth) $Cu_2(FeO)_2As_2O_8 + 3H_2O$ or $2CuO.Fe_2O_3.As_2O_5.3H_2O$ = Arsenic pentoxide 38·2, iron sesquioxide 26·5, cupric oxide 26·3, water 9·0 = 100. In anals., $RO : As_2O_5 = 6 : 1$ nearly, not 5 : 1.

**Anal.**—1, Pisani, l. c., after deducting 10·3 p. c. sand. 2, Hillebrand, Proc. Col. Soc., **1**, 115, 1884.

| | $As_2O_5$ | $P_2O_5$ | $Fe_2O_3$ | CuO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. Cornwall | 32·20 | 2·30 | 25·10 | 31·70 | 0·34 | 8·66 | = 100·30 |
| 2. Utah | 35·14 | — | 27·37 | 26·31 | 0·44 | 9·33 | $Al_2O_3$ 0·66, MgO 0·16, quartz 0·40=99·81 |

Pisani refers here an approximate analysis by Chenevix, 5th Ed., p. 583.

**Pyr., etc.**—In the closed tube usually decrepitates and yields water; becomes brown after calcination. B.B. on charcoal fuses easily, giving out arsenical fumes, and leaving a black magnetic scoria with grains of copper. Easily soluble in the acids.

**Obs.**—From Cornwall, involved in a quartz rock in small compact masses, from which gangue it is difficult to separate it entirely. Also from the American Eagle mine, Tintic district, Utah, with olivenite, conichalcite, etc.; it occurs in irregular patches scattered through the ore.

HENWOODITE. *J. H. Collins*, Min. Mag., **1**, 11, 1876. *C. Le Neve Foster*, ibid., p. 8. In botryoidal globular masses having a crystalline structure. Fracture conchoidal. H. = 4–4·5. G. = 2·67. Color turquois-blue. Streak white with bluish green tinge. Analyses, Collins:

| | $P_2O_5$ | $Al_2O_3$ | $Fe_2O_3$ | CuO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. | 48·94 | 18·24 | 2·74 | 7·10 | 0·54 | 17·10 $SiO_2$ 1·37, loss 3·97 = 100 |
| 2. | 48·20 | — | — | 7·00 | — | 19·50 |

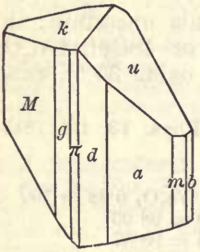
The iron, lime, and silica are regarded as due to impurities. In the closed tube decrepitates slightly, gives off water, and turns brown. B.B. infusible, colors the flame green. Copper reactions with borax.

Occurs on limonite at the West Phenix mine, Cornwall. Named from Mr. Wm. Jory Henwood.

**656. CHALCOSIDERITE.** Chalkosiderit *Ullmann*, Syst. Tab. Ueb., 323, 1824. *Maskelyne*, J. Ch. Soc., **28**, 586, 1875.

Triclinic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·7910 : 1 : 0·6051$; $\alpha = 92° 58'$, $\beta = 93° 29\frac{2}{3}'$, $\gamma = 107° 41'$ Maskelyne.

$100 \wedge 010 = {}^*72° 4'$, $100 \wedge 001 = 85° 22\frac{2}{3}'$, $010 \wedge 001 = 85° 45\frac{2}{3}'$.



Cornwall, Maskelyne.

**Forms:**

| | | |
|---|---|---|
| *a* (100, *i-ī*) | *d* ($5\bar{1}0$, *i-$\bar{5}$*) | *M* ($1\bar{1}0$, *'I*) |
| *b* (010, *i-ĭ*) | *μ* ($7\bar{2}0$, *'i-$\frac{7}{2}$*) | *u* (011, *1-ĭ'*) |
| *m* (110, *I'*) | *π* ($5\bar{2}0$, *'i-$\frac{5}{2}$*) | *k* ($0\bar{1}1$, *'1-ĭ*) |
| | *g* ($2\bar{1}0$, *'i-$\bar{2}$*) | |

| | | |
|---|---|---|
| *am* = 31° 10′ | *ag* = 23° 11′ | *b′k* = *60° 41′ |
| *ad* = 8° 59′ | *aM* = *44° 50′ | *uk* = 64° 41′ |
| *aμ* = 13° 0′ | *mM* = 76° 0′ | *au* = 76° 58′ |
| *aπ* = 18° 26′ | *bu* = *54° 38′ | *ak* = *95° 45′ |

Crystals small with prismatic faces striated; usually united in sheaf-like groups; also as crystalline incrustations. Cleavage: *k* ($0\bar{1}1$) easy. H. = 4·5. G. = 3·108. Luster vitreous. Color light siskin-green. Streak pale green.

**Comp.**—$CuO.3Fe_2O_3.2P_2O_5.8H_2O$ = Phosphorus pentoxide 28·8, iron sesquioxide 48·6, copper oxide 8·0, water 14·6 = 100.

**Anal.**—Flight, quoted by Maskelyne, l. c.

| $P_2O_5$ | $As_2O_5$ | $Fe_2O_3$ | $Al_2O_3$ | CuO | $H_2O^a$ | $U_2O_3$ | |
|---|---|---|---|---|---|---|---|
| 29·93 | 0·61 | 42·81 | 4·45 | 8·15 | 15·00 | *tr.* | = 100·95 |

[a] Loss at 100° C. 0·46, at 120°–130° additional loss 0·13; remainder at a red heat.

**Obs.**—Occurs in bright green crystals, implanted on andrewsite at the West Phœnix mine, Cornwall. Also as a thin crystalline coating on dufrenite at Sayn, Westphalia (Ullmann).

ANDREWSITE *Maskelyne*, Chem. News, **24**, 99, 1871; J. Ch. Soc., **28**, 586, 1875. Near chalcosiderite. Occurs in globular disks with radiated structure resembling wavellite. H. = 4. G. = 3·475. Color bluish green. Streak blackish green. Analysis.—Flight, J. Ch. Soc., **28**, 586, 1875.

| $P_2O_5$ | $Fe_2O_3$ | FeO | CuO | MnO | $H_2O$ | $Al_2O_3$ | CaO | $SiO_2$ |
|---|---|---|---|---|---|---|---|---|
| 26·09 | 44·64 | 7·11 | 10·86 | 0·60 | 8·79 | 0·92 | 0·08 | 0·49 = 99·59 |

A little limonite is probably present as impurity.

The nucleus of the andrewsite globules afforded: $P_2O_5$ 12·28, $Fe_2O_3$ 73·92, CaO 4·31, $H_2O$ 7·85, CuO,MnO *tr.*, $SiO_2$ 1·48 = 99·84. This corresponds to $5Fe_2O_3.P_2O_5.5H_2O$.

**Obs.**—Occurs in Cornwall on a quartzose veinstone associated with limonite and göthite, and interpenetrated with a mineral resembling, if not identical with, dufrenite.

**657. GOYAZITE.** *Damour*, Bull. Soc. Min., **7**, 204, 1884.

Tetragonal or hexagonal. In small rounded grains.

Cleavage: basal. H. = 5. G. = 3·26. Color yellowish white. Semi-transparent. Optically uniaxial, positive, Richard.

**Comp.**—A highly basic phosphate of aluminium and calcium, $Ca_3Al_{10}P_2O_{23}.9H_2O$ or $3CaO.5Al_2O_3.P_2O_5.9H_2O$ = Phosphorus pentoxide 14·5, alumina 51·9, lime 17·1, water 16·5 = 100.

**Anal.**—Damour, l. c.

$P_2O_5$ 14·87 $Al_2O_3$ 50·66 CaO 17·33 $H_2O$ 16·67 = 99·53

**Pyr.**—B.B. fuses with difficulty on thin edges; becomes blue when ignited and moistened with cobalt solution. Gives off water in the closed tube and turns white and opaque. Not attacked by acids.

**Obs.**—From the diamond washings of Minas Geraes, Brazil.

Named from the province in which the principal diamond localities occur.

A phosphate was described by Damour in 1853 (L'Institut, 78) which may be a related mineral. Compact, of a pale or dark brick-red color. Scratches glass feebly. G. = 3·194. Supposed by Damour to be a hydrous phosphate of aluminium and calcium. B.B. in a tube gives considerable water; and in a platinum crucible at a red heat loses 12·70 p. c. of water. Found in rolled pebbles with the diamond sand of Bahia.

**658. PLUMBOGUMMITE.** Plomb rouge en stalactites—tantot en globules, *de Lisle*, Demeste Lettres Min., **2**, 399, 1779; Crist., **3**, 399, 1783. Sel acide-phosphorique-martial *G. de Laumont*, J. de Phys., **28**, 385, 1786. Plomb-gomme *de Laumont*. Aluminiate de Plomb avec eau de combinaison *Berz.*, in his Nouv. Min., 283, 1819. Bleigummi, Blei-aluminat, etc., *Berz.*, Schw. J., **27**, 65, 1819 (trl. fr. Nouv. Min.). Native Aluminiate of Lead *Smithson*, Ann. Phil., **14**, 31, 1819 (citing Berz., and also a letter by de Laumont, in which S. Tennant (who died in 1815) is said to have first analyzed plombgomme and made it a combination of oxide of lead, alumina, and water). Plomb hydro-alumineux *H.*, Tr., **3**, 410, 1822. Gummispath *Breith.*, Char., 56, 1832. Plomgomme *Beud.*, Tr., **2**, 1832. Plumbo-gummite, *Shep.*, Min., **2**, 113, 1835. Plumbo-resinite *Dana*, Min., 230, 1837. Bleigummi, Gummibleispath, Bleihydroaluminat, *Germ.* Hitchcockite *Shep.*, Rep. Canton Mine, Ga., 1856, Min., 401, 1857.

Hexagonal. Reniform, globular, botryoidal, with sometimes a concentric structure; in thin crusts; compact massive.

H. = 4–5. G. = 4–4·9; 4·88, Nuissière, Dufrénoy; 4·014, hitchcockite, Genth; Breithaupt gives 6·42. Luster resinous or gum-like. Color yellowish gray, reddish brown, greenish; also yellowish white; sometimes grayish white, bluish. Streak uncolored. Translucent; subtransparent. Optically uniaxial, positive, Bertrand[1].

**Comp.**—Uncertain; anal. 4 corresponds nearly to $PbO.2Al_2O_3.P_2O_5.9H_2O$ = Phosphorus pentoxide 19·4, alumina 27·9, lead protoxide 30·5, water 22·2 = 100. The other analyses vary widely.

**Anal.**—1–3, Damour, Ann. Mines, **17**, 191, 1840. 4, Genth, Am. J. Sc., **23**, 424, 1857.

| | $P_2O_5$ | $SO_3$ | $Al_2O_3$ | PbO | $H_2O$ | $Fe_2O_3$ | CaO | $PbCl_2$ |
|---|---|---|---|---|---|---|---|---|
| 1. Huelgoet | 8·06 | 0·30 | 34·32 | 35·10 | 18·70 | 0·20 | 0·80 | 2·27 = 99·75 |
| 2. " | 12·05 | 0·25 | 12·05 | 62·15 | 6·18 | — | — | 8·24 = 100·92 |
| 3. " | 15·18 | 0·40 | 2·88 | 70·85 | 1·24 | — | — | 9·18 = 99·73 |
| 4. *Hitchcockite* | 18·74 | — | 25·54 | 29·04 | 20·86 | 0·90 | 1·44 | $CO_2$ 1·98, Cl 0·04, insol. 0·48 = 99·02 |

Berzelius made the mineral a hydrous aluminate of lead. Damour concluded from his results that in Berzelius's investigation the phosphoric acid was precipitated with the alumina and lead, and so lost sight of. He observes that his own analyses, though so widely different, agree in affording 1 : 1 for the oxygen ratio of water and alumina, and regards the alumina as present in the state of a hydrate.

**Pyr., etc.**—In the closed tube decrepitates and yields water. B.B. in the forceps swells up like a zeolite, colors the flame azure-blue, but is imperfectly fused. On charcoal gives in addition a faint white coating of lead chloride (Plattner). With soda gives metallic lead. With cobalt solution gives a blue color. With the sodium test yields a phosphide. Soluble in nitric acid.

**Obs.**—Occurs in clay-slate at Huelgoet in Brittany, associated with galena, sphalerite, pyrite, and pyromorphite; also in a lead mine at Nuissière, near Beaujeu; at Roughten Gill, Cumberland; at Mine la Motte, Missouri(?); at Canton mine, Ga., with galena, etc. (*hitchcockite*).

Named from the Latin *plumbum, lead,* and *gummi, gum.* The identity of de Lisle's mineral (which was carnelian-like in color) with plombgomme, though questioned by de Laumont in his early paper, is admitted in his letter cited in Ann. Phil., **14**, 31, 1819.

The mineral looks usually like drops or coatings of gum, also at times somewhat like chalcedony or allophane. It differs from globular pyromorphite or sphalerite in not being fibrous within. The *hitchcockite* occurs in botryoidal crusts and thin coatings, white, bluish, yellowish, or greenish, allophane-like, sometimes concentric in structure; Shepard gives H. = 2·75–3, and says that it loses 29 p. c. on ignition.

**Ref.**—[1] Bull. Soc. Min., **4**, 37, 1881.

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## Uranite Group.

**659. TORBERNITE.** Mica viridis cryst. (fr. Joh.) *v. Born*, Lithoph., **1**, 42, 1772. Grüner Glimmer (fr. Saxony) *Wern.*, Ueb. Cronst., 217, 1780; Torberit *Wern.* (earliest name); *Karst.*, Ueb. Wern. Verbess., 43, 1793 [later spelt *Torbernite*, as in Ludwig's Wern., **1**, 308, 1803); Chalkolith [put near Chlorite] *Wern.*, Bergm. J., 376, 1789; Urankalk durch Kupfer gefärbt, Uranites spathosus pt., *Klapr.*, Schrift. Ges. N. Berl., **9**, 273, 1789; Beitr., **2**, 217, 1797. Uranglimmer *Wern.*, 1800, Ludwig, **1**, 55, 1803. Urane oxydé *H.*, Tr., 1801. Uranite *Aikin*, Min., 1814. Uran-Mica *Jameson*, Syst., 1820. Uranphyllit *Breith.*, Char., 1820. Phosphate of Uranium containing Phos. Copper *R. Phillips*, Ann. Phil., **5**, 57, 1823. Phosphate of Uranium and Copper *Berz.*, Jahresb., 1823. Kupfer-Uranit *Germ.* Copper-Uranite. Torberite *B. & M* 517, 852. Cuprouranit *Breith.*, B. H. Ztg., **24**, 302, 1865.

Tetragonal. Axis $\dot{c}$ = 2·9361; 001 ∧ 101 = 71° 11½′ Schrauf[1].

| | | | | |
|---|---|---|---|---|
| **Forms**[2]: | *m* (110, *I*) | *z* (3·0·10, $\frac{3}{10}$-*i*) | *y* (102, $\frac{1}{2}$-*i*) | *t* (114, $\frac{1}{4}$ |
| *c* (001, *O*) | *x* (105, $\frac{1}{5}$-*i*) | *o* (103, $\frac{1}{3}$-*i*) | *r* (809, $\frac{8}{9}$-*i*)? | *l* (112, $\frac{1}{2}$) |
| *a* (100, *i-i*) | *s* (207, $\frac{2}{7}$-*i*) | *ϵ* (307, $\frac{3}{7}$-*i*) | *e* (101, 1-*i*) | *v* (334, $\frac{3}{4}$) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *cx* = | 30° 25′ | 30° 53½′ | Hausm. | | | 70° 26′ | G. & L. |
| | | 32° 4′ | Lévy | *ce* = | 71° 11½′ | 71° 7′ | Kk. |
| *cs* = | 39° 59½′ | 39° 53′ | Lévy | | | 71° 22′ | Hbg. |
| *cz* = | 41° 22½′ | 41° 50′ | Hbg. | *ct* = | 46° 4′ | 46° 10′ | Lévy |
| | | 43° 15′ | G. & L. | *cl* = | 64° 17′ | 64° 22′ | Lévy |
| *co* = | *44° 23′ | 44° 21′ | Kk. | *cv* = | 72° 12′ | 72° 25′ | G. & L. |
| | | 44° 23′ | Schrauf | *xx′* = | 41° 58′ | | |
| *cϵ* = | 51° 31½′ | 51° 25′ | Lévy | *oo′* = | 59° 17′ | | |
| *cy* = | 55° 44′ | 55° 33′ | Kk. (calc.) | *yy′* = | 71° 31′ | | |
| *cf* = | 62° 56′ | 63° 22′ | Hausm. | *ee′* = | 84° 2′ | *ll′* = | 79° 9′ |
| *cr* = | 69° 2′ | 68° 15′ | Lévy | *tt′* = | 61° 14′ | *vv′* = | 84° 38′ |

Crystals usually square tables, sometimes very thin, again thick; less often pyramidal. Also in foliated, micaceous aggregates.

Cleavage: *c* perfect, micaceous. Laminæ brittle. H. = 2–2·5. G. = 3·4–3·6. Luster of *c* pearly, other faces subadamantine. Color emerald- and grass-green, and sometimes leek-, apple-, and siskin-green. Streak paler than the color. Transparent to subtranslucent. Optically uniaxial; negative.

**Comp.**—A hydrous phosphate of uranium and copper, $Cu(UO_2)_2P_2O_8 + 8H_2O$ or $CuO.2UO_3.P_2O_5.8H_2O$ = Phosphorus pentoxide 15·1, uranium trioxide 61·2, copper 8·4, water 15·3 = 100. Arsenic may replace part of the phosphorus.

**Anal.**—1, Werther, J. pr. Ch., **43**, 334, 1848. 2, Pisani, C. R., **52**, 817, 1861. 3, Church, Ch. News, **12**, 183, 1865. 4–6, Winkler, J. pr. Ch., **7**, 10, 1873.

| | $P_2O_5$ | $As_2O_5$ | $UO_3$ | CuO | $H_2O$ | |
|---|---|---|---|---|---|---|
| 1. Cornwall | 14·34 | — | 59·03 | 8·27 | 15·39 | = 97·03 |
| 2. " | 14·0 | — | 59·67 | 8·50 | 15·0 | sand 0·40 = 97·57 |
| 3. " | 13·94 | 1·96 | 61·00 | 8·56 | 14·16 | CaO 0·62 = 100·24 |
| 4. " | 13·91 | 3·10 | 62·10 | 8·07 | 15·01 | = 102·19 |
| 5. " | 13·54 | 3·24 | 60·71 | 8·13 | 15·36 | = 100·98 |
| 6. Schneeberg | 14·25 | — | 56·75 | 8·92 | 14·70 | quartz 4·21 = 98·83 |

Church finds that there is no loss *in vacuo* or dry air, at 100° 11·1 p. c. ($6H_2O$), and the rest upon ignition.

**Pyr., etc.**—In the closed tube yields water. In the forceps fuses at 2·5 to a blackish mass, and colors the flame green. With salt of phosphorus gives a green bead, which with tin on charcoal becomes on cooling opaque red (copper). With soda on charcoal gives a globule of copper. Soluble in nitric acid.

**Obs.**—Gunnis Lake formerly afforded splendid crystallizations of this species, and also Tincroft and Wheal Buller, near Redruth, and elsewhere in Cornwall. Found also at Johanngeorgenstadt, and Eibenstock and Schneeberg, in Saxony; in Bohemia, at Joachimsthal and Zinnwald; in Belgium, at Vielsalm. A variety from Providence in Cornwall is in 8-sided tables with a low pyramid, and has a leek-green color, with G. = 3·329–3·372 (Breith., B. H. Ztg., **24**, 303, 1865).

As noted below, some so-called torbernite belongs to the corresponding arsenate, zeunerite.

First named *torberite* (*torbernite*) by Werner, after the chemist Torber Bergmann [*Lat.* Torbernus, as written by Bergmann himself]. Then, this naming after persons having been denounced as an innovation (see Karsten's Werner's Verbess., 43, 1793), Werner substituted *Chalcolite* (fr. *χαλκός, copper*, signifying, as he says, "ein Kupferhaltender Stein") in allusion to Bergmann's determination in 1780 that the mineral was muriate of copper. When, finally, it was shown by Klaproth to be an ore of uranium instead of copper, Werner, with Karsten and others, threw aside *chalcolite*, because false in signification, and used *Uranglimmer*. Chalcolite has since crept back again, but is no more appropriate now than it was sixty years ago. The name *torberite* was written as it should be, *torbernite*, by some mineralogists of the last century.

Both this species and the autunite have gone under the common name of *uranite;* the former also as *Copper-uranite*, the latter *Lime-uranite*.

**Ref.**—[1] Min. Mitth., 181, 1872. [2] This list contains the forms noted by Lévy, Min. Heul., 3, 329, 1837, angles quoted by Dufrénoy and repeated by Mlr., Min., 517, 1852; Hausm., Min., **2**, 1104, 1847; Greg and Lettsom, Min., 384, 1858, whose list as here noted contains several angles not given by Mlr.; Hbg., Min. Not., **6**, 41, 1863; Kk., Min. Russl., **5**, 35, 1866. As suggested by Schrauf, some of these observations may have been made on the following species, zeunerite, so that the list of forms is not above doubt.

**660. ZEUNERITE.** *Weisbach*, Jb. Min., 207, 1872; 315, 1873; Jb. Berg-Hütt., 1877. Kupferuranite, Kupfer-Uranglimmer, pt.

Tetragonal. Axis $\acute{c}$ = 2·9125; 001 ∧ 101 = *71° 3′ Weisbach[1].

**Forms**[1]: *c* (001, *O*); *a* (100, *i-i*), *z* (107, $\frac{1}{7}$-*i*), *p* (407, $\frac{4}{7}$-*i*), *e* (101, 1-*i*), *i* (201, 2-*i*).

Angles: *cz* = 22° 35½′, *cp* = 59° 0′, *ce* = 71° 3′, *ci* = 80° 15½′, *ee′* = 83° 57′.

In tabular crystals resembling torbernite; also acute pyramidal.

Cleavage: *c* perfect; *a* distinct. Fracture uneven. Brittle. H. = 2–2·5. G. = 3·2. Luster on *c* pearly. Color grass-green to emerald- and apple-green.

**Comp.**—An arsenate of copper and uranium corresponding to the phosphate torbernite, $Cu(UO_2)_2As_2O_8 + 8H_2O$ or $CuO.2UO_3.As_2O_5.8H_2O$ = Arsenic pentoxide 22·3, uranium trioxide 56·0, cupric oxide 7·7, water 14·0 = 100.

**Anal.**—Winkler, J. pr. Ch., **7**, 8, 1873.

$As_2O_5$ 20·94 $UO_3$ 55·86 CuO 7·49 $H_2O$ 15·68 = 99·97

**Pyr., etc.**—Yields arsenical fumes on charcoal, and with soda gives a globule of copper. Soluble in nitric acid.

**Obs.**—First found with other uranium minerals at the mine Weisser Hirsch, near Schneeberg, Saxony; the crystals rest upon quartz or upon iron ocher. Also found at Geisterhalde, near Joachimsthal; Wheal Gorland, Cornwall, on smoky quartz with chalcocite and melaconite; and Zinnwald, Saxony, on quartz.

Named for the Director of the Academy at Freiberg.

**Artif.**—Winkler (l. c., p. 14) has obtained zeunerite artificially, having the following composition: $As_2O_5$ 22·11, $UO_3$ 57·21, CuO 7·01, $H_2O$ 14·65 = 100·98.

**Ref.**—[1] Schneeberg, l. c. Schrauf gives *ce* = 68° 20′, which varies widely from the allied species; he adds *i* (*ci* = 78° 46′), Min. Mitth., 182, 1872. Cf. also torbernite, ref. [2]; the two species were probably early confounded.

**661. AUTUNITE.** Var. of Uranglimmer, Urankalk, or Chalcolite, *of authors prior to* 1819. Sel à base de chaux, ðu l'oxide d'urane joue le rôle d'acide, *Berz.*, N. Syst. Min., 295, 1819. Uranit *Berz.*, Jahresb., **4**. 46, 1823. Kalk-Uranit. Kalk-Uranglimmer, *Germ.* Lime-Uranite. Autunite *B. & M.*, 519, 1852. Calcouranit *Breith.*, B. H. Ztg., **24**, 302, 1865.

Orthorhombic, but approaching the tetragonal species, torbernite, closely. Axes $\breve{a} : \bar{b} : \acute{c}$ = 0·9875 : 1 : 2·8517 Des Cloizeaux[1].

100 ∧ 110 = 44° 38⅓′, 001 ∧ 101 = *70° 54′, 001 ∧ 011 = 70° 40½′.

**Forms:** *a* (100, *i*-ī), *b* (010, *i*-ì), *c* (001, *O*), *m* (110, *I*), *u* (101, 1-ī), *e* (011, 1-ì), *l* (112, ½).

Angles: *mm‴* = 89° 17′, *uu′* = 141° 48′, *ee′* = 141° 41′, *cl* = *63° 46′, *ll′* = 79° 20′, *ll‴* = 78° 8′

In thin tabular crystals, nearly tetragonal in form and deviating but slightly from torbernite in angle; also in foliated aggregates, with micaceous structure.

Cleavage: basal, eminent. Laminæ brittle. H. = 2–2·5. G. = 3·05–3·19. Luster of *c* pearly, elsewhere subadamantine. Color lemon- to sulphur-yellow. Streak yellowish. Transparent to translucent.

Optically −. Ax. pl. ∥ *b*. Bx ⊥ *c*. Ax. angles, Dx.:

(1) 2E = 60° 57′ at 17°, 57° 32′ at 47°, 56° 36′ at 71½°, 55° 8′ at 81°, 54° 10′ at 91°.
(2) 2E = 59° 46′ at 17°, 57° 46′ at 26½°, 55° 24′ at 47°, 53° 18′ at 71½°, 50° 12′ at 91°.

Refractive Index: $\beta = 1·572$

**Comp.**—A hydrous phosphate of uranium and calcium, probably analogous to torbernite, $Ca(UO_2)_2P_2O_8 + 8H_2O$ or $CaO.2UO_3.P_2O_5.8H_2O$=Phosphorus pentoxide 15·5, uranium trioxide 62·7, lime 6·1, water 15·7 = 100.

Some analyses give 10 and others 12 molecules of water, but it is not certain that the additional amount is essential. Cf. below.

**Anal.**—1, Winkler, J. pr. Ch., **7**, 12, 1873. 2–4, Church, J. Ch. Soc., **28**, 109, 1875. 5, Jannettaz, Bull. Soc. Min., **10**, 17, 1887. Also 5th Ed., p. 586.

| | $P_2O_5$ | $UO_3$ | CaO | $H_2O$ | |
|---|---|---|---|---|---|
| 1. Falkenstein | 15·09 | 62·24 | 6·11 | 16·00 | = 99·44 |
| 2. Cornwall | $\frac{2}{2}$ 13·84 | 60·00 | 5·01 | 18·95 | = 97·80 |
| 3. Autun | 14·32 | 61·34 | 5·24 | 19·66 | = 100·56 |
| 4. " | $\frac{2}{2}$ 13·40 | 60·84 | 5·31 | 20·33 | = 99·88 |
| 5. Madagascar | 14·93 | 55·08 | 6·51 | 22·08 | $Fe_2O_3$ 1·36 =99·96 |

Church found that the mean loss of water (anals. 2, 3, 4) in dry air, *in vacuo* and at 100° (or *in vacuo* alone), was 15·03 p. c., and at a red heat 4·68 p. c. more. He concludes that unaltered crystals contain 10 p. c. $H_2O$, or if dried *in vacuo*, $2H_2O$.

The early analysis of Berzelius gave 15·48 p. c. $H_2O$ = 8 molecules.

**Pyr., etc.**—Same as for torbernite, but no reaction for copper.

**Obs.**—Autunite is found usually with uraninite and other minerals containing uranium; also associated with silver, tin, and iron ores. Occurs in the Siebengebirge, in the hornstone of a trachytic range; at Johanngeorgenstadt and Eibenstock; Falkenstein in Saxon Voigtland; at Lake Onega, Wolf Island, Russia; near Limoges, and at St. Symphorien near Autun; formerly at South Basset, Wheal Edwards, and near St. Day, England.

In the U. States, occurs sparingly at the feldspar quarry in Middletown, Conn., associated with columbite and albite, in minute tabular crystals and thin scales, of light green and lemon-yellow colors; with uraninite at Branchville, Conn.; also in minute crystals at Chesterfield, Mass., on the quartz or albite, and sometimes in the red centers of tourmalines; at Acworth, N. H., straw-yellow and light green; also in a gneiss quarry on the Schuylkill, near Philadelphia, about ¼ m. above the suspension bridge. In N. Carolina, at the Flat Rock and other mica mines in Mitchell Co.; in Alexander Co. Found in the Black Hills, S. Dakota; at Silver Reef, Utah.

Berzelius calls the uranite of Cornwall and that of Autun, respectively, *chalcolite* and *uranite*, in his article announcing the composition, in JB., 4, 146, 147, 1823; and the special application of *uranite* to this species dates from that time. Yet, in order to avoid confusion from the double use of the name, it is better to adopt for the species the name of *autunite*, from one of its noted localities.

**Ref.**—[1] Ann. Mines, **11**, 261, 1854; **14**, 339, 1858. Brezina makes the Johanngeorgenstadt mineral monoclinic, with $\breve{a} : \bar{b} : \acute{c} = 0·3463 : 1 : 0·3525$, $\beta = 90° 30'$, Zs. Kr., 3, 273, 1879.

An early paper on the crystallization of "Oxyd of Uranium" (probably including both torbernite and autunite), with two plates, is given by Phillips in Trans. G. Soc., 3, 112, 1816 (read Feb. 1815).

**862. URANOSPINITE.** *Weisbach*, Jb. Min., 315, 1873; Jb. Berg-Hütt., 1877.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 1 : 1 : 2·9136$ approx.

**Forms:** *c* (001, *O*); *q* (1·0·10, $\frac{1}{10}$-ī), *y* (102, ½-ī), *r* (101, 1-ī), *x* (012, ½-ĭ).

Angles: *cq* = 16° 15′ (meas. 17°), *cy* = *cx* = *55° 32′, *cr* = 71° 3′ (meas. 71½°).

In thin tabular crystals rectangular in outline.

Cleavage: *c* perfect. H. = 2–3. G. = 3·45. Color siskin-green. Optically biaxial.

**Comp.**—Probably an arsenate of uranium and calcium corresponding to autunite, $Ca(UO_2)_2As_2O_8 + 8H_2O$ or $CaO.2UO_3.As_2O_5.8H_2O$ = Arsenic pentoxide 22·9, uranium trioxide 57·2, lime 5·6, water 14·3 = 100.

**Anal.**—Winkler, J. pr. Ch., 7, 11, 1873.

$As_2O_5$ 19·37 $UO_3$ 59·18 CaO 5·47 $H_2O$ 16·19 = 100·21

Church urges that the water may correspond to 10 equivalents instead of 8, Min. Mag., 1, 236, 1877.

**Obs.**—Occurs with uraninite and various secondary uranium minerals at Neustädtel near Schneeberg, Saxony.

**Artif.**—Obtained by Winkler (l. c.) by mixing uranium nitrate with a solution of lime in an excess of arsenic acid. The minute yellow crystals gave: $As_2O_5$ 23·01, $UO_3$ 59·01, CaO 5·62, $H_2O$ 14·27 = 101·91.

**663. URANOCIRCITE.** *Weisbach*, Jahrb. Berg-Hütt., 1877, Abhandl., p. 48. Barium-uranite.

Orthorhombic. In crystals similar to autunite.

Cleavage: *c* perfect; *a*, *b* distinct. G. = 3·53. Luster pearly on *c*. Color yellow-green. Transparent to translucent. Optically biaxial. Bx ⊥ *c*. 2E = 15°–20°.

**Comp.** — A phosphate of barium and uranium analogous to autunite, $Ba(UO_2)_2P_2O_8 + 8H_2O$ or $BaO.2UO_3.P_2O_5.8H_2O$ = Phosphorus pentoxide 14·0, uranium trioxide 56·7, baryta 15·1, water 14·2 = 100.

**Anal.**—Winkler, quoted by Weisbach.

$P_2O_5$ 15·06 $UO_3$ 56·86 BaO 14·57 $H_2O$ 13·99 = 100·48

Earlier analyses by Georgi, and Uwao Imai, gave confirmatory results. Church (Min. Mag., 1, 234, 1877) finds that *in vacuo* over $H_2SO_4$, at 20° C., $6H_2O$ go off; and the remainder ($2H_2O$) at a red heat.

**Obs.**—Occurs in quartz veins near Falkenstein, Saxon Voigtland. Formerly called autunite (lime-uranite).

**664. PHOSPHURANYLITE.** *F. A. Genth*, Am. Ch. J., 1, 92, 1879.

Occurs as a pulverulent incrustation; consisting of microscopic rectangular scales, with pearly luster. Color deep lemon-yellow.

**Comp.**—Hydrous uranium phosphate, $(UO_2)_3P_2O_8 + 6H_2O$ or $3UO_3.P_2O_5.6H_2O$ = Phosphorus pentoxide 12·7, uranium trioxide 77·6, water 9·7 = 100.

**Anal.**—1, Genth, l. c.; 1*a*, same, after deducting the lead oxide, present as impurity.

| | $P_2O_5$ | $UO_3$ | $H_2O$ | PbO | | |
|---|---|---|---|---|---|---|
| 1. | 11·30 | 71·73 | 10·48 | 4·40 | = | 97·91 |
| 1*a*. | 12·08 | 76·71 | 11·21 | — | = | 100 |

**Pyr.**—B.B. in the closed tube yields water, and becomes brownish yellow on cooling. Easily soluble in nitric acid.

**Obs.**—Occurs with other uranium minerals at the Flat Rock mine, Mitchell Co., N. C.; incrusts the quartz, feldspar, and mica; also at the Buchanan mine.

**665. TRÖGERITE.** *Weisbach*, Jb. Min., 870, 1871.

Monoclinic. In thin tabular crystals ∥ *b*, resembling gypsum; crystals united in druses.

Cleavage: *b* perfect. G. = 3·3. Luster on cleavage face pearly. Color lemon-yellow.

**Comp.**—A hydrous uranium arsenate, $(UO_2)_3As_2O_8 + 12H_2O$ or $3UO_3.As_2O_5.12H_2O$ = Arsenic pentoxide 17·6, uranium trioxide 65·9, water 16·5 = 100.

**Anal.**—Winkler; two other analyses on material less pure gave concordant results, J. pr. Ch., 7, 7, 1873.

$As_2O_5$ 19·64 $UO_3$ 63·76 $H_2O$ 14·81 = 98·21

**Obs.**—Occurs with walpurgite and other uranium minerals at the Weisser Hirsch mine at Neustädtel, near Schneeberg, Saxony. Named after the mining administrator, R. Tröger.

Reported with uraninite from the Bald Mountain mining district, Black Hills, S. Dakota.

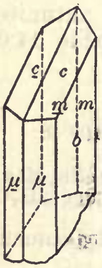
For remarks on the form, cf. Schrauf, Min. Mitth., 185, 1872.

FRITZSCHEITE *Breithaupt*, B. H. Ztg., **24**, 302, 1865. A mineral much resembling autunite in its four-sided quadratic (or nearly so) tables, with a perfect basal cleavage; with H. = 2–2·5; G. = 3·504?; vitreous to pearly in luster; reddish brown to hyacinth-red in color and streak; translucent; affording Fritzsche (l. c.) reactions for uranium, manganese, vanadium, phosphorus, and water. The red color is attributed to the manganese, and it is considered a mangan-uranite containing some vanadium. It occurs with crystals of autunite and torbernite at Neuhammer, near Neudeck in Bohemia, in a hematite mine; at Johanngeorgenstadt, of fine red color, with torbernite. Red crystals in groups, supposed to be this mineral, have been observed on specimens of uranite from Autun, and from Steinig, near Elsterberg, in Saxon Voigtland.

**666. WALPURGITE.** Walpurgin *A. Weisbach*, Jb. Min., 870, 1871; 1, 1877; Jb. Berg-Hütt. Sachs., 1877.

Triclinic. In thin scale-like crystals resembling gypsum; usually tabular ‖ *b* and twins with *b* as twinning-plane; sometimes a feather-like striation on *a*.

Measured angles: $m\underline{m} = 62° 30'$, $\mu\underline{\mu} = 72° 18'$, $bc = 70° 52'$, $cm = 80° 40'$, $c\mu = 82° 59'$, $bm = 59° 2'$, $\underline{b}\mu = 53° 50'$. Extinction-angle 8° with vertical axis in plane normal to *b*, 16° for twin, Weisbach-Groth[1].



Cleavage: *b* distinct. H. = 3·5. G. = 5·76. Luster adamantine to greasy. Color pomegranate- and wax-yellow.

**Comp.**—Probably a basic arsenate of bismuth and uranium, $Bi_{10}(UO_2)_3(OH)_{24}(AsO_4)_4$ or $5Bi_2O_3.3UO_3.2As_2O_5.12H_2O$ = Arsenic pentoxide 11·9, uranium trioxide 22·4, bismuth trioxide 60·1, water 5·6=100.

**Anal.**—Winkler, J. pr. Ch., **7**, 6, 1873.

| $As_2O_5$ | $UO_3$ | $Bi_2O_3$ | $H_2O$ | | |
|---|---|---|---|---|---|
| 11·88 | 20·29 | 61·43 | 4·32 | = | 97·92 |
| 13·03 | 20·54 | 59·34 | 4·65 | = | 97·56 |

**Obs.**—Occurs with trögerite and other uranium minerals at the Weisser Hirsch mine at Neustädtel, near Schneeberg, Saxony.

**Ref.**—[1] Zs. Kr., **1**, 93, 1877. Cf. Schrauf, Min. Mitth., 183, 1872.

**667. RHAGITE.** *Weisbach*, Berg-Hütt., Abh.; Jb. Min., 302, 1874.

In crystalline aggregates, spherical or mammillary, smooth on the surface.

Fracture subconchoidal. Brittle. H. = 5. G. = 6·82. Luster resinous to adamantine. Color yellowish green, sometimes wax-yellow. On the edges translucent.

**Comp.**—Perhaps (Rg.) $2BiAsO_4.3Bi(OH)_3$ or $5Bi_2O_3.2As_2O_5.9H_2O$ = Arsenic pentoxide 15·7, bismuth trioxide 78·8, water 5·5 = 100.

**Anal.**—Winkler, J. pr. Ch., **10**, 190, 1874.

| $As_2O_5$ | $Bi_2O_3$ | $Fe_2O_3,Al_2O_3$ | CoO | CaO | $H_2O$ | gangue | | |
|---|---|---|---|---|---|---|---|---|
| 14·20 | 72·76 | 1·62 | 1·47 | 0·50 | 4·62 | 3·26 | = | 98·43 |

**Pyr., etc.**—Easily soluble in hydrochloric acid, with difficulty in nitric acid. In the matrass decrepitates, and crumbles to a yellow powder, giving off its water; on charcoal fusible.

**Obs.**—Occurs on bismutite and quartz, accompanied by walpurgite, at the Weisser Hirsch mine, Neustädtel, near Schneeberg, Saxony.

Named from ρἀξ (ραγος), *grape*, in allusion to the color and botryoidal grouping

**668. MIXITE.** *Schrauf*, Zs. Kr., **4**, 277, 1879.

In very slender acicular crystals, deeply striated vertically; extinction parallel[1]. Also as an incrustation in irregular particles, granular and rough or spherical, reniform, with partial concentric fibrous structure.

H. = 3–4. G. = 3·79. Color emerald-green to bluish green, pale green, or whitish; streak somewhat lighter. Translucent to transparent in fine fibers.

**Comp.**—A hydrated basic arsenate of copper and bismuth, but formula doubtful.

Schrauf suggests $20CuO.Bi_2O_3.5As_2O_5.22H_2O$ = Arsenic pentoxide 32·0, bismuth trioxide 12·9, cupric oxide 44·0, water 11·1 = 100.

**Anal.**—1, Schrauf, l. c. 2. Hillebrand, Am. J. Sc., **35**, 305, 1888; also Pearce Proc. Col Soc., **1**, 151, 1886.

| | G. | | $As_2O_5$ | $P_2O_5$ | $Bi_2O_3$ | CuO | ZnO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | | $\frac{3}{3}$ | 30·45 | | 13·07 | 43·21 | — | 11·07 | FeO 1·52, CaO 0·83 = 100·15 |
| 2. Utah | 3·79 | $\frac{2}{2}$ | 28·79 | 0·06 | 11·18 | 43·89 | 2·70 | 11·04 | $Fe_2O_3$ 0·97, CaO 0·26, $SiO_2$ 0·42=99·31 |

**Pyr., etc.**—In dilute nitric acid the mineral is instantly covered with a layer of a brilliant white powder of bismuth arsenate, insoluble in the acid; the copper arsenate goes into solution. On ignition becomes blackish green and gives off water. Roasted on charcoal gives a silver-white bead of copper and bismuth, with a coating of bismuth trioxide.

**Obs.**—Occurs with bismuth ocher, bismutite, and torbernite in the Geistergang at Joachimsthal. Also at Wittichen, Baden, in crevices in barite with erythrite. In Utah, Tintic district, at the Mammoth mine in tufts of minute acicular crystals in a loosely coherent gangue.

Named after Bergrath A. Mixa.

**Ref.**—[1] Cross, Am. J. Sc., **35**, 306, 1888; cf. Schrauf, l. c., who makes it oblique 6° to 9°.

## Antimonates; also Antimonites, Arsenites.

A number of antimonates have been included in the preceding pages among the phosphates, arsenates, etc. Cf. pp. 754, 803, 804.

| | | | | |
|---|---|---|---|---|
| **669.** | **Atopite** | $Ca_2Sb_2O_7$ | Isometric | |
| **670.** | **Bindheimite** | Contains $PbO, Sb_2O_5, H_2O$ | | |
| **671.** | **Romeite** | $CaSb_2O_4$ | Tetragonal | $\dot{c}$ = 1·0257 |
| | | | | $\breve{a} : b : \dot{c}$ |
| **672.** | **Nadorite** | $(PbCl)SbO_2$ | Orthorhombic | 0·7490 : 1 : 1·0310 |
| **673.** | **Ecdemite** | $Pb_6Cl_2As_2O_7$ | Tetragonal or Orthorhombic | |
| | | | | $\breve{a} : \bar{b} : \dot{c}$ |
| **674.** | **Ochrolite** | $Pb_6Cl_2Sb_2O_7$ | Orthorhombic | 0·9050 : 1 : 2·0137 |
| **675.** | **Trippkeite** | $nCuO.As_2O_3$? | Tetragonal | $\dot{c}$ = 0·9160 |

**669. ATOPITE.** *A. E. Nordenskiöld*, G. För. Förh., **3**, 376, 1877.

Isometric; in octahedrons, with cube and dodecahedron.

H.= 5·5–6. G.= 5·03. Luster greasy. Color yellow to resin-brown. Translucent.

**Comp.**—Perhaps calcium pyroantimonate, $Ca_2Sb_2O_7$ or $2CaO.Sb_2O_5$=Antimony pentoxide 74·1, lime 25·9 = 100. Iron, manganese, and the alkali metals are also present.

**Anal.**—Nordenskiöld, l. c.

$\frac{2}{3}$ $Sb_2O_5$ 72·61 FeO 2·79 MnO 1·53 CaO 17·85 $K_2O$ 0·86 $Na_2O$ 4·40 = 100·04

**Pyr., etc.**—B.B. in forceps in O.F. unchanged. On charcoal in R.F. sublimes in part, fuses at first with difficulty, and gives finally, when the antimony pentoxide is all reduced to the metallic state and driven off, a dark infusible slag. In salt of phosphorus dissolves to a clear bead, yellow while hot, and colorless on cooling. Insoluble in acids; decomposed with difficulty by fusion with sodium carbonate. Easily reduced by hydrogen.

**Obs.**—Occurs sparingly in octahedrons embedded in hedyphane, which in turn forms little veins in rhodonite, at Långban, in Wermland, Sweden. Named from ἄτοπος, *unusual.*

SCHNEEBERGITE *A. Brezina*. Vh. G. Reichs., 313, 1880.
Isometric: in small (0·5–1 mm.) octahedrons. Fracture conchoidal. Brittle. Cleavage dodecahedral in traces. H. = 6·5. G. = 4·1 Weidel. Luster vitreous to adamantine. Color honey-yellow. Transparent. Consists principally (Weidel) of calcium and antimony, with a little iron, and traces of copper, bismuth, zinc, magnesia, and sulphuric acid. B.B. infusible, becomes slightly brown. Insoluble in acids. Found by Lhotsky, at Schneeberg, Tyrol, near the union of anhydrite (or gypsum) with chalcopyrite and magnetite.

**670. BINDHEIMITE.** Blei-Niere (fr. Nerchinsk) *Karst.*, Tab., 50, 77, 78, 1800 (citing anal. by *Bindheim*, Schrift. Ges. Nat. Fr. Berlin, **10**, 374, 1792). Antimonate of Lead. Antimonbleispath, Antimonsaures Bleioxyd, *Germ.* Stibiogalenit *Glock.*, Syn., 257, 1847. Bleinierite *Nicol.* Min., 383, 1849. Pfaffite *Adam*, Tabl. Min., 37, 1869.

Amorphous, reniform, or spheroidal; also earthy or incrusting. Structure sometimes curved lamellar.

H. = 4. G. = 4·60–4·76 Siberia, Hermann; 5·05 white, Cornwall, Heddle; 4·707 brown, ib., Heddle. Luster resinous, dull, or earthy. Color white, gray, brownish, yellowish. Streak white to grayish or yellowish. Opaque to translucent.

**Comp.**—A hydrous antimonate of lead, but analyses vary widely and no general formula can be given.

Anal. 1 gives nearly $Pb_3Sb_2O_8 + 4H_2O$ = Antimony pentoxide 30·2, lead protoxide 63·0, water 6·8 = 100. Other varieties give $2PbO.Sb_2O_5.3H_2O$. Anal. 7, made on apparently very pure material, gives $Sb_2O_5 : PbO : H_2O = 5 : 6·3 : 11$, and, as noted by Dunnington, most analyses give the molecular ratio $PbO + Sb_2O_5 : H_2O = 1 : 1$ or $1 : 2$.

**Anal.**—1, Hermann, J. pr. Ch., **34**, 179. 1845. 2, C. Stamm, Pogg., **100**, 618, 1857. 3, 4, Heddle, Phil. Mag., **12**, 126, 1856. 5, Dick, ibid. 6, Mixter, King's Rep. G. Surv. 40th Par., **2**, 759, 1877. 7, Dunnington, Proc. Amer. Assoc., 182, 1877. 8, Wait, Trans. Am. Inst. Mng. Eng., **8**, 51, 1880. Also W. F. Hillebrand, Proc. Col. Soc., **1**, 119, 1884, an impure variety from Secret Cañon, Nevada.

| | G. | $Sb_2O_5$ | PbO | $H_2O$ | |
|---|---|---|---|---|---|
| 1. Nerchinsk | 4·6–4·76 | 31·71 | 61·83 | 6·46 | = 100 |
| 2. Horhausen | | 41·13 | 48·84 | 5·43 | $Fe_2O_3$ 3·35, CuO 0·84 = 99·59 |
| 3. Cornwall, *white* | $\frac{2}{2}$ | 42·33 | 46·86 | 11·74 | = 100·93 |
| 4. " *brown* | | 46·70 | 43·94 | 6·63 | = 97·27 |
| 5. " | | 47·36 | 40·73 | 11·91 | = 100 |
| 6. Nevada | | 51·94 | 40·89 | 4·58 | Ag 0·33, $Fe_2O_3$ 0·60, insol. 1·66 = 100 |
| 7. Sevier Co., Ark. | 4·73 | 49·67 | 40·35 | 5 98 | $Fe_2O_3$ 2·98, $SiO_2$ 1·14 = 100·12 [= 100·09 |
| 8. " " | | 41·72 | 45·38 | 5·00 | $Fe_2O_3$ 2·06, $Al_2O_3$ 4·05, $SiO_2$ 1·84, Ag 0·04 |

**Pyr., etc.**—In the closed tube gives off water. B.B. on charcoal reduced to a metallic globule of antimony and lead, coating the charcoal white at some distance from the assay, and yellow nearer to it.

**Obs.**—A result of the decomposition of other antimonial ores; thus at Nerchinsk in Siberia; Horhausen; near Endellion in Cornwall, with jamesonite, from which it is derived, etc. In the U. States, in Sevier county, Arkansas; also Montezuma mine, Humboldt valley, Nevada.

*Bleinierite* is German for *Lead-kidney-ite!* and *Stibiogalenite* implies the presence of galena or lead sulphide; hence the substitute above after the earliest analyst of the species.

**671. ROMEITE.** Roméine *Damour*, Ann. Mines, **20**, 247, 1841; **3**, 179, 1853.

Tetragonal. Axis $\dot{c} = 1·0257$; $001 \wedge 101 = 45° 43\frac{1}{2}'$ Damour[1].

In groups of minute octahedrons *o* (111). Angles: $oo' = 71° 12'$, $oo'' = *110° 50'$.

Cleavage none. H. above 5·5. G. = 4·713. Color hyacinth- or honey-yellow. Double refraction strong[2].

**Comp.**—An antimonite of calcium, perhaps $CaSb_2O_4$ = Antimony 69·8, oxygen 14·0 (antimony trioxide 83·8), lime 16·2 = 100.

The analysis gives more nearly $Ca_2Sb_3O_8$ = Antimony 63·4, oxygen 16·9, lime 19·71 = 100.

**Anal.**—Damour, l. c.

| | | | | | | |
|---|---|---|---|---|---|---|
| O 15·82 | Sb 62·18 | Fe 1·31 | MnO 1·21 | CaO 16·29 | $SiO_2$ sol. 0·96 | insol. 1·90=99·67 |
| or $Sb_2O_5$ 40·79 | **$Sb_2O_3$** 36·82 | FeO 1·70 | 1·21 | 16·29 | 0·96 | 1·90=99·67 |

**Pyr., etc.**—B.B. fuses to a blackish slag. With borax affords a colorless glass in the inner flame, a violet in the outer (manganese). With soda on charcoal gives white antimonial fumes and globules of metallic antimony; fused on platinum foil with soda gives a bluish green manganate. Insoluble in acids.

**Obs.**—Romeite was found by B. de Lom at St. Marcel in Piedmont, in small nests or veins in the gangue which accompanies manganese, consisting in part of feldspar, epidote, quartz, limonite, and greenovite.

Named by Damour after the crystallographer Romé de Lisle (or Romé ~~de~~ l'Isle, 1736–1790).

**Ref.**—[1] L. c. [2] On the anomalous double refraction see Btd., Bull. Soc. Min., **4**, 240, 1881.

### 672. NADORITE. *Flajolot*, C. R., **71**, 237, 406, 1870.

Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c} = 0{\cdot}7490 : 1 : 1{\cdot}0310$ Cesàro[1].

$100 \wedge 110 = 36^\circ\ 50'$, $001 \wedge 101 = 54^\circ\ 0\tfrac{1}{6}'$, $001 \wedge 011 = 45^\circ\ 52\tfrac{1}{2}'$.

**Forms**[2]:
*a* $(100, i\text{-}\bar{\imath})$
*b* $(010, i\text{-}\breve{\imath})$
*c* $(001, O)$
$\pi$ $(430, i\text{-}\tfrac{4}{3})$
*q* $(230, i\text{-}\tfrac{3}{2})$
*r* $(130, i\text{-}\breve{3})$
$\vartheta$ $(103, \tfrac{1}{3}\text{-}\bar{\imath})$
$\zeta$ $(15{\cdot}0{\cdot}8, \tfrac{15}{8}\text{-}\bar{\imath})$
$\eta$ $(101, 1\text{-}\bar{\imath})$
*e* $(503, \tfrac{5}{3}\text{-}\bar{\imath})$
*d* $(201, 2\text{-}\bar{\imath})$
$\epsilon$ $(703, \tfrac{7}{3}\text{-}\bar{\imath})$
$\delta$ $(11{\cdot}0{\cdot}3, \tfrac{11}{3}\text{-}\bar{\imath})$
*l* $(011, 1\text{-}\breve{\imath})$ tw. pl.
*p* $(111, 1)$

Also doubtful *x* (37·17·12), *y* (17·5·4).

$\pi\pi''' = 58^\circ\ 39'$
$qq' = 83^\circ\ 20\tfrac{1}{2}'$
$rr' = 47^\circ\ 59'$
$\eta\eta' = 108^\circ\ 0'$
$ee' = 132^\circ\ 54'$
$ll' = 91^\circ\ 45'$
$pp' = 87^\circ\ 34'$
$pp'' = {}^*119^\circ\ 39'$
$pp''' = 62^\circ\ 26'$
$ap = {}^*46^\circ\ 13'$

Twins: tw. pl. *l* (011), hence crossing at angles of nearly 90 (f. 2), since $ll' = 91^\circ\ 45'$. Crystals tabular ‖ *a*; also prismatic ‖ $\grave{c}$

Cleavage *a*, very perfect. H. = 3·5–4. G. = 7·02. Luster resinous to adamantine. Color smoky-brown to brownish yellow. Streak yellow. Translucent.

Optically +. Ax. pl. ‖ *b*. Bx ⊥ *c*. Ax. angle large. $2H_o = 145^\circ$. Dispersion strong, $\rho > v$. Dx.

**Comp.**—$PbClSbO_2$ or $PbSb_2O_4 . PbCl_2$ = Antimony 30·5, lead 52·4, chlorine 9·0, oxygen 8·1 = 100.

1. 2.

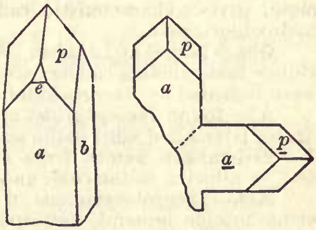


Fig. 1, 2, Cesàro.

**Anal.**—1, Pisani, C. R., **71**, 319, 1870. 2, Flajolot, l. c. and Zs. G. Ges., **24**, 47, 1872. 3, Tobler, Zs. G. Ges., **24**, 40, 1872.

| | | Sb | Pb | O | Cl |
|---|---|---|---|---|---|
| 1. | G. = 7·02 | 31·17 | 51·88 | 8·22 | 9·00 = 100·27 |
| 2. | | 31·55 | 51·60 | 8·00 | 8·85 = 100·00 |
| 3. | | 31·21 | 50·69 | 8·56 | 8·15 $H_2O$ 0·67 = 99·28 |

Pisani gives: $Sb_2O_3$ 37·40, PbO 27·60, Pb 26·27, Cl 9·00 = 100·27.

**Pyr., etc.**—In the closed tube decrepitates and gives a white sublimate. B.B. on charcoal yields an antimony coating and a globule of metallic lead. Added to a bead of salt of phosphorus saturated with copper gives the blue coloration of the flame due to copper chloride. Soluble in hydrochloric acid.

**Obs.**—From Djebel-Nador, in the province of Constantine, Algiers; it occurs in cavities in a deposit of zinc in the Nummulitic limestone, cf. Braun, Zs. G. Ges., **24**, 30, 1872.

**Ref.**—[1] Bull. Soc. Min., **11**, 44, 1888. Cesàro's position is here accepted, as also his interpretation of the planes and angles of Des Cloizeaux; cf. Dx., ib., **5**, 122, 1882, and earlier, C. R., **73**, 81, 1871.

### 673. ECDEMITE. Ekdemit *A. E. Nordenskiöld*, G. För. Förh., 3, 379, 1877. Heliophyllit *G. Flink*, Öfv. Ak. Stockh., **45**, 574, 1888; *Hamberg*, G. För. Förh., **11**, 229, 1889.

Tetragonal[1] (?). In acute pyramidal crystals, *p*, with $cp = 52^\circ$–$54^\circ$ approx. Hamberg; faces strongly striated horizontally. Also in crystals tabular ‖ *c*. Commonly massive, coarsely foliated or granular; also as a crystalline incrustation.

Cleavage: basal, nearly perfect. Brittle. H. = 2·5–3. G. = 6·89–7·14. Luster on cleavage plane vitreous, on fracture surfaces greasy. Color bright yellow to green. Translucent in thin splinters. Optically uniaxial, negative; in part also biaxial.

Hamberg shows that basal (cleavage) sections of heliophyllite are in part normally uniaxial, in part biaxial. In the case of the foliated masses (A) the lamellæ cross at right angles as if twinned about a prism of 90°. There are also acute pyramidal crystals of tetragonal form (B); of these sections ‖ *c* show an isotropic ground-mass, also systems of doubly-refracting lamellæ as if twinned as above; the lamellæ in part diagonal, also in the direction of a ditetragonal prism (210). Sections of ecdemite showed a structure somewhat similar to that last mentioned. These biaxial, doubly-refracting lamellæ are regarded as secondary, the original structure having been normal tetragonal. Cf. below.

**Comp.**—Perhaps (Flink), $Pb_4As_2O_7.2PbCl_2$ = Arsenic trioxide 12·1, lead protoxide 81·3, chlorine 8·6 = 102·0 deduct (O = 2Cl) = 100.

This composition is analogous to that taken for ochrolite, which, however, is based on the analysis of a very small amount of material. Hamberg shows that analyses 2–4 agree more closely with the complicated formula $Pb_{13}Cl_8As_4O_{15} = Pb_9As_4O_{15}.4PbCl_2$. Nordenskiöld gives the formula $Pb_5As_2O_8.2PbCl_2$.

**Anal.**—1, Nordenskiöld, l. c. 2, Flink, l. c. 3, 4, Hamberg, l. c.

| | | $As_2O_3$ | $Sb_2O_3$ | PbO | Cl | |
|---|---|---|---|---|---|---|
| 1. *Ecdemite* | G. = 7·14 | 10·60 | — | 83·45 | 8·00 | = 102·05 |
| 2. *Heliophyllite* | G. = 6·886 | 11·69 | — | 80·70 | 8·00 | FeO,MnO 0·54 = 100·93 |
| 3. " *A* | | 10·85 | 0·56 | 81·03 | 8·05 | FeO,MnO 0·07, CaO 0·08 = 100·64 |
| 4. " *B* | | 10·49 | 1·38 | 80·99 | 7·96 | FeO,MnO 0·16, CaO 0·11 = 101·09 |

The oxygen equivalent of the chlorine (1·8) is to be deducted.

**Pyr., etc.**—Fuses easily to a yellow mass, with the loss of lead chloride as a white sublimate; gives a characteristic lead coating on charcoal. Soluble readily in nitric acid or in warm hydrochloric acid.

**Obs.**—Found at Långban, Wermland, Sweden, in small granular masses, embedded in a yellow manganesian calcite; also as an incrustation. Associated crystals of a similar composition were regarded by Nordenskiöld as orthorhombic (see below).

Also found (*heliophyllite*) at the Harstig mine, Pajsberg, Sweden; it occurs in crystals in druses later filled with barite and inesite.

Ecdemite is named from εκδημος, *unusual;* heliophyllite from ἥλιος, *sun*, and φύλλον, *leaf*, in allusion to the color and structure.

**Ref.**—[1] See observations of Hamberg. Nordenskiöld gives the angles on the supposed orthorhombic mineral, dimorphous with ecdemite, *cp* = 65° 24′, *pp′* = 78° 32′. Brögger gives (quoted by Flink) for the same angle, *cp* = 65° 36′; the crystals are regarded as twins or fourlings. Flink calculates for heliophyllite the axial ratio $\breve{a} : \bar{b} : \dot{c} = 0·9666 : 1 : 2·2045$ corresponding to the axial ratio of ochrolite.

**674. OCHROLITE.** Ochrolith *G. Flink*, Öfv. Ak. Stockh., **46**, 5, 1889.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·90502 : 1 : 2·01375$ Flink.

$100 \wedge 110 = 42° 8\frac{3}{4}'$, $001 \wedge 101 = 65° 48'$, $001 \wedge 011 = 63° 35\frac{1}{2}'$.

**Forms:** *c* (001, *O*), *d* (101, 1-$\bar{i}$), *e* (011, 1-$\breve{i}$).

Angles: *cd* = 65° 48′, *dd‴* = *48° 24′, *ce* = 63° 35½′, *ee‴* = *52° 49′, *de* = 79° 30′.

In small crystals, thick tabular ‖ *c*, and often elongated ‖ $\bar{b}$ by extension of *d*. Crystals often united in diverging groups having the macro-axis in common. Luster adamantine. Color sulphur-yellow, sometimes with tinge of gray. Translucent.

**Comp.**—Probably $Pb_4Sb_2O_7.2PbCl_2$ = Antimony trioxide 16·6, lead oxide 77·0, chlorine 8·2 = 101·8, less oxygen 1·8 = 100.

**Anal.**—Flink on 0·2 gr., after deducting 5 p. c. $CaCO_3$.

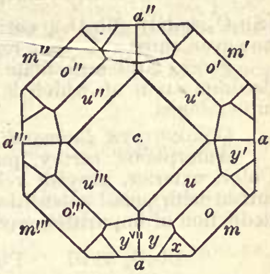
| $Sb_2O_3$ | PbO | Cl |
|---|---|---|
| [17·59] | 76·52 | 7·72 |

Dissolves in nitric acid, the solution becoming turbid upon dilution; also soluble in caustic potash.

**Obs.**—Found sparingly in the Harstig mine at Pajsberg, Sweden; occurs in druses with barite, mimetite, hematite. Named in allusion to the bright sulphur-yellow color from ὦχρος, *bright yellow*, and λίθος, *stone*.

**675. TRIPPKEITE.** *Damour* and *vom Rath*, Zs. Kr., **5**, 245, 1880, Bull. Soc. Min., **3**, 175.

Tetragonal. Axis $\dot{c} = 0{\cdot}9160$; $001 \wedge 101 = 42° \ 29\frac{1}{3}'$ Rath.



**Forms:** *m* (110, *I*) *ϵ* (331, 3) *x* (312, $\frac{3}{2}$-3)
*c* (001, *O*) *u* (112, $\frac{1}{2}$) *y* (314, $\frac{3}{4}$-3) *z* (24·5·20, $\frac{6}{5}$-$\frac{24}{5}$)
*a* (100, *i-i*) *o* (111, 1)

$uu' = {}^*45° \ 13'$ $\quad \epsilon\epsilon'' = 151° \ 8'$ $\quad yy' = 30° \ 25'$
$oo' = 68° \ 4\frac{1}{2}'$ $\quad cy = 35° \ 55'$ $\quad xx^{vii} = 30° \ 10'$
$\epsilon\epsilon' = 86° \ 26'$ $\quad cx = 55° \ 23'$ $\quad yy^{vii} = 21° \ 23'$
$uu'' = 65° \ 52'$ $\quad xx' = 43° \ 11'$ $\quad zz^{vii} = 17° \ 31'$
$oo'' = 104° \ 40'$

Habit octahedral, crystals small, brilliant.

Cleavage: *a* perfect; *m* less perfect. Color bluish green. Optically uniaxial, positive, Dx.

**Comp.**—According to a qualitative examination by Damour, essentially an arsenite of copper ($n$CuO,$As_2O_3$).

**Pyr., etc.**—Easily soluble in acids. B.B. in the closed tube becomes emerald-green on slight heating, then the green disappears and the color becomes brownish; on continued ignition the color becomes yellowish green a second time. Fuses easily to a green slag. In the open tube gives crystals of arsenic trioxide.

**Obs.**—Occurs with olivenite, as an older formation, in druses in massive cuprite from Copiapo, Chili. Named after the young mineralogist, Dr. Paul Trippke, who died June 16, 1880.

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The following are antimonates, or antimonites, of doubtful character.

AMMIOLITE. Antimonite de Mercure *Domeyko*, Ann. Mines, **6**, 183, 1844. Cinabrio subido *Domeyko*, Min., 168, 1845. Ammiolite *Dana*, Min., 534, 1850. Antimoniato de cobre con cinabrio terroso *Domeyko*, Min., 129, 1860.

Earthy powder. Color deep red, scarlet.

Composition doubtful, but regarded as antimonate of copper mixed with cinnabar and with other impurities. Analyses by Domeyko of the material obtained in the earliest part of a process of levigation:

| $Sb_2O_5$ | CuO | Hg | S | $Fe_2O_3$ | quartz | $H_2O$ and loss. |
|---|---|---|---|---|---|---|
| 24·1 | 16·9 | 19·9 | 3·3 | 2·2 | 24·8 | 8·8 |
| 29·5 | 15·6 | 23·6 | 3·3 | 3·1 | 8·1 | 16·9 |
| 23·1 | 18·1 | 19·8 | 3·1 | 1·1 | | |

Rivot has found in a similar substance from Chili (Ann. Mines, **6**, 556, 1854): Sb 36·5, Cu 12·2, Hg 22·2, Te 14·8, Fe,S *tr.*, quartz 2·5, O and loss 11·8. He observes that his result indicates the presence of mercury telluride (cf. coloradoite, p. 64) and antimonic acid along with antimonate of copper.

Found in many of the Chilian mines, filling cavities in the quartzose or argillo-ferruginous gangue of the mercurial tetrahedrite, and in the pores of the imperfectly compact tetrahedrite itself, and has proceeded from the decomposition of this mercurial ore.

Named from *ἄμμιον, vermilion.*

F. Field has analyzed a red earthy substance from Tambillos, near Coquimbo, Chili, and made it a compound of antimonite of mercury and sulphantimonite of mercury; but there is much uncertainty over his results Cf. J. Ch. Soc., **12**, 27, 1860, and Min., 5th Ed., p. 548.

AREQUIPITE *A. Raimondi*, Minéraux du Pérou, Paris, p. 167, 1878.

Compact, wax-like. Fracture conchoidal. H. nearly 6. Color honey-yellow. On the basis of a qualitative analysis, stated to be a silico-antimonate of lead. B.B. on charcoal fuses with difficulty, yielding buttons of lead, and gives off antimonial vapors. Slightly attacked by nitric acid; dissolves slowly in hydrochloric acid to which a little nitric has been added, and leaves a residue of silica. Occurs sparingly in a quartzose gangue, with argentiferous lead carbonate and chrysocolla, at the Victoria mine, Mt. de la Trinité, near Tibaya, Province of Arequipa, Peru.

BARCENITE *J. W. Mallet*, Am. J. Sc., **16**, 306, 1878.

Massive; structure finely granular, compact or porous; also columnar (pseudomorphous). Fracture tolerably even. Brittle. H. = 5·5. G. = 5·343. Luster dull, earthy, sometimes slightly resinous. Color dark gray, nearly black. Streak ash-gray, with slight greenish tint. Anal.—J. R. Santos:

| Sb | S | Hg | Ca | O | $H_2O$ | |
|---|---|---|---|---|---|---|
| 50·11 | 2·82 | 20·75 | 3·88 | [17·61] | 4·73 | (below 130° C. 1·23) $SiO_2$ 0·10 = 100 |

The sulphur is assumed to exist as HgS, and is accordingly deducted with a corresponding amount of mercury. For the remainder the following atomic ratios are then obtained: $RO : Sb_2O_3 : Sb_2O_5 = 4 : 1 : 5$, and $Sb_2O_5 : H_2O = 1 : 5$. The antimonic acid ($Sb_2O_5.5H_2O$) is again assumed to exist independently as an impurity, and the formula for the remainder written: $[Sb_2O_3.4(RO)].(Sb_2O_5)_5$ corresponding to a normal antimonate $\overset{\text{I}}{R}SbO_3$. The result reached, however, must at best be regarded as of very doubtful value.

From Huitzuco, State of Guerrero, Mexico; associated with livingstonite, from the decomposition of which it has been formed. Named after Sr. Mariano Barcena, a Mexican mineralogist.

CORONGUITE *Raimondi*, Minéraux du Pérou, pp. 88, 91, 1878.

Amorphous, earthy, pulverulent, sometimes slightly lamellar. H. = 2·5–3. G. = 5·05. Color, exterior, grayish yellow; interior, blackish, with luster slightly resinous. Intimately mixed with small quantities of sulphur, antimony, silver, and lead. An analysis, after the deduction of impurities, gave:

$Sb_2O_5$ 58·97 $PbO$ 21·48 $Ag_2O$ 7·82 $Fe_2O_3$ 0·52 $H_2O$ 11·21 = 100

It is hence, if homogeneous, an antimonate of lead and silver. Found at the mines of Mogollon, Huancavelica, and Empalme, in the district of Corongo, province Pallasca, and at Pasacancha, province of Pomabamba, Peru.

TAZNITE *Domeyko*, C. R., **85**, 977, 1877; Min. Chili, 3d Ed., p. 298, 1879.

Amorphous, more or less fibrous in structure. Earthy. Color yellow. Soluble in hydrochloric acid. Regarded as an arsenio-antimonate of bismuth, analogous to bindheimite, but doubtless heterogeneous; believed to have been derived from the alteration of some sulpharsenite or sulphantimonite of bismuth. Very impure, from the admixture of varying quantities of bismuth ocher. An analysis gave: $Bi_2O_3$ (sol. in $HNO_3$) 42·00, $Bi_2O_3$ (united with Sb and As) 29·50, $Sb_2O_5$ 5·29, $As_2O_5$ 12·20, $Fe_2O_3$ 7·00, $H_2O$ 4·90, insol. 1·00 = 101·89. Obtained with other bismuth minerals from the mines of Tazna and of Choroloque, in Bolivia.

Some other related antimony minerals, of doubtful character, are mentioned on pp. 293, 294.

## Phosphates or Arsenates with Carbonates, Sulphates, Borates.

| | | | | |
|---|---|---|---|---|
| 676. | **Dahllite** | $2Ca_3P_2O_8.CaCO_3.\frac{1}{2}H_2O$ | | |
| 677. | **Diadochite** | $2Fe_2O_3.2SO_3.P_2O_5.12H_2O$ pt. | | |
| 678. | **Pitticite** | Contains $Fe_2O_3$, $SO_3$, $As_2O_5$, $H_2O$ | | |
| 679. | **Svanbergite** | Contains $Na_2O$, CaO, $Al_2O_3$, $SO_3$, $P_2O_5$, $H_2O$ | Rhombohedral | $\dot{c}$<br>1·2063 |
| 680. | **Beudantite** | Contains CuO, PbO, $Fe_2O_3$, $SO_3$, $(P,As)_2O_5$, $H_2O$ | Rhombohedral | $\dot{c}$<br>1·1842 |
| 681. | **Lindackerite** | Contains FeO, NiO, CuO, $SO_3$, $As_2O_5$, $H_2O$ | | |
| 682. | **Lüneburgite** | $3MgO.B_2O_3.P_2O_5.8H_2O$ | | |

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**676. DAHLLITE.** *W. C. Brögger* and *H. Bäckström*, Öfv. Ak. Stockh., **45**, 493, 1888.

In crusts with fibrous structure normal to the surface.

H. = 5. G. = 3·053. Luster resinous. Color pale yellowish white; colorless in thin section. Optically uniaxial, negative. Double refraction slightly greater than that of apatite.

**Comp.**—$2Ca_3P_2O_8.CaCO_3.\frac{1}{2}H_2O$ = Phosphorus pentoxide 39·0, carbon dioxide 6·0, lime 53·7, water 1·3 = 100.

**Anal.**—H. Bäckström, l. c.

| $P_2O_5$ | $CO_2$ | CaO | FeO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|
| 38·44 | 6·29 | 53·00 | 0·79 | 0·89 | 0·11 | 1·37 = 100·89 |

**Pyr., etc.**—Decrepitates B.B., but does not fuse. Dissolves in cold dilute acid with the evolution of carbon dioxide.

**Obs.**—Occurs as a crust from 6 to 8 mm. in thickness, upon a bright red massive apatite at Ödegaard, Bamle, Norway.

The natural suggestion that the mineral is a mechanical mixture of apatite and calcite is answered by the microscopic examination, showing it to be fresh and homogeneous.

Named for the brothers Dr. Tellef Dahll and Johann Dahll, mineralogists and geologists.

CIPLYTE *J. Ortlier* [Ann. Soc. G. Nord., **16**, 270, 1888–89], Bull. Soc. Min., **13**, 160, 1890. Stated to be a silico-phosphate of calcium occurring in the chalk of Ciply and other points in Belgium, associated with phosphorite. Composition, based upon an analysis of impure material: $4CaO.2P_2O_5.SiO_2$?. It is only feebly soluble in sulphuric acid and hence can be separated from the enclosing mass. No physical description is given.

**677. DIADOCHITE.** Diadochit *Breith.*, J. pr Ch., **10**, 503, 1837. Phosphoreisensinter *Rg.* Destinezite *Forir & Jorissen*, Bull. Soc. G. Belg., **7**, 117, 1881.

Monoclinic. In microscopic six-sided tables, perhaps related to gypsum in form (Cesàro). Reniform or stalactitic; structure curved lamellar.

Fracture conchoidal. Fragile. H. = 3. G. = 2·035. Luster resinous, inclining to vitreous. Color yellow or yellowish brown. Streak uncolored.

**Comp.**—Formula uncertain. *Destinezite,* anal. 4, gives $2Fe_2O_3.2SO_3.P_2O_5.12H_2O$ (Cesàro) = Phosphorus pentoxide 16·9, sulphur trioxide 19·1, iron sesquioxide 38·2, water 25·8 = 100.

Rammelsberg calculates for anal. 1, $7Fe_2O_3.6SO_3.3P_2O_5.54H_2O$.

**Anal.**—1, Plattner, Rg., Min. Ch., 360, 1860. 2, 3, Carnot, Bull. Soc. Min., **3**, 39, 1880; the material in 2 was brown, vitreous, of 3 whitish, earthy. 4, Cesàro, Mem. Soc. G. Belg., **12**, 173, 1885.

| | | $P_2O_5$ | $As_2O_5$ | $SO_3$ | $Fe_2O_3$ | $H_2O$ | CaO | MgO | |
|---|---|---|---|---|---|---|---|---|---|
| 1. Arnsbach | | 14·82 | — | 15·14[a] | 39·69 | 30·35 | — | — | = 100 |
| 2. Isère | G. = 2·22 | 16·70 | 0·45 | 13·37 | 36·63 | 32·43 | 0·30 | *tr.* | = 99·88 |
| 3. " | G. = 2·10 | 17·17 | — | 13·65 | 36·60 | 32·20 | 0·15 | *tr.* | = 99·77 |
| 4. Destinezite | | 16·76 | — | 18·85 | 37·60 | 25·35 | — | — | $H_2O$ hygr. 0·30, insol.<br>[1·40 = 100·26 |

[a] 14·9 p. c., Rg.

**Pyr., etc.**—Yields much water in the closed tube, and swells up, becoming lusterless and opaque yellow; when ignited gives off sulphuric acid. B.B. in the forceps swells up and falls to powder, but carefully ignited fuses easily to a grayish black slag, and colors the flame bluish green. On charcoal affords a steel-gray magnetic globule. With soda affords metallic particles, and gives a sulphide which blackens silver. With borax and salt of phosphorus reacts for iron. Soluble in hydrochloric acid.

**Obs.**—From alum-slate near Gräfenthal and Saalfeld in Thuringia. Also at the anthracite mine of Peychagnard, Isère, France. Named from *διάδοχος, a successor*, on the supposition that it is an iron sinter, in which phosphoric acid has replaced the arsenic acid.

*Destinezite* occurs in yellowish white nodular masses of an earthy aspect on the surface, but dull on the fracture; it is from the ampelite at Argenteau, Belgium. Named after M. Destinez.

**678. PITTICITE.** Eisenpecherz *Karsten* [not *Wern.*], Tab., 66, 98, 1808. Fer oxydé, resinite *Haüy*, Tabl., 98, 1809. Pittizit *Hausm.*, Handb., 285, 1813. Eisensinter *Wern.*, Hoffm. Min., 3, b, 302, 1816; 4, b, 141, 1817; fr. Freiesleben G. Arb., 5, 74, 261. Arseneisensinter *Germ.* Pitchy Iron Ore. Diarsenate of Iron. Sideretine *Beud.*, Tr., **2**, 609, 1832 [not *Pittizite* Beud., p. 484]. Pitticit *Hausm.*, Handb., 1022, 1847.

Reniform and massive.

H. = 2–3. G. = 2·2–2·5. Luster vitreous, sometimes greasy. Color yellowish and reddish brown, blood-red and white. Streak yellow to white. Translucent to opaque.

**Comp.**—A hydrated arsenate and sulphate of ferric iron, but formula doubtful; perhaps not homogeneous.

**Anal.**—1, Rg., Pogg., **62**, 139, 1844. 2, Id., Min. Ch., 384, 1860. 3, Frenzel, Jb. Min., 787, 1873. 4, Church, Chem. News, **24**, 135, 1871. 5, Genth, Am. J. Sc., **40**, 205, 1890. Also earlier, 5th Ed., p. 589.

| | | $As_2O_5$ | $SO_3$ | $Fe_2O_3$ | $H_2O$ | |
|---|---|---|---|---|---|---|
| 1. Seiglitzstollen | | 24·67 | 5·20 | 54·66 | [15·47] | = 100 |
| 2. Schwarzenberg | | 26·70 | 13·91 | 34·85 | 24·54 | = 100 |
| 3. Freiberg | G. = 2·398 | 29·53 | 13·84 | 29·27 | 25·16[a] | CuO 0·94 = 98·74 |
| 4. Redruth | | 33·99 | 7·28 | 32·54 | 24·92 | = 100 |
| 5. Utah | | 39·65 | 1·14 | 33·89 | 18·24 | CuO 1·17, $Fe_2O_3$ (insol.) 4·08,<br>[$SiO_2$ 1·92 = 100·09 |

[a] At 100°, loses 15·56 p. c. $H_2O$.

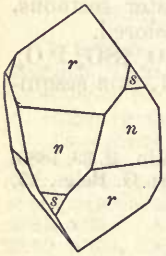
Anal. 5 shows almost no sulphuric acid, Genth calculates $4FeAsO_4.Fe(OH)_3 + 10H_2O$. An iron-sinter mentioned on p. 821, from Nerchinsk, analyzed by Hermann had the composition of scorodite.

**Pyr., etc.**—In the closed tube yields water, and at a high heat gives off sulphur dioxide. In the forceps and on charcoal like scorodite. With soda on charcoal gives arsenical fumes and a sulphide which blackens silver.

**Obs.**—Occurs in old mines near Freiberg and Schneeberg in Saxony, and elsewhere; occurs also at Redruth in Cornwall. An ore on Hopkins's farm near Edenville, N. Y., is referred by Beck to this species. The mineral analyzed by Genth (anal. 5) was from the Clarissa mine, Tintic district, Utah.

**679. SVANBERGITE.** Svanbergit *Igelström*, Öfv. Ak. Stockh., **11**, 156, 1854.

Rhombohedral. Axis $\dot{c} = 1{\cdot}2063$; $0001 \wedge 10\bar{1}1 = 54° 19\frac{1}{2}'$ Dauber[1].



Seligmann.

**Forms:** *c* $(0001, O)$, *r* $(10\bar{1}1, R)$, *n* $(40\bar{4}1, 4)$, *V* $(50\bar{5}1, 5)$; *s* $(02\bar{2}1, -2)$.

Angles: $cn = 79° 49\frac{1}{2}'$, $cV = 81° 50'$, $cs = 70° 15'$, $rr' = 89° 25'$, $nn' = 116° 57'$, $VV' = 118° 1'$, $ss' = 109° 12'$, $rn = 25° 30'$.

In rhombohedral crystals, resembling cubes; also in modified forms.

Cleavage: basal, perfect. H. = 5. G. = 3·30; 2·571 Breith.; 3·29 Blomstrand. Luster vitreous to adamantine. Color honey-yellow to yellowish brown, reddish brown, and rose-red. Streak reddish or colorless. Subtransparent. Optically uniaxial, positive. Double refraction strong.

**Comp.**—A hydrated phosphate and sulphate of aluminium and calcium chiefly; formula doubtful.

**Anal.**—1, Igelström, l. c , and J. pr. Ch., **64**, 252, 1855. 2, Blomstrand, Öfv. Ak. Stockh., **25**, 204, 1868.

| | G. | $P_2O_5$ | $SO_3$ | $Al_2O_3$ | FeO | MnO | PbO | MgO | CaO | $Na_2O$ | $H_2O$ | Cl | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Wermland | 3·30 | 17·80 | 17·32 | 37·84 | 1·40 | — | — | — | 6·00 | 12·84 | 6·80 | *tr.* | [= 100 |
| 2. Westanå | 3·29 | 15·70 | 15·97 | 34·95 | 0·73 | *tr.* | 3·82 | 0·24 | 16·59 | — | 12·21 | — | [= 100·21 |

**Pyr., etc.**—In a tube yields acid water. B.B. on coal fuses only on the thinnest edges; with soda in reducing flame a red hepatic mass, which becomes green with water and yields hydrogen sulphide with dilute acid. With borax, an iron-colored glass. With cobalt solution a fine blue. But little acted upon by acids.

**Obs.**—From Horrsjöberg in Wermland, Sweden, occurring with lazulite, cyanite, pyrophyllite, damourite, hematite, etc., in gneiss; also from the iron mine at Westanå, Scania. It is near beudantite in crystallization.

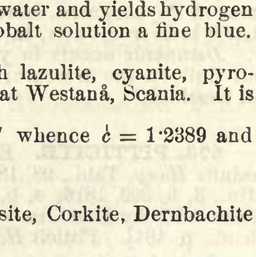
**Ref.**—[1] Pogg., **100**, 579, 1857; Seligmann obtained $nn^{\text{iv}} = 62° 54'$ whence $\dot{c} = 1{\cdot}2389$ and $rr' = 90° 26'$, but he measures $rr' = 89° 13'$. Zs. Kr., **6**, 227, 1881.

**680. BEUDANTITE.** *Levy*, Ann. Phil., **11**, 195, 1826. Beirosite, Corkite, Dernbachite *Adam*, Tabl. Min., 49, 1869.

Rhombohedral. Axis $\dot{c} = 1{\cdot}1842$; $0001 \wedge 10\bar{1}1 = 53° 49\frac{1}{4}'$ Dauber[1].

**Forms:** *c* $(0001, O)^2$; *r* $(10\bar{1}1, R)^2$, *V* $(50\bar{5}1, 5)^3$; *η* $(01\bar{1}1, -1)^3$, *s* $(02\bar{2}1, -2)^2$, *t* $(05\bar{5}2, -\frac{5}{2})^3$, *u* $(-04\bar{4}1, -4)^2$, *v* $(05\bar{5}1, -5)^2$.

Angles: $cr = 53° 49'$, $cs = 69° 55'$, $ct = 73° 42'$, $cu = 79° 38'$, $cv = 81° 41'$, $rr' = {*}88° 42'$, $ss' = 108° 51'$, $tt' = 112° 26\frac{1}{2}'$, $uu' = 116° 50'$, $vv' = 117° 56\frac{1}{2}'$.



Crystals usually acute rhombohedrons, often modified; also in nearly square rhombohedrons (*r*), with *c*, resembling the isometric cube with octahedron. Faces *c* flat, dull; *r* bright, curved.

Cleavage: *c* easy. H. = 3·5–4·5. G. = 4–4·3. Luster vitreous to subadamantine, resinous. Color dark to clear olive-green, yellowish green, black, brown. Streak greenish gray to yellow. Usually opaque, rarely transparent. Optically negative.

**Comp.**—A phosphate or arsenate with sulphate of ferric iron and lead; formula doubtful. Includes (1) the mineral from Cork and Dernbach with little or no arsenic, and (2) that from Horhausen (the original beudantite) with little phosphorus.

The Cork crystals are black, brown, or green and opaque; G. = 4·295, green, Rg.; those of Dernbach, olive-green to yellowish green, sometimes transparent, with H. = 3·5, G. = 4·002 Sandberger. These two varieties form Cork and Dernbach have been called by Adam, *corkite* and *dernbachite*, respectively, while the name *beudantite* is given to that from Horhausen.

Beudantite and svanbergite have nearly the same form and may prove also to have analogous formulas.

**Anal.**—1. Sandberger, Pogg., **100**, 611, 1857. 2, Rg., ibid., p. 581. 3, 4, Percy, Phil. Mag., **37**, 161, 1850. 5, Sandberger, l. c.

| | | | $P_2O_5$ | $As_2O_5$ | $SO_3$ | $Fe_2O_3$ | PbO | CuO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Dernbach | G. = 4·002 | $\frac{2}{3}$ | 13·22 | *tr.* | 4·61 | 44·11 | 26·92 | *tr.* | 11·44 | = 100·30 |
| 2. Cork, *green* | G. = 4·295 | $\frac{2}{2}$ | 8·97 | 0·24 | 13·76 | 40·69 | 24·05 | 2·45 | 9·77 | = 99·93 |
| 3. Horhausen | | | 1·46 | 9·68 | 12·31 | 42·46 | 24·47 | 8·49 | | = 98·87 |
| 4. " | | | *und.* | 13·60 | 12·35 | 37·65 | 29·52 | 8·49 | | = 101·61 |
| 5. " | | | 2·79 | 12·51 | 1·70 | 47·28 | 23·43 | [12·29] | | = 100 |

**Pyr., etc.**—Heated yields water. B.B., alone, the Cork mineral is infusible, but yields on charcoal fumes of sulphur dioxide and affords a yellow slag, and with soda a kernel of lead; the Dernbach fuses easily on charcoal with intumescence to a globule of lead, mixed with a black hepatic slag; the Horhausen also fuses easily, affording a gray slaggy globule, and after long blowing the odor of arsenic.

**Obs.**—Occurs at the Glendore iron mine, near Cork, with quartz and limonite; at Dernbach, near Montabaur, in Nassau; at Horhausen, on limonite.

**Ref.**—[1] Cork; from Dernbach *rr'* = 88° 51', Horhausen, 88° 12', Pogg., **100**, 579, 1857. Rath obtained, for Dernbach crystals, *ss'* = 108° 50', ∴ *rr'* = 88° 40', Vh. Ver. Rheinl., **34**, **177**, 1877.

[2] Dauber, l. c. [3] Sandb., ib., p. 614, 1857.

### 681. LINDACKERITE. *J. F. Vogl*, Jb. G. Reichs., 4, 552, 1853.

Orthorhombic. In oblong rhombohedral tables, grouped in rosettes, and in reniform masses.

H. = 2–2·5. G. = 2·0–2·5. Luster vitreous. Color verdigris- to apple-green. Streak paler to white.

**Comp.**—Perhaps $3NiO.6CuO.SO_3\ 2As_2O_5.7H_2O$ = Arsenic pentoxide 33·7, sulphur trioxide 5·9, cupric oxide 34·8, nickel protoxide 16·4, water 9·2 = 100.

**Anal.**—Lindacker quoted by Vogl, l. c.

$As_2O_5$ 28·58 $SO_3$ 6·44 CuO 36·34 NiO 16·15 FeO 2·90 $H_2O$ 9·32 = 99·73

**Pyr., etc.**—B.B. on charcoal gives alliaceous fumes, and fuses to a black bead. With borax and salt of phosphorus a copper reaction. Soluble after long heating in hydrochloric acid, the solution giving a yellowish brown precipitate with hydrogen sulphide.

**Obs.**—From Joachimsthal.

### 682. LÜNEBURGITE. *Nöllner*, Ber. Ak. München, 291, 1870.

In flattened masses with fine crystalline fibrous to earthy structure. G. = 2·05.

**Comp.**—$3MgO.B_2O_3.P_2O_5.8H_2O$ = Phosphorus pentoxide 29·8, boron trioxide 14·7, magnesia 25·2, water 30·3 = 100.

**Anal.**—Nöllner, l. c.

$P_2O_5$ 29·8 $B_2O_3$ 12·7 MgO 25·3 $H_2O$ 32·2 = 100

Upon ignition a little (0·7 p. c.) fluorine goes off.

**Obs.**—From the gypsum-bearing marl of Lüneburg, Hannover.

## APPENDIX TO PHOSPHATES, ARSENATES, ETC.

**Miriquidite** *Frenzel*, Jb. Min., 939, 1872, 673, 1874.
Rhombohedral. In minute crystals with *r* ($10\bar{1}1$, *R*) and *e* ($01\bar{1}2$, $-\frac{1}{2}$); approx. angles $rr' = 114°$, $re = 57°$ Rath. Faces *r* often horizontally striated and curved. Also massive. Brittle. H. = 4. Luster vitreous. Color blackish brown to yellowish or reddish brown. Streak ocher-yellow. Translucent to opaque.

Contains $As_2O_5$ $P_2O_5$, PbO, $Fe_2O_3$, $H_2O$; not analyzed.

B.B., fusible to a globule, coloring the charcoal yellow (PbO). In matrass gives water, and with the fluxes reacts for iron.

Found at Schneeberg with chalcocite, pyromorphite, cuprite, torbernite, etc.

The following arsenates of nickel need confirmation:

**Arsenate of Nickel.** Nickelerz *C. Bergemann*, J. pr. Ch., **75**, 239, 1858. Ærugite *Adam*, Tabl. Min., 43, 1869. Crystalline massive or amorphous. H. = 4. G. = 4·838. Color dark grass-green to brownish in spots where amorphous; streak lighter.

Comp.—Perhaps $Ni_5As_2O_{10}$ or $5NiO.As_2O_5$ = Arsenic pentoxide 38·0, nickel protoxide 62·0 = 100. Analysis afforded:

$As_2O_5$ 36·57 $P_2O_5$ 0·14 NiO 62·07 CoO 0·54 CuO 0·34 $Bi_2O_3$ 0·24 $Fe_2O_3$ *tr.* = 99·90

Unaltered in the closed tube. B.B. on charcoal affords arsenical fumes; with borax in R.F. gives a gray bead (nickel); with soda on charcoal gives off arsenical fumes and yields a magnetic mass. From Johanngeorgenstadt, along with the normal nickel arsenate below, also nickel oxide and native bismuth.

**Arsenate of Nickel.** Nickelerz *C. Bergemann*, J. pr. Ch., **75**, 239, 1858. Xanthiosite *Adam*, Tabl. Min., 42, 1869. Amorphous. H. = 4. G. = 4·982. Color sulphur-yellow. Comp.—Perhaps $Ni_3As_2O_8$ or $3NiO.As_2O_5$ = Arsenic pentoxide 50·5, nickel protoxide 49·5 = 100. Analysis by Bergemann, l. c.:

$As_2O_5$ 50·53 $P_2O_5$ *tr.* NiO 48·24 CoO 0·21 CuO 0·57 $Bi_2O_3$ 0·62 = 100·17

Like the preceding in pyrognostic characters. Also occurs at Johanngeorgenstadt.

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## Nitrates.

| | | | | |
|---|---|---|---|---|
| **683.** | **Soda Niter** | $NaNO_3$ | Rhombohedral | $\dot{c} = 0·8276$ |
| **684.** | **Niter** | $KNO_3$ | Orthorhombic | $\breve{a} : \bar{b} : \dot{c} = 0·5910 : 1 : 0·7010$ |
| **685.** | **Nitrocalcite** | $Ca(NO_3)_2 + nH_2O$ | | |
| **686.** | **Nitromagnesite** | $Mg(NO_3)_2 + nH_2O$ | | |
| **687.** | **Nitrobarite** | $Ba(NO_3)_2$ | | Isometric, tetartohedral |
| | | | | $\breve{a} : \bar{b} : \dot{c}$ |
| **688.** | **Gerhardtite** | $Cu_4(OH)_6(NO_3)_2$ | Orthorhombic | 0·9217 : 1 : 1·1562 |
| **689.** | **Darapskite** | $NaNO_3.Na_2SO_4 + H_2O$ | Tetragonal | |
| **690.** | **Nitroglauberite** | $6NaNO_3.2Na_2SO_4 + 3H_2O$ | | |

**683. SODA NITER.** Soude nitratée native *M. de Rivero*, Ann. Mines, **6**, 596, 1821. Nitrate of Soda. Soda Niter. Cubic Niter. Niter cubique. Natron-Salpeter *Leonh.*, Handb., 246, 1826. Nitratin *Haid.*, Handb., 1835. Natronitrite *Weisbach*, Synops. Min., 8, 1875. Chilisalpeter, Salpetersaures Natron, *Germ.* Nitro, Salitre sodico, Caliche, *Span.*

Rhombohedral. Axis $\dot{c} = 0·8276$; $0001 \wedge 10\bar{1}1 = 43° 42'$, $rr' = {}^*73° 30'$ Brooke-Rammelsberg[1].

Isomorphous with calcite. Usually in massive form, as an incrustation or in beds.

Cleavage: *r* perfect. Fracture conchoidal, seldom observable. Rather sectile. H. = 1·5–2. G. = 2·24–2·29; 2·290 Tarapaca, Hayes. Luster vitreous. Color white; also reddish brown, gray, and lemon-yellow. Transparent. Taste cooling. Optically −. Double refraction strong. Refractive indices for yellow (Na):

$$\omega = 1{\cdot}58739 \qquad \epsilon = 1{\cdot}33608 \text{ Schrauf}^2$$

**Comp.**—Sodium nitrate, $NaNO_3$ = Nitrogen pentoxide 63·5, soda 36·5 = 100.

**Pyr., etc.**—Deflagrates on charcoal with less violence than niter, causing a yellow light, and also deliquesces. Colors the flame intensely yellow. Dissolves in three parts of water at 60° F.

**Obs.**—In the district of Tarapaca, northern Chili, and also in the neighboring parts of Bolivia, the dry pampa for 40 leagues, at a height of 3,300 feet above the sea, is covered with beds of this salt (caliche) several feet in thickness, along with gypsum, common salt, glauber salt, and remains of recent shells. The *azufrado* or *caliche jaune* is a deposit rich in the nitrate and colored yellow by alkaline iodides, cf. V. L'Olivier, Ann. Ch. Phys., **7**, 289, 1876. These nitrate deposits are of great commercial value; they formerly belonged to Peru, but passed into the hands of Chili in 1884.

Deposits also occur in Humboldt Co., Nevada, 25 miles east of Lovelock's station; also near Calico, San Bernardino Co., Cal. Reported from southern New Mexico (Min. Res., 1882).

**Ref.**—[1] Ann. Phil., **21**, 452, 1823; Rg., Kryst. Ch., 348, 1881; Haüy gives 73° 44′, Mohs 73° 27′, Schrauf 74° 10′. An increase of 100° C. causes *rr′* to increase about 27′ Mlr. [2] Ber. Ak. Wien, **41**, 784, 1860.

**684. NITER.** Nitrate of Potash. Saltpeter. Salpeter, Salpetersaures Kali, *Germ.* Kalisalpeter *Hausm.*, Handb., 849, 1813. Potasse nitratée *Fr.* Salitre *Span.*

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·5910 : 1 : 0·7010 Miller[1].

100 ∧ 110 = 30° 35′, 001 ∧ 101 = 49° 52′, 001 ∧ 011 = 35° 1¾′.

**Forms:** *a* (100, *i*-ī), *b* (010, *i*-ĭ), *c* (001, *O*); *m* (110, *I*); *x* (012, ½-ĭ), *k* (011, 1-ĭ), *i* (021, 2-ĭ); *p* (111, 1).

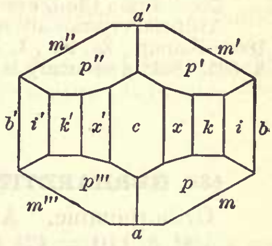
Angles: *mm‴* = *61° 10′, *xx′* = 38° 38′, *kk′* = *70° 3½′, *ii′* = 109° 0′, *pp′* = 88° 20′, *pp″* = 108° 3′, *pp‴* = 48° 38′.

Twins: tw. pl. *m*, pseudohexagonal, resembling aragonite. Generally in thin crusts, silky tufts, and delicate acicular crystallizations.

Cleavage: *k* (011) perfect; *b* less so; *m* imperfect. Fracture subconchoidal to uneven. Brittle. H. = 2. G. = 2·09–2·14. Luster vitreous. Streak and color white. Subtransparent. Taste saline and cooling.

Optically −. Ax. pl. ∥ *a*. Bx ⊥ *c*. 2E = 8° 40′, Mlr. Refractive indices for yellow (Na):

| $\alpha$ | $\beta$ | $\gamma$ | |
|---|---|---|---|
| 1·33463 | 1·50562 | 1·50643 | ∴ 2V=7° 12′ 2E=10° 51′ Schrauf[2] |
| 1·3327 | 1·5031 | 1·5046 | and 2E=7°·5 Kohlrausch[3] |



After Mlr.

**Comp.**—Potassium nitrate, $KNO_3$ = Nitrogen pentoxide 53·5, potash 46·5 = 100.

**Pyr., etc.**—Deflagrates vividly on burning coals, and detonates with combustible substances. Colors the flame violet. Dissolves easily in water; not altered by exposure.

**Obs.**—Found generally in minute needle-form crystals, and crusts on the surface of the earth, on walls, rocks, etc. It forms abundantly in certain soils in Spain, Egypt, and Persia, especially during hot weather succeeding rains. Also manufactured from soils where other nitrates (nitrate of calcium or sodium) form in a similar manner, and beds called *nitriaries* are arranged for this purpose in France, Germany, Sweden, Hungary, and other countries. Refuse animal matter, also, if putrified in calcareous soils, gives rise to the calcium nitrate. Old plaster, lixiviated, affords about 5 p. c. of niter. In India it is obtained in large quantities for the arts.

In Madison Co., Kentucky, it is found scattered through the loose earth covering the bottom of a large cave. Also in other caverns in the Mississippi valley. Those of Tennessee, along the limestone slopes and in the gorges of the Cumberland table-land, afford it abundantly.

Niter, according to Frankenheim, is dimorphous, like calcium carbonate; one form orthorhombic and isomorphous with aragonite, the other *rhombohedral*, like soda niter (q.v.), isomorphous with calcite. The former is the normal one between − 10° C. and 300° C.; and between these temperatures the rhombohedral is easily transformed into it. Above 300° the rhombohedral is the normal one, the orthorhombic here changing to it, and retaking again its form on a diminution of temperature, Pogg., **92**, 354, 1854.

**Ref.**—[1] At 19° C., Phil. Mag., **17**, 38, 1840; Min., 601, 1852; an increase of 100° increases *kk'* about 44', *mm'* remains about constant. [2] Ber. Ak. Wien, **41**, 787, 1860. [3] Zs. Kr., **2**, 102, 1877.

**685. NITROCALCITE.** Kalksalpeter *Haus.*, Handb., 1813. Nitrate of lime. Calcium nitrate. Chaux nitratée. Nitrocalcite *Shep.*, Min., **2**, 84, 1835. Calcinitre *Huot.*, Min., **2**, 430, 1841.

In efflorescent silken tufts and masses. Color white or gray. Taste sharp and bitter.

**Comp.**—Hydrous calcium nitrate, $Ca(NO_3)_2 + nH_2O$. The amount of water of crystallization is uncertain.

**Pyr., etc.**—On burning coals it slowly fuses with a slight detonation, and dries. Very deliquescent before, but not after, being desiccated by heat.

**Obs.**—It occurs in silky efflorescences, in many limestone caverns, as those of Kentucky. The salt forms in covered spots of earth, where the soil is calcareous, and is extensively used in the manufacture of saltpeter. According to Hausmann, a large part of the so-called niter in nature is this salt.

On the crystallization of the artif. salt, $Ca(NO_3)_2 + 4H_2O$, cf. Rg., Kr. Ch., 358, 1881 (Mgc., etc.).

**686. NITROMAGNESITE.** Nitrate of Magnesia *Beud.*, Tr., **2**, 384, 1832. Nitromagnesite *Shep.*, Min., **2**, 85, 1835. Magnesinitre *Huot.*, Min., **2**, 431, 1841. Magnésie nitratée. Magnesia salpeter.

In efflorescences. White. Taste bitter.

**Comp.**—Hydrous magnesium nitrate, $Mg(NO_3)_2 + nH_2O$.

**Obs.**—From limestone caves, along with nitrocalcite.

The existence of this species as a natural product has not yet been clearly made out.

On the artif. salt, $Mg(NO_3)_2 + 6H_2O$, cf. Rg., Kr. Ch., 359, 1881 (Mgc.).

**687. NITROBARITE.** Barytsalpeter, Salpetersaurer Baryt, *Germ.* Nitrobarite *H. C. Lewis*, Amer. Nat., **16**, 78, 1882.

Isometric; tetartohedral. In octahedrons made up of the plus and minus tetrahedrons, 111 and $1\bar{1}1$; also in twins like spinel.

Crystals colorless, in part covered with a thin brownish black coating resembling wad.

**Comp.**—Barium nitrate, $Ba(NO_3)_2$ = Nitrogen pentoxide 41·4, baryta 58·6 = 100.

**Obs.**—From Chili, exact locality unknown.

Artificial crystals are tetartohedral and often highly modified. Cf. Scc., Pogg., **109**, 366, 1860; Baumh., Zs. Kr., **1**, 51, 1877; Lewis, ib., **2**, 64; Wulff, ib., **4**, 122, 1879; Henriques, ib., **5**, 365, 1881; a summary is given in Rg., Kr. Ch., 354, 1881.

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**688. GERHARDTITE.** *H. L. Wells* and *S. L. Penfield*, Am. J. Sc., **30**, 50, 1885.

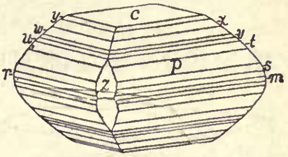
Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}92175 : 1 : 1{\cdot}15617$ Penfield.

$100 \wedge 110 = 42° 40'$, $001 \wedge 101 = 51° 26\frac{1}{6}'$, $001 \wedge 011 = 49° 8\frac{1}{2}'$.

| Forms: | *z* (201, 2-ī) | *w* (223, $\frac{2}{3}$) | *t* (778, $\frac{7}{8}$) | *s* (221, 2) |
|---|---|---|---|---|
| *c* (001, *O*) | *y* (112, $\frac{1}{2}$) | *v* (7·7·10, $\frac{7}{10}$) | *p* (111, 1) | *r* (551, 5) |
| *m* (110, *I*) | *x* (13·13·20, $\frac{13}{20}$) | *u* (334, $\frac{3}{4}$) | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *mm'''* | = 85° 20′ | *cw* | = 48° 40½′ | *cp* | = 59° 37′ | *ss'* | = 89° 45′ |
| *cz* | = *68° 16′ | *cv* | = 50° 3′ | *cs* | = 73° 40′ | *pp'''* | = 71° 34′ |
| *zz'''* | = 43° 28′ | *cu* | = 51° 59′ | *cr* | = 83° 19′ | *ss'''* | = 81° 8½′ |
| *cy* | = 40° 28′ | *ct* | = 56° 11′ | *pp'* | = 78° 44′ | *zp* | = *39° 3½′ |
| *cx* | = 47° 57′ | | | | | | |

In crystals, the pyramidal zone strongly striated and the faces often in oscillatory combination.



Cleavage: *c* highly perfect, yielding flexible laminæ; *a* less perfect. Sectile, fragile. H. = 2. G. = 3·426. Luster vitreous, brilliant. Color deep emerald-green. Streak light green. Transparent.

Pleochroic: ∥ 𝔠 ($\breve{a}$) blue, ∥ 𝔟 ($\bar{b}$) and ∥ 𝔞 ($\acute{c}$) green. Optically −. Ax. pl. ∥ *b*. Bx ⊥ *c*. Dispersion $\rho < v$. Axial angles: $2K_y = 76° 20'$, $2K_{gr} = 80° 4'$ ($n_y = 1·703$, $n_{gr} = 1·722$).

**Comp.**—Basic cupric nitrate, $Cu(NO_3)_2.3Cu(OH)_2$ or $4CuO.N_2O_5.3H_2O$ = Nitrogen pentoxide 22·5, cupric oxide 66·2, water 11·3 = 100.

**Anal.**—H. L. Wells, l. c.

| | | | | | |
|---|---|---|---|---|---|
| 1. | $N_2O_5$ 22·76 | CuO 66·38 | $H_2O$ 11·26 | = | 100·40 |
| 2. | [22·25] | 66·26 | 11·49 | = | 100 |

**Pyr., etc.**—Fuses at 2, coloring the flame green. With soda on charcoal easily reduced to metallic copper with deflagration. In the closed tube gives nitrous fumes and strongly acid water. Soluble in dilute acids; insoluble in water.

**Obs.**—Occurs with acicular crystals of malachite in cavities in cuprite at the United Verde copper mines at Jerome, Arizona; only a few specimens have been found.

Named after Charles Gerhardt, the chemist who first established the composition of the corresponding artificial salt, Ann. Ch. Phys., **18**, 178, 1846, or C. R., **22**, 961, 1846.

**Artif.**—Obtained by Gerhardt (l. c.) as already noted. Further, the same compound has been formed by Wells by heating a solution of normal nitrate with metallic copper in a sealed tube to 150° C. for 24 hours or more. The crystals (Pfd.) were tabular ∥ *c* and elongated ∥ $\bar{b}$. The form is near that of the natural crystals, but they are referred to the monoclinic system with the axial ratio $\grave{a} : \bar{b} : \acute{c} = 0·9178 : 1 : 1·1402$; $\beta = {}^*85° 27' = 001 \wedge 100$. Observed forms: *a* (100), *c* (001), *m* (110), *d* (101), *e* (011). Angles: *cd* = *48° 25½′, *ee′* = *97° 19′, *mm‴* = 84° 55′, *cm* = 86° 39′. Twins: tw. pl. *a*.

Cleavage: *c* perfect. Brittle. Luster brilliant. Color dark green. Transparent. Pleochroic, green and blue. Ax. pl. ∥ *b*. Negative bisectrix in the obtuse axial angle. Dispersion $\rho < v$. $2H_{gr} = 63° 50'$ (section not exactly ⊥ 𝔟).

Bourgeois, however, has repeated these experiments and obtained orthorhombic crystals; he has also obtained similar results by heating the nitrate of copper in a sealed tube at 130° with urea, Bull. Soc. Min., **13**, 66, 1890. Michel has also obtained orthorhombic crystals of the same basic nitrate at ordinary temperatures and under the normal atmospheric pressure by the action for several years of a solution of cupric nitrate and fragments of Iceland spar (ibid., p. 139).

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## 689. DARAPSKITE. *A. Dietze*, Zs. Kr., **19**, 445, 1891.

Tetragonal. In square tabular crystals with several undetermined pyramids on the edges. Colorless. Transparent.

**Comp.**—$NaNO_3.Na_2SO_4 + H_2O$ = Nitrogen pentoxide 22·0, sulphur trioxide 32·7, soda 38·0, water 7·3 = 100; or, Sodium nitrate 34·7, sodium sulphate 58·0, water 7·3 = 100.

**Anal.**—Dietze, l.c.

| | | | |
|---|---|---|---|
| $N_2O_5$ 22·26 | $SO_3$ 32·88 | $Na_2O$ 38·27 | $H_2O$ 7·30 = 100·71 |

The water is readily expelled by heat, without decrepitation.

**Obs.**—From the Pampa del Toro in Atacama, Chili; intimately associated with blödite and soda niter. Named after Dr. L. Darapsky.

## 690. NITROGLAUBERITE. *Schwartzemberg*, Domeyko, 3d App., Min. Chili, 46, 1871.

From the desert of Atacama, forming a white, homogeneous mass with fibrous crystalline structure. Comp.—$6NaNO_3.2Na_2SO_4.3H_2O$ = Sodium nitrate 60·1, sodium sulphate 33·5, water 6·4 = 100. Analysis:

| | | | | |
|---|---|---|---|---|
| $Na_2SO_4$ 33·90 | $NaNO_3$ 60·35 | $H_2O$ 5·75 | = | 100 |

Dissolves in water. An artificial salt, having the composition $2NaNO_3.2Na_2SO_4.3H_2O$, has been described, cf. Rg., Kryst. Ch., 468, 1881.

# Oxygen Salts.

## 5. BORATES.

**The aluminates, ferrates, etc., allied chemically to the borates, have been already introduced among the oxides. They include the species of the Spinel Group, pp. 220–229, also chrysoberyl, p. 229, etc.**

| | | | | |
|---|---|---|---|---|
| **691. Nordenskiöldine** | $CaSn(BO_3)_2$ | Rhombohedral | ć = 0·8221 | |
| **692. Jeremejevite** | $AlBO_3$ | Hexagonal | ć = 0·6836 | |
| **693. Sussexite** | $H(Mn,Mg,Zn)BO_3$ | | | |
| **694. Ludwigite** | $Mg_3\overset{II}{Fe}\overset{III}{Fe}_2B_2O_{10}$ | Orthorhombic | | |
| | | | ă : b̄ : ć | |
| **695. Pinakiolite** | $Mg_3\overset{II}{Mn}\overset{III}{Mn}_2B_2O_{10}$ | Orthorhombic | 0·8338 : 1 : 0·5881 | |
| **696. Hambergite** | $Be_2(OH)BO_3$ | " | 0·7988 : 1 : 0·7268 | |
| **697. Szaibelyite** | $H_6Mg_{10}B_8O_{26}$? | | | |
| **698. Boracite** | $Mg_7Cl_2B_{16}O_{30}$ | Isometric, tetrahedral | | |
| **699. Rhodizite** | $\overset{I}{R}Al_2B_3O_8$ | Isometric, tetrahedral | | |
| **700. Warwickite** | $Mg_6FeTi_2B_6O_{20}$? | Orthorhombic | ă : b̄ = 0·977 : 1 | |
| **701. Howlite** | $H_5Ca_2B_5SiO_{14}$ | Orthorhombic | | |

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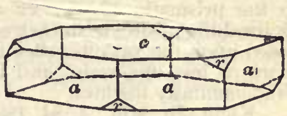
| | | | | |
|---|---|---|---|---|
| **702. Lagonite** | $Fe(BO_2)_3.1\frac{1}{2}H_2O$ | | | |
| **703. Larderellite** | $(NH_4)_2B_8O_{13}.4H_2O$ | Monoclinic? | | |
| | | | à : ḃ̄ : ć | β |
| **704. Colemanite** | $Ca_2B_6O_{11}.5H_2O$ | Monoclinic | 0·7748 : 1 : 0·5410 | 69° 51′ |
| Priceite, Pandermite | | | | |
| **705. Pinnoite** | $MgB_2O_4.3H_2O$ | Tetragonal | ć = 0·7609 | |
| | | | à : ḃ̄ : ć | β |
| **706. Heintzite** | $K_2Mg_4B_{18}O_{32}.16H_2O$? | Monoclinic | 2·9137 : 1 : 1·7338 | 80° 12′ |
| **707. Borax** | $Na_2B_4O_7.10H_2O$ | Monoclinic | 1·0995 : 1 : 0·5632 | 73° 25′ |
| **708. Ulexite** | $NaCaB_6O_9.8H_2O$? | | | |
| **709. Bechilite** | $CaB_4O_7.4H_2O$ | | | |
| Hayesine | $CaB_4O_7.6H_2O$? | | | |
| **710. Hydroboracite** | $CaMgB_6O_{11}.6H_2O$ | Monoclinic? | | |

**691. NORDENSKIÖLDINE.** Nordenskiöldin *W. C. Brögger*, G. För. Förh., **9**, 255, 1887; Zs. Kr., **16**, 61, 1890.

Rhombohedral. Axis $\dot{c} = 0{\cdot}8221$; $0001 \wedge 10\bar{1}1 = 43° 30\frac{1}{2}'$ Brögger.

In tabular crystals with the forms: *c* (0001, *O*), *a* ($11\bar{2}0$, *i*-2), *r* ($10\bar{1}1$, *R*). Angles: $cr = {}^{*}43° 30\frac{1}{2}'$, $rr' = 73° 12'$, $ar = 53° 24'$.

Cleavage: basal, perfect. Fracture conchoidal. Brittle. H. = 5·5–6. G. = 4·200 Cleve. Luster somewhat pearly on *c*; elsewhere vitreous. Color sulphur-, lemon-, or wine-yellow. Transparent to translucent. Optically negative. Double refraction strong.



**Comp.**—A borate of calcium and tin, $CaSn(BO_3)_2$ or $CaO.SnO_2.B_2O_3$ = Boron trioxide 25·1, tin dioxide 54·5, lime 20·4 = 100.

Regarded by Groth as a stannate, $Ca(BO)_2SnO_4$. Brögger points to similarity in axial ratio to proustite, also calcite and soda niter.

**Anal.**—P. T. Cleve, l. c.

$B_2O_3$ [23·18] $SnO_2$ 53·75 $ZrO_2$(?)0·90 CaO 20·45 ign. 1·72[a] = 100

[a] Probably also $B_2O_3$.

**Pyr., etc.**—B.B. on the platinum wire, when strongly heated, sinters but does not fuse, though coloring the flame green, especially after being moistened with sulphuric acid. Gives a colorless glass with salt of phosphorus after long blowing. Only imperfectly decomposed by hydrochloric acid.

**Obs.**—From the island Arö in the Langesund fiord, southern Norway; occurs very sparingly, with meliphanite, homilite, cancrinite, elæolite, etc.

Named in honor of the Swedish mineralogist and explorer, A. E. Nordenskiöld.

**692. JEREMEJEVITE.** Jeremeiewit *Damour*, Bull. Soc. Min., **6**, 20, 1883. Eichwaldit *Websky*, Ber. Ak. Berlin, 671, 1883, Jb. Min., **1**, 1, 1884. Jeremejewit *Germ.*, Jeremejeffite, Yeremeyevite.

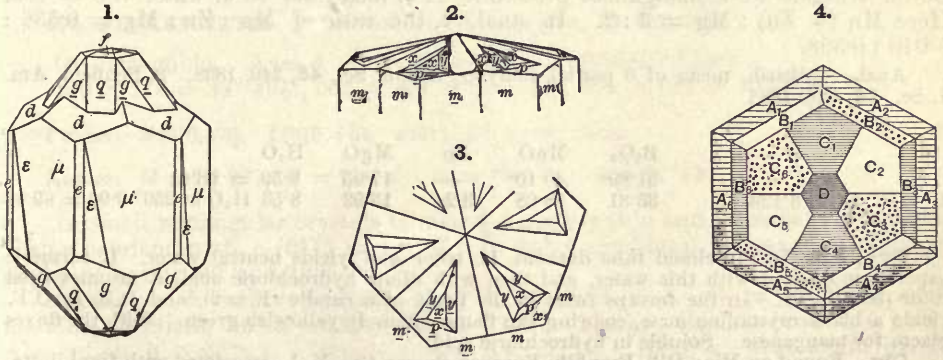
Hexagonal. Axis $\dot{c} = 0{\cdot}68358$; $0001 \wedge 10\bar{1}1 = 38° 17' 6''$ Websky.

**Forms:** *a* ($11\bar{2}0$, *i*-2), *e* ($21\bar{3}0$, $i\text{-}\frac{3}{2}$), *n* ($10\bar{1}4$, $\frac{1}{4}$), *f* ($10\bar{1}3$, $\frac{1}{3}$), *d* ($10\bar{1}1$, 1), *q* ($70\bar{7}5$, $\frac{7}{5}$), *g* ($41\bar{5}3$, $\frac{5}{3}\text{-}\frac{5}{4}$). Also various vicinal forms, $\epsilon$, $\mu$, etc.

Angles: $nn''' = 22° 19\frac{1}{2}'$, $ff''' = 29° 29'$, $dd''' = 76° 34'$, $qq'' = 95° 43'$, $nn' = 11° 6\frac{1}{2}'$, $ff' = 14° 37'$, $dd' = 36° 5\frac{1}{2}'$, $qq' = 43° 31'$, $gg' = 29° 11'$, $gg^{xi} = 16° 44'$.

In elongated prisms resembling beryl; summits rounded and prismatic faces broken by vicinal planes.

Cleavage none. Fracture uneven. Brittle. H. = 6·5. G. = 3·28. Luster vitreous. Colorless to pale yellow. Transparent. Optically negative.


1. 2. 3. 4.

Figs. 1–3, Websky; 4, Klein.

Websky describes the crystals as consisting, in the first place, of an outer zone which is hexagonal with perhaps pyramidal (or trapezohedral) hemihedrism and optically uniaxial—to this he limits the original name of Damour. He assumes also a twinning with tw. axis ⊥ *a* ($11\bar{2}0$) with hemimorphic development. Within, more or less irregularly bounded, is a core in sectors seeming to form an orthorhombic trilling; to this he gives the name *eichwaldite*. Optically biaxial. For the former he gives $\acute{c} = 0{\cdot}68358$; for the latter he deduces $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}5523 : 1 : 0{\cdot}5434$, with the forms *x* (104), *p* (101), *y* (136). Optically —. Ax. pl. inclined 30° to the prismatic edges. $2E = 52°$, $\rho > v$. $\beta = 1{\cdot}64$. The terminal planes referred to the eichwaldite project at the extremity beyond the jeremejevite (f. 2, 3). The crystallographic results, based upon the various reflections from the parts of the rounded summits, must be regarded as more or less uncertain, and it is difficult to believe that the two parts of the crystals are fundamentally distinct.

Klein (Jb. Min., **1**, 84, 1891) has studied the optical structure more minutely. He finds a section to consist of three and often four parts (f. 4), of which *A* is uniaxial; *B* is biaxial with variable angle, 6° to 35° (in air), ax. pl. ⊥ edge *B*/*C*; *C*, divided into differently orientated sectors, is biaxial with an angle of 52°, ax. pl. in $C_1$ ⊥ line bisecting angle $B_1B_2$, etc.; finally, *D*, sometimes but not always observed, is uniaxial and negative like *A*. Elevation of temperature makes no change in optical relations, but pressure normal to the axis $\acute{c}$ made *A* biaxial with ax. pl. ⊥ pressure; while with both *B* and *C* the axial angle could be increased, or diminished to 0°, according as the pressure was normal or parallel to the ax. plane. No difference in density could be detected between the parts *A*, *B*. *C*.

**Comp.**—An aluminium borate, $AlBO_3$ or $Al_2O_3.B_2O_3$ = Boron trioxide 40·6, alumina 59·4 = 100. A little iron sesquioxide replaces part of the alumina.

**Anal.**—Damour, l. c.

| | | | | |
|---|---|---|---|---|
| G. = 3·28 | $B_2O_3$ [40·19] | $Al_2O_3$ 55·03 | $Fe_2O_3$ 4·08 | $K_2O$ 0·70 = 100 |

**Pyr.**—B.B. in the forceps loses its transparency, becomes white and tinges the flame green, but does not fuse. Gives a fine blue when moistened with cobalt solution and subsequently ignited. In fine powder dissolves in concentrated caustic potash leaving a faint residue of iron sesquioxide.

**Obs.**—Collected by the director of the Nerchinsk mines, J. I. Eichwald, at Mt. Soktuj, a northern extension of the Adun-Chalon chain in Dauria, in the Nerchinsk mining region in eastern Siberia; the crystals were found loose in a granitic sand beneath the turf.

Jeremejevite is named after Prof. Eremeyev (*Germ.* Jeremējew), of the School of Mines at St. Petersburg; the name here retains essentially the German form.

On a borate of aluminium, $3Al_2O_3.B_2O_3$, and other borates prepared by Ebelmen, cf. Ann. Ch. Phys., **33**, 63, 1851, also Mallard, Bull. Soc. Min., **11**, 308, 1888.

### 693. SUSSEXITE. *G. J. Brush*, Am. J. Sc., **46**, 140, 240, 1868.

Orthorhombic[1](?). In fibrous seams or veins.

H. = 3. G. = 3·42. Luster silky to pearly. Color white with a tinge of pink or yellow. Translucent.

**Comp.**—$HRBO_3$, where R = Mn, Zn, and Mg, or $2(Mn,Zn,Mg)O.B_2O_3.H_2O$ = Boron trioxide 34·1, manganese protoxide 41·5, magnesia 15·6, water 8·8 = 100. Here Mn (+ Zn) : Mg = 3 : 2. In anal. 2, the ratio of Mn : Zn : Mg = 0·536 : 0·040 : 0·398.

**Anal.**—1, Brush, mean of 6 partial analyses, Am. J. Sc., **46**, 240, 1868. 2, Penfield, Am. J. Sc., **36**, 323, 1888.

| | | $B_2O_3$ | MnO | Zn | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. | | 31·89 | 40·10 | — | 17·03 | 9·59 | = 98·61 |
| 2. | G. = 3·123 | 33·31 | 38·08 | 3·24 | 15·92 | 8·53 | $H_2O$ at 250° 0·90 = 99·98 |

**Pyr., etc.**—In the closed tube darkens in color and yields neutral water. If turmeric paper is moistened with this water, and then with dilute hydrochloric acid, it assumes a red color (boric acid). In the forceps fuses in the flame of a candle (F = 2), and B.B. in O.F. yields a black crystalline mass, coloring the flame intensely yellowish green. With the fluxes reacts for manganese. Soluble in hydrochloric acid.

**Obs.**—Found on Mine Hill, Franklin Furnace, Sussex Co., N. J., associated with franklinite, zincite, willemite, and other manganese and zinc minerals. Named from the county in which the locality is situated.

**Ref.**—[1] Cf. Dx., Min., **2**, 15, 1874.

**694. LUDWIGITE.** *G. Tschermak*, Min. Mitth., 59, 1874.

Orthorhombic, Renard[1]. Prismatic angle: $mm''' = 89° 20'$. Observed forms: 110, 410, 310, 120 Mallard[2].

In finely fibrous masses; fibers parallel, often radiating; also short and interwoven. Extinction parallel.

Tough upon fracture, but easily cut. H. = 5. G. = 3·91–4·02. Luster silky on fresh fracture. Color blackish green to nearly black with a tinge of violet; greenish brown in microscopic splinters. Streak dark. Strongly pleochroic. Axial plane probably ⊥ prismatic axis.

**Comp.**—Perhaps $3MgO.B_2O_3 + FeO.Fe_2O_3$ = Boron trioxide 16·6, iron sesquioxide 37·9, iron protoxide 17·0, magnesia 28·5 = 100.

The above formula of Tschermak and Ludwig finds some support in the fact that a corresponding composition is obtained by Flink for pinakiolite, which he characterizes as a manganese-ludwigite. Whitfield's analysis, however, gives different results. He obtains the ratio $MgO : FeO : Fe_2O_3 : B_2O_3 : H_2O = 76 : 24 : 24 : 17 : 20$; the first three terms here agree with Tschermak's formula, the others do not. Further, $RO : (B_2O_3 + Fe_2O_3) = 3 : 1$, also $H_2 : Mg : Fe = 1 : 3 : 1$ and $B : Fe = 2 : 3$ nearly. The corresponding percentage composition is: Boron trioxide 11·2, iron sesquioxide 38·4, iron protoxide 17·3, magnesia 28·8, water 4·3 = 100.

The formula is then $3(H_2,Mg,Fe)O.(B,Fe)_2O_3$ or $3RO.B_2O_3$, analogous to that of sussexite.

**Anal.**—1, 2, Ludwig and Sipöcz; 1 mean of 7 partial analyses. 3, Whitfield, Am. J. Sc., **34**, 284, 1887.

| | G. | $B_2O_3$ | $Fe_2O_3$ | FeO | MgO | MnO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. *Dark green* | 3·951 | 16·09 | 39·92 | 12·46 | 31·69 | *tr.* | — | = | 100·16 |
| 2. *Black* | 4·016 | 15·06 | 39·29 | 17·67 | 26·91 | *tr.* | — | = | 98·93 |
| 3. " | | 12·04 | 37·93 | 15·78 | 30·57 | 0·16 | 3·62 | = | 100·10 |

**Pyr., etc.**—Heated in the air the mineral becomes red; in fine splinters fusible with difficulty to a black, strongly magnetic, slag. With the fluxes gives the reaction for iron. Dissolved slowly by cold hydrochloric acid when in the state of a fine powder.

**Obs.**—Occurs embedded in a crystalline limestone, with irregularly situated beds of magnetite, at Morawitza in the Banat, Hungary; the magnetite is embedded in the mineral in the form of grains or fine thread-like veins.

Named after Ernst Ludwig, Professor of Chemistry at Vienna.

**Alt.**—F. Berwerth has described (ibid., 247, 1874) ludwigite altered to limonite. An analysis of material, having a brownish red color, and graduating insensibly into pure ludwigite, afforded: $Fe_2O_3$ 75·34, MnO *tr.*, CaO 0·09, MgO 5·80, $CO_2$ 1·65, $SiO_2$ 2·83, $H_2O$ 14·51, $B_2O_3$ 0·80=101·02. G. = 3·41. Besides the limonite (88·17 p. c.), some talc, brucite, magnesite, and calcite are also present as mechanically mixed impurities.

**Artif.**—An artificial borate allied to ludwigite has been prepared by Ebelmen, cf. Mld., l.c.; it is orthorhombic with a prismatic angle of 89° 10'.

**Ref.**—[1] Bull. Ac. Belg., **9**, 547, 1885. [2] Bull. Soc. Min., **11**, 310, 1888.

**695. PINAKIOLITE.** Pinakiolith *G. Flink*, Zs. Kr., **18**, 361, 1890.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·83385 : 1 : 0·58807$ Flink[1].

$100 \wedge 110 = 39° 49\tfrac{1}{3}'$, $001 \wedge 101 = 35° 11\tfrac{2}{3}'$, $001 \wedge 011 = 30° 27\tfrac{1}{2}'$.

**Forms:** *b* (010, *i*-$\breve{i}$), *l* (310, *i*-$\bar{3}$), *e* (011, 1-$\breve{i}$) as tw. plane.

Angles: *bl* = 74° 28', *ll'* = *31° 4', *ee'* = *60° 55', *le* = 82° 12'.

In small rectangular crystals tabular ∥ *b*, usually thin and often bent or broken. Twins common with *e* (011) as tw. pl.; in habit cruciform, the axes crossing at angles of nearly 60° and 120°.

Cleavage: *b* rather perfect. Very brittle. H. = 6. G. = 3·881. Luster metallic, brilliant on crystalline faces. Color black. Streak brownish gray. Absorption $\mathfrak{b} > \mathfrak{a} > \mathfrak{c}$. Optically –. Ax. pl. ∥ *c*. Bx ⊥ *b*. Ax. angle about 60°. Dispersion probably $v > \rho$.

**Comp.**—$3MgO.B_2O_3 + MnO.Mn_2O_3$ = Boron trioxide 16·7, manganese sesquioxide 37·7, manganese protoxide 16·9, magnesia 28·7 = 100.

**Anal.**—Flink, l. c. 1*a* from 1, after deducting $SiO_2$ and $H_2O$.

| | $B_2O_3$ | $Mn_3O_4$ | $Fe_3O_4$ | MgO | CaO | PbO | |
|---|---|---|---|---|---|---|---|
| 1. | 15·65 | 49·39 | 2·07 | 28·58 | 1·09 | 0·76 | $SiO_2$ 1·21, $H_2O$ 0·47 = 99·22 |
| 1*a*. | 16·05 | 50·63 | 2·12 | 29·30 | 1·12 | 0·78 | = 100 |

A determination of the oxygen set free gave 4·34 p. c. (required by the formula 3·80).

**Pyr., etc.**—Fuses with some difficulty to a black non-magnetic glass. With potassium bisulphate and fluorite colors the flame intensely green. Reacts for manganese with the fluxes. Dissolves in warm concentrated hydrochloric acid with the evolution of chlorine.

**Obs.**—Occurs at Långban, Wermland, Sweden, in bands in granular dolomite with hausmannite. Also associated with tephroite, manganophyllite, berzeliite.

Named from πινάκιον, *a small tablet*, and λίθος, *stone*, in allusion to the form of the crystals.

**Ref.**—[1] L.c.; cf. also Brögger, ibid., p. 376, on the morphological relations of pinakiolite to manganite, etc.

## 696. HAMBERGITE. *W. C. Brögger*, Zs. Kr., **16**, 65, 1890.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·79877 : 1 : 0·72676 Brögger.

100 ∧ 110 = 38° 37′, 001 ∧ 101 = 42° 17⅝′, 001 ∧ 011 = 36° 0½′.

**Forms:** *a* (100, *i*-ī), *b* (010, *i*-ĭ); *m* (110, *I*); *e* (011, 1-ĭ).

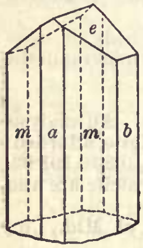
Angles: *mm‴* = 77° 14′, *bm* = *51° 23′, *ee′* = *72° 1′, *me* = 68° 28½′.

In prismatic crystals (f. 1), the faces *a* vertically striated.

Cleavage: *b* perfect; *a* less so. Brittle. H. = 7·5. G. = 2·347. Luster vitreous. Color grayish white. Transparent to translucent.

Optically +. Ax. pl. ∥ *b*. Bx ⊥ *c*. Double refraction very strong. Dispersion small $v > \rho$. Axial angles, Bgr.:

1.



| | | | |
|---|---|---|---|
| For Li | $2H_{a.r}$ = 95° 21′ | $2H_{o.r}$ = 102° 46′ | ∴ $2V_r$ = 86° 50′ |
| For Na | $2H_{a.y}$ = 95° 42′ | $2H_{o.y}$ = 102° 28′ | ∴ $2V_y$ = 87° 7 |
| For Tl | $2H_{a.gr}$ = 96° 8′ | $2H_{o.gr}$ = 102° 13′ | ∴ $2V_{gr}$ = 87° 24½′ |

Refractive indices:

| | | | |
|---|---|---|---|
| $\alpha_r$ = 1·5542 | $\beta_r$ = 1·5891 | $\gamma_r$ = 1·6294 | |
| $\alpha_y$ = 1·5595 | $\beta_y$ = 1·5908 | $\gamma_y$ = 1·6311 | ∴ $2V_y$ = 87° 40′ |
| $\alpha_{gr}$ = 1·5693 | $\beta_{gr}$ = 1·5928 | $\gamma_{gr}$ = 1·6331 | |

**Comp.**—$Be_2(OH)BO_3$ or $4BeO.B_2O_3.H_2O$ = Boron trioxide 37·1, beryllium oxide 53·3, water 9·6 = 100.

**Anal.**—Bäckström, quoted by Brögger, l. c.

$B_2O_3$ [36·72] BeO 53·25 ⅜ $H_2O$ 10·03 = 100

The water goes off only at a strong red heat, and the last fourth requires the blast lamp.

**Pyr., etc.**—B.B. decrepitates violently, but does not fuse. Insoluble in ordinary acids, but completely dissolved by digestion with hydrofluoric acid over a water bath.

**Obs.**—Occurs in a small vein near Helgaråen on the mainland near the entrance to the Langesund fiord, southern Norway. The vein consists of feldspar, black mica, barkevikite, red spreustein, and in traces zircon and fluorite.

Named after the Swedish mineralogist, A. Hamberg.

## 697. SZAIBELYITE. Szaibelyit *K. F. Peters*, Ber. Ak. Wien, **44**, 143, June 1861. Boromagnesit *Groth*, Tab. Ueb., 38, 1874.

In small nodules bristled with acicular crystals.

H. = 3–4. G. = 3. Color white outside, yellow within. Streak white. Translucent. Optically biaxial.

**Comp.**—$2Mg_5B_4O_{11}.3H_2O$ or $5MgO.2B_2O_3.1\frac{1}{2}H_2O$ = Boron trioxide 38·1, magnesia 54·5, water 7·4 = 100.

**Anal.**—Stromeyer, Ber. Ak. Wien, **47** (1), 347, 1863, after deducting impurities.

*Crystals* $B_2O_3$ [38·35] MgO 54·65 $H_2O$ 7·00 = 100

A granular form contained more water (12·35 p. c.).

**Pyr., etc.**—Yields water. B.B. splits open, glows, and fuses to a pale, hornlike, brownish gray mass, coloring the flame yellowish red. Dissolves with difficulty in hydrochloric acid.

**Obs.**—Occurs in kernels embedded in a gray granular limestone at Rezbánya, in Hungary. Named after Szajbelyi, who collected the limestone containing it.

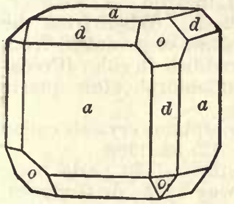
**698. BORACITE.** Kubische Quarz-Krystalle (fr. Lüneburg) *Lasius*, Crell's Ann., **2**, 333, 1787. Lüneburger Sedativ-Spath *Westrumb*, Kl. phys.-ch. Abh., **3**, 167, 1789. Borazit *Wern.* Bergm. J., 393, 1789, 234, 1790. Borate of Magnesia. Magnésie boratée *Fr.* Parasit *O. Volger*, Pogg., **92**, 77, 1854. Massive Boracite of Stassfurt = Stassfurtit *G. Rose*, Pogg., **97**, 632, 1856.

Isometric and tetrahedral in external form under ordinary conditions, but in molecular structure orthorhombic and pseudo-isometric; the structure becomes isotropic, as required by the form, only when heated to 265°. Observed forms[1]:

*a* (100, $i$-$i$)
*d* (110, $i$)
*o* (111, 1)
*o*, (1$\bar{1}$1, − 1)
$\eta$ (17·3·0, $i$-$\frac{17}{3}$)$^4$
$\vartheta$ (13·3·0, $i$-$\frac{13}{3}$)$^4$
*h* (410, $i$-4)$^3$
*f* (310, $i$-3)$^2$
*e* (210, $i$-2)$^3$
*l* (530, $i$-$\frac{5}{3}$)$^4$
*p* (221, 2)$^3$
$\Sigma$ (552, $\frac{5}{2}$)$^2$
$\rho$ (441, 4)$^5$
$\sigma$, (8$\bar{8}$1, − 8)$^5$
$\tau$, (16·$\bar{1}\bar{6}$·1, − 16)$^5$
*n* (211, 2-2)$^5$
*n*, (2$\bar{1}$1, − 2-2)
*u* (431, 4-$\frac{4}{3}$)$^4$
*v* (531, 5-$\frac{5}{3}$)

Also doubtful 12·1·0 and $\zeta$ (1$\bar{1}$6).

1.



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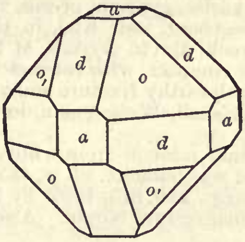

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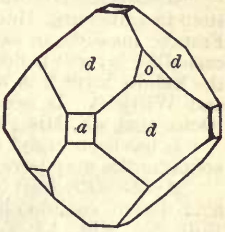
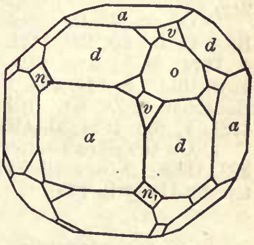


Penetration-twins: tw. pl. *o*. Habit cubic and tetrahedral or octahedral; also dodecahedral. Crystals usually isolated, embedded; less often in groups. Faces *o* bright and smooth, *o*, dull or uneven. Also massive.

Cleavage: *o*, *o*, in traces. Fracture conchoidal, uneven. Brittle. H. = 7 crystals. G. = 2·9–3. Luster vitreous, inclining to adamantine. Color white, inclining to gray, yellow, and green. Streak white. Subtransparent to translucent. Commonly shows double refraction[6], which, however, disappears upon heating to 265°, when a section becomes isotropic. Refractive indices, Dx.:

4.



After Groth.

$$n_r = 1·663 \qquad n_y = 1·667 \qquad n_{bl} = 1·675$$

Also, Mld.:

$$\beta - \alpha = 0·00477 \qquad \gamma - \alpha = 0·01074 \qquad \gamma - \beta = 0·00597$$

$$\therefore \alpha = 1·6622 \qquad \beta = 1·6670 \text{ (Dx.)} \qquad \gamma = 1·6730$$

Strongly pyroelectric[7], the opposite polarity corresponding to the position of the + and − tetrahedral faces. The faces of the dull tetrahedron *o*, (1$\bar{1}$1) form the analogous pole, those of the polished form *o* (111) the antilogous pole, Rose.

As very early observed, boracite commonly shows double refraction, at variance with the external form; this has been variously explained, and some authors have attributed it to alteration. Sections show tw. lamellæ which in general may be explained (Mallard) as having the dodecahedral faces as tw. plane; further, a simple dodecahedral crystal has a structure as if made up of twelve biaxial individuals (ax. angle about 90°), with ax. pl. parallel to the longer diagonal of the rhombic face to which the bisectrix is normal; other forms, however, show distinct types of internal structure. Increase of temperature brings about a change in position of the tw. lamellæ, and at 265° (Mallard) they disappear and a section becomes normally isotropic, at the same time the pyroelectricity disappears also; the molecular structure then agrees with the external crystallographic form. No chemical change has taken place, for even at 300° no chlorine is lost (Jannasch). The molecular structure of boracite has been minutely studied optically and by etching especially by Klein and Baumhauer, also pyroelectrically by Mack (cf. references beyond).

**Comp.**—$Mg_7Cl_2B_{16}O_{30}$ or $6MgO.MgCl_2.8B_2O_3$ = Boron trioxide 62·5, magnesia 31·4, chlorine 7·9 = 101·8, deduct (O = Cl) 1·9 = 100.

A little iron (FeO) is sometimes present (as an impurity?) and the *Eisenstassfurtit* (iron-boracite, Huyssenite, Dana, Min., 799, 1868) of Huyssen from Stassfurt is described as having half the Mg replaced by Fe, Jb. Min., 329, 1865. For analyses see 5th Ed., p. 596.

**Var.**—1. *Ordinary.* In crystals of varied habit. 2. *Massive*, with sometimes a subcolumnar structure; *Stassfurtite* of Rose. It resembles a fine-grained white marble or granular limestone. *Parasite* of Volger is the plumose interior of some crystals of boracite.

**Pyr., etc.**—The massive variety gives water in the closed tube. B.B. both varieties fuse at 2 with intumescence to a white crystalline pearl, coloring the flame green; heated after moistening with cobalt solution assumes a deep pink color. Mixed with oxide of copper and heated on charcoal colors the flame deep azure-blue (copper chloride). Soluble in hydrochloric acid.

Alters very slowly on exposure, owing to the magnesium chloride present, which takes up water. It is the frequent presence of this deliquescent chloride in the massive mineral, thus originating, that led to the view that there was a hydrous boracite (stassfurtite). *Parasite* of Volger is a result of the same kind of alteration in the interior of crystals of boracite; this alteration giving it its somewhat plumose character, and introducing water.

**Obs.**—Observed in beds of anhydrite, gypsum, or salt. In crystals at Kalkberg and Schildstein in Lüneburg, Hannover; at Segeberg, near Kiel, in Holstein; at Luneville, La Meurthe, France; massive, or as part of the rock, also in crystals, at Stassfurt, Prussia. When from the carnallite layer it is fine granular or compact, with conchoidal fracture, white or greenish; from the kainite layer it is white, soft, with earthy fracture and yellowish or reddish in color (Precht and Wittjen). It occurs at Douglashall, Westeregeln, in crystals pseudomorph after quartz (Ochsenius, Jb. Min., **1**, 271, 1889).

It has been urged that the original mineral from which the pseudomorphous crystals called achtaragdite may have been formed was boracite, cf. p. 435 and Zs. Kr., **17**. 93, 1889.

**Artif.**—Obtained by Heintz (Pogg., **110**, 613, 1860) by fusing a mixture of 10 parts boric acid, 100 of sodium chloride, 5 of magnesium borate. Also in the wet way by A. de Gramont, Bull. Soc. Min., **13**, 252, 1890.

**Ref.**—[1] See Mlr., Min.. 602, 1852. [2] Schrauf, Min. Mitth., 114, 1872, Atlas xxxvi, 1877. [3] Klein, Jb. Min., 1, 242, 1884. [4] Mgg., ibid., 1, 251, 1889. [5] Bkg., Westeregeln, Zs. Kr., **15**, 572, 1889; $n_r$ (not $n$) is given by Miller.

[6] On the *double refraction* phenomena of boracite see: Brewster, Ed. Phil. J., **5**, 217, 1821; Biot, C. R., **13**, 155, 1841; Volger, Monographie, Hannover, 1855; Dx., N. R., p. 5, 1867, Min., **2**, 4, 1874; Mld., Ann. Mines, **10**, 93, 1876; Bull. Soc. Min., **2**, 147, 1879; also on the effect of heat, ibid., **5**, 144, 214, 1882, and **6**, 122, 129, 1883; E. Geinitz, Jb. Min., 484, 1876, 394, 1877; Baumhauer, Zs. Kr., **3**, 337, 1879, and later **10**, 451, 1885; Klein, Jb. Min., **2**, 209, 1880, **1**, 239, 1881, **1**, 235, 1884, also ib., p. 181, ref. (critique of Mld.).

[7] On the *pyroelectricity*, Friedel and Curie, Bull. Soc. Min., **6**, 191, 1883; Mack, Zs. Kr., **8**, 503, 1883. Also earlier Hankel, Riess and Rose, etc. Boracite was first shown to be pyroelectric by Haüy in 1791.

**699. RHODIZITE.** Rhodizit *G. Rose*, Pogg., **33**, 253, 1834, **39**, 321, 1836. Rhodicit *Hausm.*

Isometric and tetrahedral, like boracite. In dodecahedrons, faces *o* smooth and shining, *d* often uneven.

H. = 8. G. = 3·41 Rose; 3·38 Dmr. Luster vitreous, inclined to adamantine. Color white. Translucent. Pyroelectric, the angles replaced by *o*, the antilogous pole, Rose. Exhibits the phenomena of double refraction, analogous to boracite, but does not become isotropic with elevation of temperature[2].

**Comp.**—A borate of aluminium and potassium, with also cæsium and rubidium; perhaps $R_2O.2Al_2O_3.3B_2O_3$.

**Anal.**—Damour, Bull. Soc. Min., **5**, 98, 1882.

| $B_2O_3$ | $Al_2O_3$ | $Fe_2O_3$ | $K_2O,Cs_2O,Rb_2O$ | $Na_2O$ | CaO | MgO |
|---|---|---|---|---|---|---|
| 33·93 | 41·40 | 1·93 | 12·00 | 1·62 | 0·74 | 0·82 ignition 2·96 = 95·40 |

The loss and 2·96 of volatile matter (at a white heat) are referred to boric acid giving 41·49 p. c. There is probably no water present, possibly a little fluorine, Dmr.

**Pyr., etc.**—B.B. in the platinum forceps fuses with difficulty on the edges to a white opaque glass, tingeing the flame at first green, then green below and red above, and finally red throughout. With borax and salt of phosphorus fuses to a transparent glass.

**Obs.**—Found by G. Rose in minute crystals on red tourmalines from near Sarapulsk and Shaitansk in the vicinity of Ekaterinburg in the Ural, and named from ῥοδίζειν, in allusion to its tingeing the flame red. The largest crystals seen were two lines in diameter.

**Ref.**—[1] Bull. Soc. Min., **5**, 31, 72, 1882. [2] Cf. Klein, Jb. Min., **1**, 77, ~~1891~~.

**700. WARWICKITE.** *Shepard*, Am. J. Sc., **34**, 313, 1838, **36**, 85, 1839. Enceladite *T. S. Hunt*, ib., **2**, 30, 1846, **11**, 352, 1851.

Orthorhombic. Axes $\breve{a} : \bar{b} = 0{\cdot}977 : 1$ Des Cloizeaux[1].

**Forms:** *a* (100, *i*-ī), *b* (010, *i*-ĭ); *h* (310, *i*-3̄), *m* (110, *I*), *g* (130, *i*-3̆).

Angles: *ma* = *44° 20′, *mm‴* = 88° 40′, *hh‴* = 36° 5′, *gg′* = 37° 41′.

Usually in elongated prismatic crystals with rounded terminations.

Cleavage: *a* perfect. Fracture uneven. Brittle. H. = 3–4. G. = 3·355 Dmr.; 3·362 Smith. Luster of cleavage surface submetallic-pearly to subvitreous; often nearly dull. Color dark hair-brown to dull black, sometimes a copper-red tinge on cleavage surface. Pleochroic. Streak bluish black.

Optically +. Double refraction strong. Ax. pl. ∥ *b*. Bx ⊥ *a*. 2E = 125° approx., Lcx.[2]

**Comp.**—Perhaps $6MgO.FeO.2TiO_2.3B_2O_3$ = Boron trioxide 30·7, titanium dioxide 23·5, iron protoxide 10·6, magnesia 35·2 = 100.

**Anal.**—J. L. Smith, Am. J. Sc., **8**, 432, 1874.

| $B_2O_3$ | $TiO_2$ | FeO | MgO | |
|---|---|---|---|---|
| 27·80 | 23·82 | 7·02 | 36·80 | $SiO_2$ 1·00, $Al_2O_3$ 2·21 = 98·65 |

**Pyr., etc.**—Yields water. B.B. infusible, but becomes lighter in water; moistened with sulphuric acid gives a pale green color to the flame. With salt of phosphorus in O.F. a clear bead, yellow while hot and colorless on cooling; in R.F. on charcoal with tin a violet color (titanium). With soda a slight manganese reaction. Decomposed by sulphuric acid; the product, treated with alcohol and ignited, gives a green flame, and boiled with hydrochloric acid and metallic tin gives on evaporation a violet-colored solution.

**Obs.**—Occurs in granular limestone 2½ m. S.W. of Edenville, N. Y., with spinel, chondrodite, serpentine, etc. Crystals usually small and slender; sometimes over 2 in. long and ⅜ in. broad. The latter are the *enceladite* of Hunt.

**Ref.**—[1] Dx., Min., **2**, 16, 1874. [2] Bull. Soc. Min., **9**, 74, 1886.

**701. HOWLITE.** Silicoborocalcite *H. How*, Phil. Mag., **35**, 32, 1868. Howlite *Dana*, Min., p. 598, 1868.

Orthorhombic? Penfield. In small rounded embedded nodules consisting of microscopic thin flattened prismatic crystals, sometimes terminated by two domes. Extinction parallel. Ax. pl. ⊥ to axis of crystals. Texture compact, without cleavage; also chalk-like or earthy.

Fracture nearly even and smooth. H. = 3·5; often less. G. = 2·55; 2·59 Pfd. Luster subvitreous, glimmering. Color white. Subtranslucent, or translucent in thin splinters.

**Comp.**—A silico-borate of calcium, $H_5Ca_2B_5SiO_{14}$ or $4CaO.5B_2O_3.2SiO_2.5H_2O$ = Silica 15·3, boron trioxide 44·6, lime 28·6, water 11·5 = 100.

**Anal.**—1, How, l.c. 2, Penfield and Sperry, Am. J. Sc., **34**, 220, 1887.

| | | $SiO_2$ | $B_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. | | 15·25 | [44·22] | 28·69 | — | — | 11·84 | = 100 |
| 2. | G. = 2·59 | 15·33 | 44·52 | 27·94 | 0·53 | 0·13 | 11·55 | = 100 |

A small amount of gypsum has been deducted in both cases, 4·3 p. c. for anal. 2. The water does not go off below 360° C.

**Pyr.**—Ignited in the closed tube, water reacting for boron with turmeric paper is given off

**Obs.**—Occurs in Nova Scotia, in nodules, of the size mostly of filberts, embedded in anhydrite or gypsum, at Brookville, about 3 m. S. of Windsor, and associated with ulexite; a harder kind occurs in anhydrite, and a softer in gypsum. Also 30–40 miles N.E. of Brookville and at other points in Hants Co. In aggregates of transparent scales in gypsum at Winkworth in the same region, the nodules sometimes as large as a man's head.

WINKWORTHITE *H. How*, Phil. Mag., **41**, 270, 1871.

In embedded nodules, crystalline on fracture. Glistening. H. = 2·3. Colorless to white. Translucent. Analysis.—$SiO_2$ 4·98, $B_2O_3$ [14·37], $SO_3$ 31·51, CaO 31·14, $H_2O$ 18·00 = 100. Found in gypsum at Winkworth, Nova Scotia.

Probably to be regarded as a mixture of howlite and gypsum.

**702. LAGONITE.** Borate de Fer *Omalius d'Halloy*, 1833. Lagonite *Huot*, Min., **1**, 290, 1841. Sideroborine *Huot*, **1**, 273, 1841. Lagunit *Kenng.*

An earthy mineral of an ocherous yellow color, occurring as an incrustation.

**Comp.**—$Fe_2O_3.3B_2O_3.3H_2O$ = Boron trioxide 49·5, iron sesquioxide 37·8, water 12·7=100.

**Anal.**—Bechi, Am. J. Sc., **17**, 129, 1854.

$B_2O_3$ 47·95 $Fe_2O_3$ 36·26 $H_2O$ 14·02 MgO,CaO and loss 1·77 = 100

Occurs as an incrustation at the Tuscan lagoons. First mentioned by Beudant, Min., **2**, 250, 1832.

**703. LARDERELLITE.** *Mascagni* [Viagg. Tosc., 3, 1806], *Achiardi*, Min., Tosc., **1**, 258, 1872. Larderellite *Bechi*, Am. J. Sc., **17**, 129, 1854.

Monoclinic. Very light, white to yellowish, and tasteless. Appearing under the microscope to be made up of minute tabular crystals with the plane angle of the prism 66° or 67° with sometimes also 100 and 010, Dx.[1] Extinction parallel to the diagonals of the base.

**Comp.**—A hydrous borate of ammonium $(NH_4)_2O.4B_2O_3.4H_2O$ = Boron trioxide 69·2, ammonium oxide 12·9, water 17·9 = 100.

**Anal.**—Bechi, ib.

$B_2O_3$ 68·57 $(NH_4)_2O$ 12·73 $H_2O$ 18·33 = 99·63

In Am. J. Sc., **19**, 120, 1855 (also Contin. at Georg., **1**, 128, 1853, quoted by Achiardi, Min. Tosc., **1**, 258, 1872), the results given are: $B_2O_3$ 69·24, $(NH_4)_2O$ 12·90, $H_2O$ 17·86 = 100. This is obviously an error, for these numbers give the exact *theoretical* composition.

**Pyr., etc.**—Gives off ammonia fumes in the glass tube. B.B. fuses easily to a colorless glass which gives a green color to the flame when treated with alcohol.

Dissolves in hot water, and is transformed into a new salt, represented by the formula $(NH_4)_2O.6B_2O_3.9H_2O$. A salt with the formula $(NH_4)_2O.4B_2O_3.6H_2O$ is also known.

**Obs.**—Occurs at the Tuscan lagoons.

Named after Sr. Larderel, a proprietor of the Tuscan borax industry.

**Ref.**—[1] Min., **2**, 9, 1874.

**704. COLEMANITE.** *Neuschwander*, *H. G. Hanks*, 3d Rep. Min. California, 86, 1883.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 0{\cdot}774843 : 1 : 0{\cdot}540999$; $\beta = 69° 50' 45'' = 001 \wedge 100$ Jackson[1].

$100 \wedge 110 = 36° 1' 55''$, $001 \wedge 101 = 41° 59' 46''$, $001 \wedge 011 = 26° 55' 29''$.

**Forms**[2]:
a $(100,\ i\text{-}\bar{i})$
b $(010,\ i\text{-}\grave{i})$
c $(001,\ O)$
t $(210,\ i\text{-}\bar{2})$
m $(110,\ I)$
P $(10{\cdot}19{\cdot}0,\ i\text{-}\grave{\tfrac{19}{10}})$
s $(120,\ i\text{-}\grave{2})$

J $(370,\ i\text{-}\tfrac{7}{3})$
H $(130,\ i\text{-}\grave{3})$
V $(101,\ -1\text{-}\bar{i})$
λ $(201,\ -2\text{-}\bar{i})$
i $(\bar{1}01,\ 1\text{-}\bar{i})$
h $(\bar{2}01,\ 2\text{-}\bar{i})$
W $(\bar{3}01,\ 3\text{-}\bar{i})$
Ψ $(\bar{4}01,\ 4\text{-}\bar{i})$

U $(\bar{6}01,\ 6\text{-}\bar{i})$
κ $(011,\ 1\text{-}\grave{i})$
α $(021,\ 2\text{-}\grave{i})$
β $(111,\ -1)$
σ $(331,\ -3)$
Δ $(19{\cdot}19{\cdot}6,\ -\tfrac{19}{6})$
G $(771,\ -7)$
y $(\bar{1}11,\ 1)$

v $(\bar{2}21,\ 2)$
q $(\bar{3}31,\ 3)$
k $(311,\ -3\text{-}\bar{3})$
ρ $(\bar{4}12,\ 2\text{-}\bar{4})$
B $(\bar{4}11,\ 4\text{-}\bar{4})$
Θ $(\bar{3}11,\ 3\text{-}\bar{3})$
w $(\bar{7}21,\ 7\text{-}\tfrac{\bar{7}}{2})$
o $(\bar{2}11,\ 2\text{-}\bar{2})$

γ $(\bar{3}21,\ 3\text{-}\tfrac{\bar{3}}{2})$
e $(121,\ -2\text{-}\grave{2})$[3]
ω $(131,\ -3\text{-}\grave{3})$
r $(\bar{2}32,\ \tfrac{3}{2}\text{-}\grave{\tfrac{3}{2}})$
ϵ $(\bar{2}31,\ 3\text{-}\grave{\tfrac{3}{2}})$
d $(\bar{1}21,\ 2\text{-}\grave{2})$
Q $(\bar{2}41,\ 4\text{-}\grave{2})$
x $(\bar{1}31,\ 3\text{-}\grave{3})$

Also doubtful C $(10{\cdot}1{\cdot}1,\ -10\text{-}\bar{10})$[3], Φ $(711,\ -7\text{-}\bar{7})$[3], D $(731,\ -7\text{-}\tfrac{\bar{7}}{3})$[3].

$tt''' = 39^\circ\ 58'$
$mm''' = {}^*72^\circ\ 3'\ 51''$
$zz' = 69^\circ\ 0\tfrac{1}{2}'$
$c\lambda = 41^\circ\ 31'$
$ci = 40^\circ\ 48'$
$ch = {}^*68^\circ\ 24'\ 21''$
$cW = 81^\circ\ 57'$
$c\Psi = 89^\circ\ 10\tfrac{1}{2}'$
$ca' = 110^\circ\ 9'$

$\kappa\kappa' = 53^\circ\ 51'$

$\alpha\alpha' = 90^\circ\ 54'$

$c\beta = 33^\circ\ 45\tfrac{1}{2}'$
$c\sigma = 55^\circ\ 19'$
$cm = {}^*73^\circ\ 49'\ 17''$
$cy = 47^\circ\ 31'$
$cv = 72^\circ\ 37\tfrac{1}{2}'$
$cq = 83^\circ\ 37'$
$co = 69^\circ\ 44\tfrac{1}{2}'$
$c\omega = 53^\circ\ 12'$

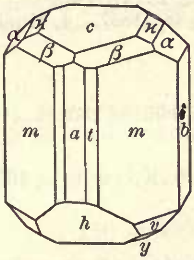
$cd = 57^\circ\ 52'$

$ak = 23^\circ\ 38'$
$a\beta = 45^\circ\ 40'$
$a\kappa = 72^\circ\ 6\tfrac{1}{2}'$
$\beta y = 62^\circ\ 40'$
$a\omega = 59^\circ\ 46'$
$a'y = 71^\circ\ 40'$

$\beta\beta' = 39^\circ\ 48'$
$\sigma\sigma' = 60^\circ\ 29'$

$\omega\omega' = 94^\circ\ 43'$
$yy' = 53^\circ\ 42'$
$dd' = 90^\circ\ 43'$
$oo' = 39^\circ\ 37'$
$vv' = 71^\circ\ 32'$
$kk' = 22^\circ\ 0'$
$BB' = 21^\circ\ 55\tfrac{1}{2}'$
$xx' = 113^\circ\ 17'$
$m'W = 44^\circ\ 33'$

1.



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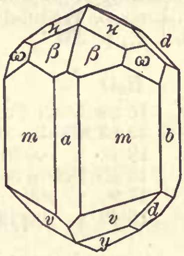
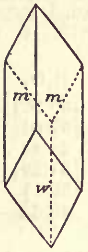


3.



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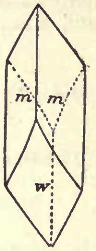
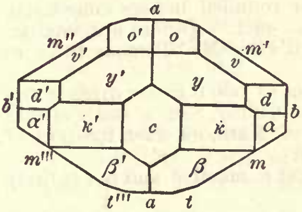


Figs. 1, 2, after Jackson. 3, 4, Washington.

5.



Crystals usually short prismatic with *m* predominating, highly modified and resembling datolite. Faces *y* ($\bar{1}11$) strongly striated ∥ edge *y*/*d*. Also resembling acute rhombohedral forms (fig. 3, 4) with *W* ($\bar{3}01$) rounded. Massive cleavable to granular and compact.

Cleavable: *b* highly perfect; *c* distinct. Fracture uneven to subconchoidal. H. = 4–4·5. G. = 2·417 B. & R.; 2·428 Evans. Luster vitreous to adamantine, brilliant. Colorless to milky white, yellowish white, gray. Transparent to translucent.

Optically +. Ax. pl. and $Bx_o \perp b$. $Bx_{a.y} \wedge \grave{c} = 83^\circ\ 44'$ Hj.; $Bx_{a.y} \wedge \grave{c} = 82^\circ\ 34'$ B. & R. Dispersion $\rho < v$ small.

$2E_y = 95^\circ\ 1'$ $2H_{a.y} = 55^\circ\ 18'$ $2H_{o.y} = 124^\circ\ 29'$ $\therefore 2V_{a.y} = 55^\circ\ 21'$ $\beta_y = 1{\cdot}5876$ Hj.
$2E_y = 95^\circ\ 15'$ $2H_{a.y} = 54^\circ\ 48'$ $2H_{o.y} = 122^\circ\ 45'$ $\therefore 2V_{a.y} = 55^\circ\ 20'$ $\beta_y = 1{\cdot}5910$ B. & R.
Also for D, $\alpha = 1{\cdot}58626$ $\beta = 1{\cdot}59202$ $\gamma = 1{\cdot}61398$ $\therefore 2V_y = 54^\circ\ 52'$ Mülheims[4]

**Comp.**—$Ca_2B_6O_{11}.5H_2O$, perhaps $HCa(BO_2)_3 + 2H_2O$ or $2CaO.3B_2O_3.5H_2O$ = Boron trioxide 50·9, lime 27·2, water 21·9 = 100.

**Anal.**—1, T. Price, 3d Rep. Min. Cal., p. 86. 2, Hjortdahl, l. c. 3 Bodewig, l. c. 4, 5, Whitfield, Am. J. Sc., **34**, 282, 1887.

| | $B_2O_3$ | CaO | $H_2O$ | |
|---|---|---|---|---|
| 1. California | [48·12] | 28·43 | 22·20 | $Al_2O_3,Fe_2O_3$ 0·60, $SiO_2$ 0·65 = 100 |
| 2. " | 47·64 | 27·97 | 22·79 | $SiO_2$ 1·28, $Al_2O_3,Fe_2O_3$ 0·19, MgO 0·13 = 100 |
| 3. " | 49·70 | 27·42 | 22·26 | = 99·38 |
| 4. Death Valley | 50·70 | 27·31 | 21·87 | MgO 0·10 = 99·98 |
| 5. " " | 49·59 | 27·38 | 22·68 | MgO 0·26, $SiO_2$ 0·45 = 100·36 |

The figures of Evans, Bull. Cal. Acad., p. 59, Feb. 1884, apparently give simply the theoretical composition.

**Pyr.**—B.B. decrepitates, exfoliates, sinters, and fuses imperfectly, coloring the flame yellowish green. Soluble in hot hydrochloric acid with separation of boric acid on cooling.

**Obs.**—First discovered (Oct. 1882) in Death Valley, Inyo Co., California; later (1883) in greater abundance in Calico district, San Bernardino county. The beautiful crystals, sometimes 2 or 3 inches in length, line geodes in the massive mineral, associated with quartz crystals as an earlier deposit, also strontianite, etc. A snow-white massive borate sometimes covers the crystals (see priceite below).

Named after Mr. William T. Coleman of San Francisco.

**Ref.**—[1]Bull. Cal. Acad., No. 2, January 1885 (read Oct. 1884); the measurements of vom Rath, Vh. Ver. Rheinl., **41**, 333, 1884, Zs. Kr., **10**, 179, 1884, Hjortdahl, Vid.-Selsk. Christ., Oct. 17, 1884, and Zs. Kr., **10**, 25, Arzruni, ib., **10**, 272, agree closely with these results. [2] Jackson, l. c. [3] Id., ibid., 358, 1886. [4] Zs. Kr., **14**, 230, 1888, also for B, C, E, etc.

PRICEITE. Cryptomorphite (?), *Chase*, Am. J. Sc., **5**, 287, 1873. Priceite *Silliman*, ibid., **6**, 128, 1873. Pandermite *Muck*, *vom Rath*, Ber. nied. Ges., p. 193, July 2, 1877.

Massive, loosely adherent, friable and chalky (priceite), to firm and compact (pandermite). H. = 3. G. = 2·26–2·30; 2·48. Color snow-white.

**Comp.**—A hydrous borate of calcium, near colemanite. Whitfield's analyses for both minerals correspond nearly to $5CaO.6B_2O_3.9H_2O$. = Boron trioxide 48·7, lime 32·5, water 18·8 = 100. The various analyses are discussed by Kenngott, Jb. Min., **1**, 241, 1885.

Analyses.—1, Silliman, l. c. 2, Chase, l. c. 3, Whitfield, ib., **34**, 283, 1887. 4, Muck, l. c. 5, Pisani, Min., p. 215, 1875. 6, Whitfield, l. c., p. 284.

| | $B_2O_3$ | CaO | $H_2O$ | |
|---|---|---|---|---|
| 1. *Priceite* | $\frac{3}{3}$ [48·92] | 31·83 | 18·29 | $NaCl, Fe_2O_3, Al_2O_3$ 0·96 = 100 |
| 2. " | [47·04] | 29·96 | 22·75 | alkalies 0·25 = 100 |
| 3. " | 48·44 | 32·15 | 19·42 | = 100·01 |
| 4. *Pandermite* | [54·59] | 29·33 | 15·45 | FeO 0·30, MgO 0·15, $K_2O$ 0·18 = 100 |
| 5. " | [50·1] | 32·0 | 17·9 | = 100 |
| 6. " | 48·63 | 32·16 | 19·40 | = 100·19 |

B.B. gives a green flame, and fuses at a red heat. In the matrass gives off neutral water. Insoluble in water, but perfectly so in hydrochloric acid.

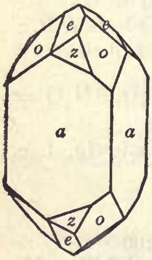
Priceite is from Curry Co., Oregon, five miles north of Chetko, where it occurs in a hard, compact form in layers, between a bed of slate above, the cavities and fissures of which it fills, and a tough blue steatite below; also occurring in boulders or rounded masses completely embedded in the steatite. Many of these masses weigh 200 lbs. each. Others are smaller, from 20 lbs. down to small pellets the size of a pea. Named after Mr. Thomas Price of San Francisco.

*Pandermite* occurs in more or less irregular lumps or nodules of varying size up to a ton, in an extensive bed beneath a thick stratum of gypsum, on the Chinar San, a small stream emptying into the Rhyndacus river which flows into the sea of Marmora near the port of Panderma. Cf. C. G. Warnford Lock, J. Soc. Arts, **28**, 767, 1880.

These two minerals are obviously identical, they may represent a massive and not entirely pure variety of colemanite.

### 705. PINNOITE. *Staute*, Ber. Chem. Ges., **17**, 1584, 1884.

Tetragonal, with pyramidal hemihedrism. Axis $\dot{c} = 0·7609$; 001 ∧ 101 = 37° 16′, Luedecke[1].



Luedecke.

**Forms:** *a* (100, *i-i*), *e* (101, 1-*i*), *o* (111, 1), *z* (312, $\frac{3}{2}$-3).

Angles: *ee′* = 50° 42′, *ee″* = 74° 32′, *oo′* = 62° 23½′, *oo″* = 94° 12′, *eo* = 31° 12′, *ao* = *58° 48·2′, *az* = 43° 9′, *a′z* = 75° 55½′.

Rarely in distinct prismatic crystals, showing pyramidal hemihedrism in the form *z* (312). Usually crystalline and fine granular to faintly fibrous, in nodules with radiated fibrous structure.

Fracture even. H. = 3–4. G. = 3·27 St., 3·373 L. Luster vitreous. Color sulphur- or straw-yellow, sometimes pistachio-green. Translucent.

**Comp.**—A hydrous magnesium borate, $MgB_2O_4.3H_2O$ or $MgO.B_2O_3.3H_2O$ = Boron trioxide 42·6, magnesia 24·4, water 33·0 = 100.

**Anal.**—1, Staute, l. c. 2, 3, Stromeyer, Zs. Nat. Halle, **58**, 646, 1885.

| | $B_2O_3$ | MgO | $H_2O$ | Fe | Cl | |
|---|---|---|---|---|---|---|
| 1. | [42·50] | 24·45 | 32·85 | 0·15 | 0·18 | = 100·13 |
| 2. *mass., yw.* | [42·68] | 24·19 | 32·50 | 0·23 | 0·40 | = 100 |
| 3. *cryst.-gran., gray* | [42·85] | 24·07 | 32·50 | 0·21 | 0·37 | = 100 |

**Pyr.**—B.B. fuses with some difficulty to a dense white mass. Soluble in acids.

**Obs.**—From the upper kainite layers at Stassfurt, associated with earthy boracite, also with kainite. Named after Oberbergrath Pinno.

**Ref.**—[1] Zs. Ver. Halle, 58, 645, 1885.

KALIBORITE *W. Feit*, Ch. Ztg., **13**, 1188, 1889; J. Ch. Soc., **58**, 341, 1890.

Massive, resembling pinnoite; separating into microscopic granules, clear and colorless when digested in water. G. = 2·05. Anal.—W. Feit, after deducting ~~1–2 p. c.~~ NaCl:

$B_2O_3$ 57·46 MgO 12·06 $K_2O$ 6·48 $H_2O$ 24·00 = 100

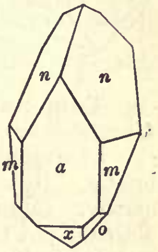
B.B. fuses with difficulty to a colorless glass. Slightly soluble in water yielding an alkaline solution; readily dissolved in warm acids.

Occurs with boracite (and stassfurtite), also pinnoite in the upper kainite layers at Schmidtsmannshall near Aschersleben; it contains a small amount of sodium chloride which probably cements together the minute granules. Regarded as an alteration-product of pinnoite.

**706. HEINTZITE.** Ein neues Mineral, etc., *Luedecke*, Zs. Nat. Halle, **62**, 354, 1889. Heintzit *Id.*, Zs. Kr., **18**, 481, 1890. Hintzeite *L. Milch*, ibid., p. 478.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 2{\cdot}1937 : 1 : 1{\cdot}7338$; $\beta = 80^\circ\ 12' = 001 \wedge 100$ Milch.

$100 \wedge 110 = 65^\circ\ 10\frac{1}{2}'$, $001 \wedge 101 = 34^\circ\ 28\frac{1}{6}'$, $001 \wedge 011 = 59^\circ\ 39\frac{1}{2}'$.



**Forms**:
*a* (100, *i*-ī)
*c* (001, *O*)
*m* (110, *I*)
*x* (ī01, 1-ī)
*n* (111, – 1)
*o* (ī12, ½)
*r* (311, – 3-3̄)

| | | |
|---|---|---|
| *mm'''* = 130° 21' | *cm* = 85° 54' | *nn'* = 102° 18' |
| *a'x* = *57° 49' | *co* = 45° 11' | *nn'''* = *77° 42' |
| *cx* = 41° 59' | *m'o* = 48° 55' | *oo'* = 80° 24' |
| *cn* = 58° 51½' | *a'r* = 37° 49' | *rr'* = 64° 10' |
| *mn* = 27° 3' | *an* = 64° 2' | *xn* = *81° 33' |

With Luedecke, the forms lettered as above have the following symbols: *a* (100) = *a'* (ī00), *c* (001) = *d* (ī02), *x* (ī01) = *c* (001), *m* (110) = *m* (120), *n* (111) = *o* (ī11), *x* (311) = (2̄11). He measures *ac* = 57° 41·4' (*a'd* = 57° 49' M), *cd* = 42° 6·5' (*xc* = 41° 59' M), *am* = 65° 23' (*am* = 65° 10½' M). He gives perfect cleavage *d* (ī02) and *c* (901), also less perfect *a* (100).

In small crystals, sometimes aggregated together; faces *m*, *c*, *n*, often hemimorphically developed.

Cleavage: *a*, *c*, both perfect. H. = 4–5. G. = 2·13. Luster vitreous. Colorless to white. Transparent, sometimes clouded.

Optically +. Ax. pl. and $Bx_o \perp b$. Axial angles, Milch:

$2H_r = 105^\circ\ 42'$ Li $2H_y = 104^\circ\ 27'$ Na $2H_{gr} = 104^\circ\ 54'$ $(n_y = 1{\cdot}4678)$

Milch gives $Bx_a \wedge \grave{c} = -7^\circ$ or $\mathfrak{c} \wedge 100 = 83^\circ$; while Luedecke gives $Bx_a \wedge \grave{c} = -64^\circ\ 44'$ or $\mathfrak{c} \wedge \bar{1}00 = 25^\circ\ 16'$. Obviously there is an error here, probably due to the confounding of the two cleavage-faces.

**Comp.**—A hydrous borate of magnesium and potassium, but formula doubtful, since the two analyses differ widely.

Anal. 1 gives $K_2O.4MgO.9B_2O_3.16H_2O$. Anal. 2, $K_2O.4MgO.11B_2O_3.14H_2O$.

**Anal.**—1, Baurath, quoted by Milch, l. c. 2, Luedecke, l. c.

| | | $B_2O_3$ | MgO | $K_2O$ | $H_2O$ | $Na_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. | G. = 2·127 | 52·39[a] | 13·80 | 8·14 | 23·83 | 0·39 | Cl 0·35 = 98·90 |
| 2. | G. = 2·129 | 60·53[b] | 12·23 | 7·39 | 19·85 | — | = 100 |

[a] Another determination gave 51·88. [b] Do., 59·27.

The sodium and chlorine in 1 are probably present as NaCl.

**Pyr., etc.**—Fuses very easily (below 1) coloring the flame intensely green. Easily soluble in hydrochloric and nitric acids.

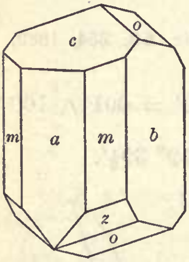
**Obs.**—Occurs at Leopoldshall, Stassfurt, embedded in nodules of pinnoite.

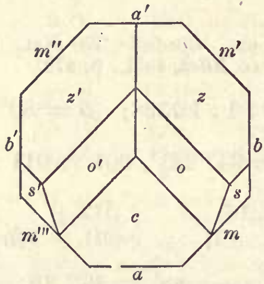
Named *Heintzite* after the chemist Heintz of Halle, and simultaneously *Hintzeite* after the German mineralogist, Ch. Hintze. Luedecke's name is taken because he first announced the species, but it is impossible to decide which chemical and optical data should be accepted where they differ.

**707. BORAX.** Tinkál or Tincal of *India.* Chrysocolla (ex nitro confecta), Borras, *Agric.*, 1546. Borax *Wall.*, Min., 1748. Borate of Soda. Borsaures Natron *Germ.* Soude boratée *Fr.*

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c} = 1{\cdot}0995 : 1 : 0{\cdot}5632$; $\beta = {}^*73° 25' = 001 \wedge 100$ Mohs-Zippe[1].

$100 \wedge 110 = 46° 30'$, $001 \wedge 101 = 29° 53\frac{5}{6}'$, $001 \wedge 011 = 28° 21\frac{1}{2}'$.





**Forms**[2]: *h* (750, *i*-$\frac{7}{5}$)[3] *s* (041, 4-*ì*)

*a* (100, *i*-*ī*) *m* (110, *I*) *o* ($\bar{1}$11, 1)

*b* (010, *i*-*ì*) *u* ($\bar{2}$01, 2-*ī*)[3] *z* ($\bar{2}$21, 2)

*c* (001, *O*)

| | | | |
|---|---|---|---|
| *hh'''* | = 73° 56' | *cm'* | = 101° 20' |
| *mm'''* | = *93° 0' | *a'o* | = 78° 20' |
| *cu* | = 54° 13' | *a'z* | = 62° 53' |
| *ss'* | = 130° 18' | *oo'* | = *57° 27' |
| *co* | = 40° 31' | *zz'* | = 83° 28' |
| *cz* | = 64° 8' | | |

In angles and in habit, borax is near pyroxene, also mirabilite.

Twins: tw. pl. *a*. Crystals prismatic, sometimes very large; faces *m, o, z,* often striated ‖ edge *m/c*.

Cleavage: *a* perfect; *m* less so; *b* in traces. Fracture conchoidal. Rather brittle. H. = 2–2·5. G. = 1·69–1·72. Luster vitreous to resinous; sometimes earthy. Color white; sometimes grayish, bluish, or greenish. Streak white. Translucent to opaque. Taste sweetish-alkaline, feeble.

Optically −. Ax. pl. ⊥ *b*. $Bx_a \perp b$. $Bx_{o.r} \wedge \acute{c} = -56° 50'$, $Bx_{o.bl} \wedge \acute{c} = -54° 50'$ Dx.[4] The position of 𝔠 ($= Bx_{o.r}$) suffers a change of 3° 26' between 21·5° and 86°. Dispersion crossed large; $\rho > v$ also large. Axial angles:

$2E_r = 59° 30'$ $2E_{bl} = 56° 30'$ at 17° C.; also $2E_r = 60° 56'$ at 56°·5 C.

$\alpha_y = 1{\cdot}447$, $\beta_y = 1{\cdot}470$, $\gamma_y = 1{\cdot}473$; $\therefore 2V_y = 39° 14'$, $2E_y = 59° 8'$, and $2E_y = 58° 59'$ meas. Dx.

Also, Tschermak[5]:

$2E_r = 59° 53'$ $2H_{a.r} = 39° 27'$ $2H_{o.r} = 140° 29'$ $\therefore 2V_r = 39° 28'$

$2E_y = 59° 23'$ $2H_{a.y} = 39° 12'$ $2H_{o.r} = 140° 56'$ $\therefore 2V_y = 39° 10'$

$2E_{gr} = 58° 18'$ $2H_{a.gr} = 38° 35'$ $2H_{o.gr} = 38° 35'$ $\therefore 2V_{gr} = 38° 35'$

Refractive indices:

| | α | β | γ | | 2V |
|---|---|---|---|---|---|
| For Li | 1·4442 | 1·4657 | 1·4686 | ∴ | 39° 52' |
| Na | 1·4468 | 1·4686 | 1·4715 | ∴ | 39° 36' |
| green glass | 1·4493 | 1·4714 | 1·4743 | ∴ | 39° 22' |
| blue " | 1·4535 | 1·4756 | 1·4785 | ∴ | 39° 22' |

Also from β and 2E, $2V_r = 39° 46'$ $2V_y = 39° 25'$ $2V_{gr} = 38° 42'$

**Comp.**—$Na_2B_4O_7.10H_2O$ or $Na_2O.2B_2O_3.10H_2O$ = Boron trioxide 36·6, soda 16·2, water 47·2 = 100.

**Pyr., etc.**—B.B. puffs up and afterward fuses to a transparent globule, called the glass of borax. Fused with fluorite and potassium bisulphate, it colors the flame around the assay a clear green. Soluble in water, yielding a faintly alkaline solution. Boiling water dissolves double its weight of this salt.

**Obs.**—Borax has been obtained since very early times from the salt lakes of Tibet, and until the discoveries in California and Nevada this was the most important source; it was brought to Europe in the crude state under the name of tincal and there purified.

The lakes furnishing the borax or tincal are in Ladák and Great Tibet. The most westerly deposits are in the lake-plain of Pugha on the Rulangchu (a branch of the Indus) at an elevation of 15,000 feet. The deposits of impure borax (*sohaga*) here occur over an area, 2 miles long by ¾ mile broad, covered by a saline efflorescence; successive crops are obtained by the action of moisture (rain or snow) and subsequent evaporation. Deposits also occur to the east of the Pugha district, at the lakes of Rudokh where a purer material (*chú tsalé*) or water borax is obtained; also farther east at the large lakes of Tengri-Nur, 100 miles north of Lhasa, and further at the lake Bul Cho to the north and Yamdok Cho or Patte to the south. (See further Spon's Encyclopedia, 1, 533, 1882). H. Warth shows that borax is present in the waters of Sambhar Lake in Rajputana, India, and also in the saline efflorescence called "reh" (p. 155) from Aligarh (Rec. G. Surv. India, **24**, 68, 1891). Borax has also been found at Viquintizoa and Escapa in Peru; at Halberstadt in Transylvania; in Ceylon. It occurs in solution in the mineral springs of Chambly, St. Ours, etc., Quebec, Canada (Hunt, Logan's G. Rep., 1853).

In *California*, it is abundant in Lake Co., 80 miles north of San Francisco, at Borax Lake and Hachinhama, two small alkaline lakes in the immediate vicinity of Clear Lake;—it is stated to have been discovered here in 1856. It is present in solution in the lake waters and in the case of Borax Lake has been obtained also in large quantities in fine crystals embedded in the lake mud and the surrounding marshy soil. The crystals are sometimes very large, up to 5 or 7 inches in length and weighing a pound each. Nine hundred pounds of crystals have been taken from one cofferdam, four feet square (Ayres). It has also been found in fine large clear crystals at Borax Lake, San Bernardino Co., with hanksite (which it sometimes incloses), thenardite, and other soda salts; at Death Valley, Inyo Co. Also occurs with the ulexite of Rhodes Marsh, etc., Esmeralda Co., Nevada. Cf. H. G. Hanks, 3d. Min. Rep. California, 1883.

Named borax from the Arabic *buraq*, which included also the *niter* (sodium carbonate) of ancient writers, the *natron* of the Egyptians. Borax was called chrysocolla by Agricola because used in soldering gold.

Prof. Bechi has analyzed a borate occurring as an incrustation at the Tuscan lagoons, which afforded: $B_2O_3$ 43·56, $Na_2O$ 19·25, $H_2O$ 37·19 = 100, giving the formula $Na_2O.2B_2O_3.6H_2O$. Am. J. Sc., **17**, 129, 1854.

**Ref.**—[1] Min., 54, 1839, credited to Naumann. [2] Mohs-Zippe, l. c. [3] Dx., Min., **2**, 7, 1874. [4] Dx., ibid. [5] Tschermak, Ber. Ak. Wien, **57** (2), 641, 1868.

TINCALCONITE *C. U. Shepard.* Borax from California, pulverulent and efflorescent, 32, p. c. water. Bull. Soc. Min., **1**, 144, 1878.

**708. ULEXITE.** Boronatrocalcit *Ulex*, Lieb. Ann., **70**, 49, 1849 Natronkalk-borat. Ulexite *Dana*, Min., 695, 1850. Natronborocalcite. Tinkalzit (fr. Africa) *Kletzinsky*, Polyt. Centr., 1384, 1859. Tiza *S. America*.

Usually in rounded masses, loose in texture, consisting of fine fibers, which are acicular or capillary crystals.

H. = 1. G. = 1·65 N. Scotia, How. Luster silky within. Color white. Tasteless.

**Comp.**—A hydrous borate of sodium and calcium, probably $NaCaB_5O_9.8H_2O = Na_2O.2CaO.5B_2O_3.16H_2O$ = Boron trioxide 43·0, lime 13·8, soda 7·7, water 35·5 = 100.

Some doubt exists as to the quantity of water; analysis 7 gives only 12 $H_2O$ (calc. 29·2 p. c.).

**Anal.**—1, Raimondi, Min. Pérou, 263, 1878. 2, Holtz, Rg., Min. Ch. Erg., 51, 1886. 3, Rg., Pogg., **97**, 301, 1856, Min. Ch., 216, 1875. 4, Rg., Jb. Min., **2**, 158, 1884. 5, Kyle, An. Soc. Argent., **10**, 169, 1880. 6, H. How, Am. J. Sc., **32**, 9, 1861. 7, Whitfield, Am. J. Sc., **34**, 284, 1887. Also 5th Ed., pp. 598, 599.

| | $B_2O_3$ | CaO | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|
| 1. Tarapacá | $\frac{3}{3}$ 43·05 | 14·05 | 6·98 | 36·13 | = 100·21 |
| 2. Atacama | [42·31] | 14·71 | 8·43 | 33·69 | $Fe_2O_3$ 0·86 = 100 |
| 3. Iquique | [44·25] | 13·67 | 7·45 | 34·63 | = 100 |
| 4. Argentine R. | 42·06 | 15·91 | 8·90 | 33·48 | = 100·35 |
| 5. " Prov. Salta | 44·71 | 14·03 | 8·22 | 33·04 | = 100 |
| 6. Nova Scotia | 44·10 | 14·20 | 7·21 | 34·49 | = 100 |
| 7. Rhodes Marsh, Nevada | 45·34 | 15·04 | 8·83 | 30·79 | = 100 |

Impurities have been deducted (gypsum, KCl, NaCl, $SiO_2$, etc.): in 1, 4·07 NaCl, in 3, 7·7 p. c. NaCl.

**Pyr.**, etc.—Yields water. B.B. fuses at 1 with intumescence to a clear blebby glass, coloring the flame deep yellow. Moistened with sulphuric acid the color of the flame is momentarily changed to deep green. Not soluble in cold water, and but little so in hot; the solution alkaline in its reactions.

**Obs.**—Occurs in the dry plains of Iquique, Chili, in the province of Tarapacá (where it is called *tiza*), in whitish rounded masses, from a hazelnut to a potato in size, which consist of interwoven fibers of the ulexite, with pickeringite, glauberite, halite, gypsum, and other impurities; at Salinas de la Puna, Province of Jujuy, Argentine Repub.; also at the Laguna Blanca, Catamarca, and in Prov. Salta; on the West Africa coast.

In Nevada, in large quantities in the salt marshes of the Columbus Mining District, in the south-eastern part of Esmeralda Co. Thus in the deposits called Teel's Marsh, Rhodes Marsh, Columbus Marsh, and Fish Lake valley—these are oval-shaped alkali flats covering 10,000 to 20,000 acres each. The ulexite occurs here in the saline crusts formed by evaporation; it is mixed with common salt, also gypsum and glauberite; it occurs in part in the form of balls ("cotton-balls") 3–4 inches through embedded in the salt. In California, in San Bernardino Co.; also the variety called "sheet cotton" from Death Valley, Inyo Co., and from Desert Springs, also called Cane Springs, in Kern Co. Also in Nova Scotia, at Windsor, Brookville, and Newport Station, filling narrow cavities, or constituting distinct nodules or mammillated masses embedded in white gypsum, and associated at Windsor with glauber salt, the luster internally silky and the color very white.

Named after the German chemist, G. L. Ulex, who gave the first correct analysis of the mineral.

**Alt.**—Occurs altered to gypsum.

The following are near ulexite:

FRANKLANDITE *Reynolds*, Phil. Mag., **3**, 284, 1877.

Massive, with fine fibrous structure. H. = 1. G. = 1·65. Color white. An analysis gave:

| $B_2O_3$ | CaO | $Na_2O$ | $H_2O$ | (Na,K)Cl | $CaSO_4$ + 2 aq. | |
|---|---|---|---|---|---|---|
| [43·76[a]] | 12·10[a] | 12·37 | 27·92 | 2·41 | 1·44 | = 100 |

[a] Other independent determinations gave $B_2O_3$ 41·81, CaO 11·94, $H_2O$ 27·66.

Deducting impurities, the formula deduced is $Na_2CaB_6O_{11}.7\frac{1}{2}H_2O$. It is very near ulexite. Slightly soluble in water, readily in dilute hydrochloric and nitric acids. Fuses easily. From Tarapacá, Chili. Named after the English chemist, Frankland.

CRYPTOMORPHITE *H. How*, Am. J. Sc., **32**, 9, 1861: Min. Mag., **1**, 257, 1877.

In dull white kernels consisting of microscopic rhombic plates. Near ulexite in composition. Analysis.—How, after deducting impurities:

$B_2O_3$ 59·10    CaO 15·55    $Na_2O$ 5·61    $H_2O$ 19·72

Occurs in white lusterless kernels of the size of a pea or bean lying between crystals of gypsum and glauber salt at Windsor, Nova Scotia. Named from κρυπτός, *concealed*, and μορφή, *form*, because the structure is only revealed by the microscope.

**709. BECHILITE.** Borate de Chaux *Beud.*, Tr., **2**, 249, 1832. Hayesine? *Bechi*, Am. J. Sc., **17**, 129, 1854. Bechilite *Dana*. Hydrous Borate of Lime. Borocalcit *Groth.*, Tab. Ueb., 38, 1874. *Alger-Phillips*, Min., 318, 1844.

In crusts, as a deposit from springs.

**Comp.**—$CaB_4O_7.4H_2O$ or $CaO.2B_2O_3.4H_2O$ = Boron trioxide 52·2, lime 20·9, water 26·9 = 100.

**Anal.**—Bechi, l. c.

$B_2O_3$ 51·14    CaO 20·85    $H_2O$ 26·25    $SiO_2,Al_2O_3,MgO$ 1·75 = 99·99

**Pyr., etc.**—Yields water. B.B. fuses easily, coloring the flame reddish yellow; moistened with sulphuric acid the flame is colored green.

**Obs.**—Found by Bechi (after whom it is named) as an incrustation at the baths of the boric acid lagoons of Tuscany. The borate mentioned by Beudant (1832) was from Monte Rotondo, Tuscany.

The *Hayesine* of D. Forbes (Phil. Mag., **25**, 113, 1863), from the waters of the hot springs, Baños del Toro, in the Cordilleras of Coquimbo, may be the above species. It occurs in the waters in the form of snow-white silky or feathery flakes, and also as a flaky sediment at the bottom. Forbes suggests that the mineral is formed by the action of hot vapors, volcanic in source, on the lime of the waters through which they pass.

HAYESINE. Hydrous borate of lime *A. A. Hayes*, Am. J. Sc., **46**, 377, **47**, 215, 1844. Borocalcite. Hydroborocalcite *Hausm.*, Handb., p. 1429, 1847. Hayesine *Dana*, Min., 217, 1850.

The supposed borate of lime of Hayes ($CaB_4O_7.6H_2O$ = Boron trioxide 46·0, lime 18·4, water 35·6 = 100) has been shown to be ulexite (cf. 5th Ed., p. 599, and Raimondi, Min. Pérou, 252, 264, 1878). The same is true of the mineral analyzed by Reichardt (JB. Ch., 737, 1858, 760, 1862; these analyses, however, are quoted by Dx., Min., **2**, 10, 1874). Two recent analyses partially sustaining the species have been made. 1, Brun, Zs. Kr., **7**, 390, 1882. 2, Darton, Am. J. Sc., **23**, 458, 1882.

| | $B_2O_3$ | CaO | $Na_2O$ | $H_2O$ | | |
|---|---|---|---|---|---|---|
| 1. Chili | [48·49] | 14·69 | 1·87 | 34·95 | = | 100 |
| 2. Bergen Hill, N. J. | 46·10 | 18·39 | — | 35·46 | = | 99·95 |

The mineral analyzed by Darton is stated to have come from a cavity with datolite at Bergen Hill, N. J.

**710. HYDROBORACITE.** *G. Hess*, Pogg., 31, 49, 1834. Hydrous Borate of Lime and Magnesia.

Monoclinic[1](?). Structure lamellar-fibrous. Resembles fibrous and foliated gypsum; fibers flattened parallel to the plane of symmetry (*b*) of a prism of 122° to 130°.

Cleavage in one, or perhaps in two directions. H. = 2. G. = 1·9–2. Color white, with spots of red from iron. Thin plates translucent. Optically biaxial. Ax. pl. ‖ *b*. A bisectrix strongly inclined to the vertical edge.

**Comp.**—$CaMgB_6O_{11}.6H_2O$ or $CaO.MgO.3B_2O_3.6H_2O$ = Boron trioxide 50·7, lime 13·5, magnesia 9·7, water 26·1 = 100.

**Anal.**—Hess, l. c.

$\frac{2}{2}$ $B_2O_3$ [49·58] CaO 13·52 MgO 10·57 $H_2O$ 26·33 = 100

**Pyr., etc.**—B.B. fuses to a clear glass, tingeing the flame slightly green, and not becoming opaque. In a matrass affords water. Somewhat soluble in water, and yielding a slightly alkaline reaction. Dissolves easily in hydrochloric and nitric acids.

**Obs.**—First observed by Hess, in a collection of Caucasian minerals. The specimen was full of holes filled with clay, containing different salts. It may be mistaken for gypsum, but is readily distinguished by its fusibility.

**Ref.**—[1] Dx., Min., 2, 14, 1874.

## Uranates.

| | | | |
|---|---|---|---|
| **711.** | **Uraninite** | Contains $UO_3$, $UO_2$, PbO, N, etc. | Isometric |
| | Bröggerite | also $ThO_2$. | |
| | Cleveite | " $ThO_2$, $Y_2O_3$, etc. | |
| | Nivenite | " " " " | |
| **712.** | **Gummite** | $(Pb,Ca)U_3SiO_{12}.6H_2O$? | |
| | Thorogummite | | |
| **713.** | **Uranosphærite** | $(BiO)_2U_2O_7.3H_2O$ | |

**711. URANINITE.** Schwarz Beck-Erz (fr. Joach.) *Brückm.*, Magn. Dei, 204, 1727. Beck-Blände = Pseudogalena picea pt. [rest (? all) pitch-like Zinc-blende] *Wall.*, 249, 1747. Swart Blende = Pechblende (fr. Saxony, etc.) pt. [id.] *Cronst.*, 198, 1758. Pseudogalena nigra compacta, Pechblende (fr. Joach. and Joh.), *De Born*, Lithoph., 133, 1772. Pechblende, Eisenpecherz [put under Iron Ores] *Wern.*, Bergm. J., 1789. Uranerz (fr. Joach.) *Klapr.*, Mem. Ac. Berl., 1786–87, 160, pub. in 1792, *Beitr.*, 2, 197, 1797 (discov. of metal uranium). Pecherz *Karst.*, Tab., 56, 1800. Urane oxydulé *H.*, Tr., 1801. Pitchblende, Protoxide of Uranium. Uranatemnite *Chapm.*, Pract Min., 148, 1853. Uranin *Haid.*, Handb., 549, 1845. Nasturan *Kobell*, Min.-Namen, 84, 1853. Pitchblende. Uranpecherz, Pechuran, *Germ.* Urane oxydulé *Fr.* Pecurano, Urano ossidolato, *Ital.* Pezblenda *Span.*

Schweruranerz (fr. Přibram) *Breith.*, Handb., 903, 1847. Coracite (fr. L. Sup.) *Le Conte*, Am. J. Sc., **3**, 117, 173, 1847. Kristallisirtes Uranpecherz (fr. Norway) *Th. Scheerer*, Pogg., **77**, 570, 1847 = Uranoniobit *Herm.*, J. pr. Ch., **76**, 326, 1859.

Cleveite *A. E. Nordenskiöld*, G. För. Förh., **4**, 28, 1878. Bröggerite, Thor-uranin, *C. W. Blomstrand*, ibid., **7**, 60, 1884. Nivenite *Hidden* and *Mackintosh*, Am. J. Sc., **38**, 481, 1889.

Isometric. In octahedrons (*o*), also with dodecahedral planes (*d*); less often in cubes with *o* and *d*. Crystals rare. Usually massive and botryoidal; also in grains; structure sometimes columnar, or curved lamellar.

Fracture conchoidal to uneven. Brittle. H. = 5·5. G. = 9·0 to 9·7 of crystals; of massive altered forms from 6·4 upwards, see below. Luster submetallic, to greasy or pitch-like, and dull. Color grayish, greenish, brownish, velvet-black. Streak brownish black, grayish, olive-green, a little shining. Opaque.

**Comp.**—A uranate of uranyl, lead, usually thorium (or zirconium), often the metals of the lanthanum and yttrium groups; also containing nitrogen in varying amounts up to 2·6 p. c. Calcium and water (essential ?) are present in small quantities; iron also, but only as an impurity. The relation between the bases varies widely and no definite formula can yet be given. Cf. Hillebrand, ref. below.

When the composition of the minerals here provisionally included together is more thoroughly understood, it may prove that they should be separated, as two or three independent species.

The ratio of $UO_3$ and $UO_2$ varies widely even in different specimens from the same locality. Thus the oxygen ratio of $UO_3$ to other bases varies from 1 : 4·37 (Branchville) to 1 : 1 in bröggerite: while nivenite gives an acid ratio. This fact, coupled with the behavior of the material when treated with acids, has led Hillebrand to suggest that while the variation may be only due to alteration, it is perhaps more probable that all specimens examined are simply mixtures of two (or more) compounds in varying amounts.

The presence of nitrogen, first shown by Hillebrand, to whom we owe most of our present knowledge of the composition of the species, is a remarkable fact, as being the only case in which this element has been identified in a mineral belonging to the original crust of the earth. The part played by the nitrogen is still uncertain; the amount seems to bear some relation to the $UO_2$ present. The nitrogen is set free, as nitrogen gas, by a non-oxidizing inorganic acid and by fusion with an alkaline carbonate; probably also by caustic alkalies in a current of $CO_2$.

**Var.**—The varieties of uraninite include:

1. *Crystallized.* *Uranniobite* of Hermann, from Norway. In crystals, usually octahedral, with G. varying for the most part from 9·0 to 9·7; occurs as an original constituent of coarse granites (pegmatyte). The variety from Branchville, which is as free from alteration as any yet examined, contains chiefly $UO_2$ with a relatively small amount of $UO_3$. Nitrogen is present in the maximum quantity, as yet observed, 2·6 p. c. Thoria is prominent, while the earths of the lanthanum and yttrium groups are only sparingly represented.

*Bröggerite*, as analyzed by Hillebrand, gives the oxygen ratio of $UO_3$ to other bases of about 1 : 1. It occurs in octahedral crystals, also with *d* and *a*. G. = 9·03.

*Cleveite* and *nivenite* contain $UO_3$ in larger amount than the other varieties mentioned, and are characterized by containing about 10 p. c. of the yttrium earths. Cleveite is a variety from the Arendal region occurring in cubic crystals modified by the dodecahedron and octahedron. G. = 7·49. Nivenite occurs massive, with indistinct crystallization. Color velvet-black. H. = 5·5. G. = 8·01. It is more soluble than other kinds of uraninite, being completely decomposed by the action for one hour of very dilute sulphuric acid at 100°.

2. *Massive*, probably amorphous. Pitchblende; nasturan of Kobell (from ναστός, *dense*). Contains no thoria; the rare earths are also absent, and nitrogen is very sparingly present if at all. Water on the other hand is prominent and the specific gravity is much lower, in some cases not above 6·5. These last differences are doubtless largely due to alteration. Here belong the kinds of pitchblende which occur in metalliferous veins, with sulphides of silver, lead, cobalt, nickel, iron, zinc, copper, as that from Johanngeorgenstadt, Příbram, etc.; probably also that from Black Hawk, Colorado, (Hillebrand).

**Anal.**—1–11, 15–21, Hillebrand, Am. J. Sc., **40**, 384, 1890; also U. S. G. Surv., Bull. **78**. In the latter place the methods, results, and conclusions are stated more minutely. 12–14, 22, Id., Am. J. Sc., **42**, 390, 1891. In these analyses the $La_2O_3$ group includes the earths insoluble in potassium sulphate, the $Y_2O_3$ group those soluble in it.

Earlier analyses are more or less incomplete or untrustworthy, see 5th Ed., p. 155; also Branchville, Comstock, Am. J. Sc., **19**, 220, 1880 (in which the thorium is overlooked).

Further, 23, Blomstrand, l. c. 24, G. Lindström, quoted by Nordenskiöld, l. c. (cf. Blomstrand, l. c., p. 69). 25, Hidden and Mackintosh, l. c. 26, Lorenzen, Nyt Mag., **28**, 249, 1884. The absence of thorium in anal. 26, while Hillebrand obtained a considerable amount in material stated to have come from the same locality, is not explained.

For analyses, see p. 891, opposite.

Blomstrand (l.c.), in discussing the composition of the natural uranates, deduces for uraninite the formula of an ortho-uranate, $\overset{IV}{U}_3(\overset{VI}{U}O_6)_2$, or $(UO_2)_3(UO_3)_2$; this Hillebrand shows has no general application.

**Pyr., etc.**—B.B. infusible, or only slightly rounded on the edges, sometimes coloring the outer flame green (copper). With borax and salt of phosphorus gives a yellow bead in O.F., becoming green in R.F. (uranium). With soda on charcoal gives a coating of lead oxide, and

| | G. | $UO_3$ | $UO_2$ | $ThO_2$ | $CeO_2$ | $La_2O_3$ | $Y_2O_3$ | PbO | CaO | N | $H_2O$ | $Fe_2O_3$ | X | insol. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Glastonbury, I. | 9·14 | ⅔ 22·08 | 59·13 | 9·57 | | | | 3·14 | 0·08 | *und.* | 0·97 | 1·21 | 1·06[a] | 0·85 | $Nb_2O_5$ 0·96 = 99·05 |
| 2. " II. | 9·05 | 23·35 | 58·01 | 9·78 | | 0·46 | | 3·24 | — | *und.* | | 0·33 | — | 1·74 | = 96·91 |
| 3. " III. | | 22·22 | 59·31 | 10·31 | | | | 3·07 | *und.* | *und.* | | 0·67 | 0·25[a] | 0·42 | = 96·25 |
| 4. " IV. | 9·59 | 26·48 | 57·43 | 9·79 | 0·25 | 0·13 | 0·20 | 3·26 | 0·08 | *und.* | 0·61 | 0·40 | 0·16[a] | 0·70 | = 99·49 |
| 5. " V. | 9·62 | ⅔ 23·03 | 59·93 | 11·10 | | | | 3·08 | 0·11 | 2·41 | 0·43 | 0·29 | 0·22[b] | 0·89 | = 101·49 |
| 6. Branchville, I. | 9·73 | 13·27 | 72·25 | 7·20 | | — | — | 4·35 | 0·18 | *und.* | 0·68 | 0·11 | 0·13[c] | 0·04 | = 98·21 |
| 7. " II. | 9·56 | 21·54 | 64·72 | 6·93 | $ZrO_2$ 0·33 | — | — | 4·34 | 0·22 | *und.* | 0·67 | 0·28 | 0·20[d] | 0·14 | = 99·37 |
| 8. " III. | 9·35 | 14·00 | 70·99 | 6·52 | | — | — | 4·35 | 0·30 | 2·63 | 0·68 | 0·27 | 0·35[e] | 1·40 | = 101·49 |
| 9. Colorado | 8·07 | ⅔ 25·26 | 58·51 | $ZrO_2$ 7·59 | 0·22 | — | — | 0·70 | 0·84 | 0·15 | 1·96 | — | 4·72[f] | — | = 99·95 |
| 10. N. Carolina, I. | 9·09 | 50·83 | 39·31 | 2·78 | 0·26 | 0·50 | 0·20 | 4·20 | 0·85 | 0·37 | 1·21 | — | 0·38[g] | 0·10 | = 100·99 |
| 11. " II. | 9·49 | 44·11 | 46·56 | 3·04 | | | | 4·53 | 0·23 | *und.* | | — | 0·38[h] | 0·06 | = 98·91 |
| 12. Marietta, S. C. | | 83·95[r] | | 1·65 | 0·19 | 2·05 | 6·16[s] | 3·58 | 0·41 | *und.* | | *tr.* | | 0·20 | $ZrO_2$ 0·20 = 98·39 |
| 13. Villeneuve | 9·05 H. | 41·06 | 34·67 | 6·41 | 0·40 | 1·11 | 2·57[t] | 11·27 | 0·39 | 0·86 | 1·47 | 0·10 | 0·28[i] | 0·13 | = 100·72 |
| 14. Johanngeorgenstadt | 6·89 | 59·30 | 22·33 | — | — | — | — | 6·39 | 1·00 | 0·02 | 3·17 | 0·21 | 3·19[k] | — | $As_2O_5$ 2·34 = 97·95 |
| 15. Åneröd, *Bröggerite* | 8·89 | 30·63 | 46·13 | 6·00 | 0·18 | 0·27 | 1·11 | 9·04 | 0·37 | 1·17 | 0·74 | 0·25 | 0·24[l] | 4·42 | $ZrO_2$ 0·06? = 100·61 |
| 16. Elvestad, I. | 9·15 | 25·36 | 50·74 | 8·48 | 0·21 | 0·26 | 1·10 | 10·06 | 0·77 | 1·28 | 0·73 | 0·21 | 0·48[m] | 0·45 | $ZrO_2$ 0·08? = 100·21 |
| 17. " II. | 8·32 | 22·04 | 43·03 | 8·43 | | | | 8·58 | 0·37 | 1·08 | 0·74 | 0·30 | 0·42[n] | 15·45 | = 100·44 |
| 18. Skraatorp | 8·97 | 32·00 | 43·88 | 8·98 | 0·17 | 0·36 | 0·97 | 9·46 | 0·36 | 1·03 | 0·77 | 0·09 | 0·53[a] | 1·54 | = 100·14 |
| 19. Huggenäskilen | 8·93 | 35·54 | 43·38 | 6·63 | 0·20 | 0·23 | 1·03 | 9·44 | 0·41 | 1·08 | 0·79 | 0·32 | 0·62[o] | 0·42 | = 100·09 |
| 20. Arendal, *Cleveite* | 7·50 | 41·71 | 24·18 | 3·66 | | | 9·76 | 10·54 | 1·04 | *und.* | 1·23 | 0·03 | 1·23[p] | 1·10 | $CO_2$ *undet.* = 94·50 |
| 21. " | | 26·80 | 44·18 | 4·15 | — | 0·67 | 9·05 | 10·95 | 0·61 | 1·24 | *und.* | 0·24 | 0·69[q] | 1·19 | = 99·77 |
| 22. Texas, *Nivenite* | 8·29 | 44·17 | 20·89 | 6·69 | 0·34 | 2·36 | 9·46[u] | 10·08 | 0·32 | 0·54 | 1·48 | 0·14 | 0·46[a] | 1·47 | $ZrO_2$ 0·34 = 98·74 |
| 23. *Bröggerite* | 8·73 | 38·82 | 41·25 | 5·64 | — | 0·38[v] | 2·42 | 8·41 | 0·30 | — | 0·83 | 1·26[y] | 0·81[a] | — | = 100·12 |
| 24. *Cleveite* | 7·49 | 42·04 | 23·89 | 4·76 | — | 2·33[v] | 10·34[w] | 11·31 | — | — | 4·28 | 1·05 | — | — | = 100 |
| 25. *Nivenite* | 8·01 | 46·75 | 19·89 | 7·57 | — | — | 11·22[x] | 10·16 | — | — | 2·54[z] | 0·58 | — | 1·22 | = 99·93 |
| 26. Huggenäskilen | 8·92 | 38·23 | 50·42 | — | — | — | — | 9·72 | 0·21 | — | 0·70 | 0·25[y] | 0·31[a] | — | = 99·84 |

[a] $SiO_2$. [b] $SiO_2$ 0·16, $P_2O_5$ 0·02, F 0·04. [c] MnO 0·10, $SiO_2$ 0·03. [d] MnO 0·07, $SiO_2$ 0·13. [e] MgO,alk. 0·15, $SiO_2$ 0·20. [f] ZnO 0·44, FeO 0·32, MnO 0·16, $SiO_2$ 2·79, $P_2O_5$ 0·22, $As_2O_5$ 0·43, $CuFeS_2$ 0·12, FeS 0·24. [g] MgO,alk. 0·30, $SiO_2$ 0·08. [h] MgO,alk. 0·25, $SiO_2$ 0·13. [i] $SiO_2$ 0·19, $Bi_2O_3$ 0·09. [k] $SiO_2$ 0·50, $Al_2O_3$ 0·20, $Bi_2O_3$ 0·75, CuO 0·17, MnO 0·09, MgO 0·17, $Na_2O$ 0·31, $P_2O_5$ 0·06, $UO_3$ 0·75, $SO_3$ 0·19. [l] $SiO_2$ 0·22, $P_2O_5$ 0·02. [m] MnO 0·06, $SiO_2$ 0·38, $P_2O_5$ 0·04. [n] MgO,alk. 0·13, $SiO_2$ 0·29. [o] MgO,alk. 0·13, $SiO_2$ 0·49. [p] MgO 0·10, alk. 0·23, $SiO_2$ 0·90. [q] MgO 0·04, alk. 0·15, $SiO_2$ 0·50. [r] $AsU_3O_8$. [s] At wght. 113·6. [t] Do. 111·2. [u] Do. 111·4. [v] $Ce_2O_3$. [w] Incl. 3·47 $Er_2O_3$. [x] Incl. $Er_2O_3$, at. wght. 124·2. [y] FeO. [z] Ign.

frequently the odor of arsenic. Many specimens give reactions for sulphur and arsenic in the open tube. Soluble in nitric and sulphuric acids; the solubility differs widely in different varieties, being greater in those kinds containing the rare earths. Not attractable by the magnet.

**Obs.**—As noted above, uraninite occurs either as a primary constituent of granitic rocks or as a secondary mineral with ores of silver, lead, copper, etc. Under the latter condition it is found at Johanngeorgenstadt, Marienberg, and Schneeberg in Saxony, at Joachimsthal and Přibram in Bohemia, and Rezbánya in Hungary. It is associated with torbernite at Tincroft and Tolcarn mines near Redruth in Cornwall; also near Adrianople, Turkey. Occurs in Norway in pegmatyte veins at several points near Moss, viz.: Ånneröd (*bröggerite*), Elvestad, Huggenäskilen, Skraatorp; also near Arendal at the Garta feldspar quarry (*cleveite*), associated with orthite, fergusonite, thorite, etc.

In the U. States, at the Middletown feldspar quarry, Conn., in large octahedrons, rare; also more abundantly at Hale's quarry in Glastonbury, a few miles N.E. of Middletown. At Branchville, Conn., in a pegmatyte vein, not uncommon as small octahedral crystals, often aggregated together; usually embedded in albite. In N. Carolina, at the Flat Rock mine and other mica mines in Mitchell Co., rather abundant, but usually altered, in part or entirely, to gummite and uranophane; the crystals are sometimes an inch or more across and cubic in habit. In S. Carolina, at Marietta. In Texas, at the gadolinite locality in Llano Co. (*nivenite*). In large quantities at Black Hawk, near Central City, Colorado. Rather abundant in the Bald Mountain district, Black Hills, S. Dakota.

Also with monazite, etc., at the Villeneuve mica veins, Ottawa Co., Quebec, Canada.

Cleveite is named after the Swedish chemist, P. T. Cleve. Bröggerite after the Swedish mineralogist, W. C. Brögger. Nivenite after Mr. William Niven, of New York City.

**Alt.**—The hydrous mineral called gummite occurs as a result of the alteration of this species; also uranic ocher.

*Coracite* is from about 90 m. above Sault Ste. Marie, on the north side of L. Superior; it appears to be a uraninite partly altered to gummite. Analyses.—1, Whitney, Am. J. Sc., **7**, 434, 1849, 5th ed., p. 155. 2, Genth, ibid., **23**, 421, 1857. Whitney found 15·92 p. c. $CaCO_3$, which was separated by Genth before analysis.

| | $UO_3.UO_2$ | PbO | $Fe_2O_3$ | CaO | MgO | $SiO_2$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. | 72·60 | 6·56 | 2·74[a] | 5·99 | — | 5·33 | 5·68 | $Al_2O_3$ 1·10 = 100 |
| 2. | 62·68[c] | 7·39 | 3·51 | 5·33 | 0·56 | 13·15 | 6·14[b] | $Al_2O_3$ 0·52 = 99·28 |

[a] FeO. [b] Incl. $CO_2$. [c] $UO_3$ 46·21, $UO_2$ 16·47.

**712. GUMMITE.** Feste Uranokker pt. *Wern.*, Min. Syst., 26, 1817, Hoffm. Min., **4**, a, 279. Lichtes Uranpecherz *Freiesleben.* Uranisches Gummi-Erz, *Breith.*, Uib., 60, 1830, Char., 218, 1832. Urangummi *Breith.*, Handb., 903, 1847. Phosphor-Gummit *Herm.*, J. pr. Ch., **76**, 327, 1859.

Uranisches Pittin-Erz, Pittinus inferior, *Breith.*, Handb., 901, 1847. Eliasit *Haid.*, Jb. G. Reichs., **3**, No. 4, 124, 1852. Pittinit *Herm.*, J. pr. Ch., **76**, 322, 1859.

Crystalline (Foullon); perhaps in part amorphous. In rounded or flattened pieces, looking much like gum.

H. = 2·5–3. G. = 3·9–4·20 Breith. Luster greasy. Color reddish yellow to orange- or hyacinth-red, reddish brown. Streak yellow. Feebly translucent.

**Comp.**—An alteration-product of uraninite of doubtful composition.

Foullon calculates the formula $(Pb,Ca,Ba)U_3SiO_{12}+6H_2O$, for the essential part of gummite which is associated with uranophane (p. 699) and sometimes intimately mixed with it.

**Anal.**—1, Kersten, Schw. J., **66**, 18, 1832. 2, Ragsky, Pogg., Erg., **4**, 348, 1854. 3, Hermann, l. c. 4–10, von Foullon, Jb. G. Reichs., **33**, 1, 1883. 11, Genth, Am. Ch. J., **1**, 89, 1879.

| | | $UO_3$ | PbO | $Fe_2O_3$ | $Mn_2O_3$ | CaO | MgO | BaO | $SiO_2$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Johanngeorgenstadt | 72·00 | — | — | 0·05 | 6·00 | — | — | 4·26 | 14·75 | $P_2O_5$<br>[2·30, As,F *tr.* = 99·36 |
| 2. | Joachimsthal, *Elias.* | 61·33 | 4·62 | 6·63 | 1·17[a] | 3·09 | 2·20 | — | 5·13 | 10·68 | $P_2O_5$<br>[0·84, FeO 1·09, $CO_2$ 2·52, As *tr.* = 99·30 |
| 3. | " *Pitt.* | 68·45 | 2·51 | 4·54 | — | 2·26 | 0·55 | — | 5·00 | 10·06 | $Bi_2O_3$<br>[2·67, insol. 3·20 = 99·24 |
| 4. | " *Elias.* | 63·38 | 5·04 | 8·64 | 1·92 | 4·54 | 0·85 | — | 4·92 | 10·24 | = 99·53 |
| 5. | " " | 63·76 | 4·44 | 8·55 | 1·84 | 4·36 | 0·82 | — | 5·01 | 9·41 | = 98·19 |
| 6. | " | 66·91 | 4·47 | 7·38 | 0·97 | 3·41 | 0·09 | — | 4·63 | 10·24 | = 98·10 |
| 7. | " | 66·57 | 3·92 | 7·25 | 0·74 | 3·87 | *tr.* | — | 4·96 | 11·86 | Cu *tr.*=<br>[99·17 |
| 8. | Mitchell Co., N. C. | 74·67 | *und.* | 0·46 | — | 3·38 | — | 1·06 | 5·02 | 9·80 | |
| 9. | " | 74·92 | 5·51 | 0·36 | — | 3·01 | — | 1·01 | 5·03 | 9·91 | = 99·75 |
| 10. | " | 74·50 | 4·69 | 1·06 | — | 3·04 | — | 0·92 | 5·04 | 9·94 | = 99·19 |
| 11. | " G.=4·84 | ⅔ 75·20 | 5·57 | — | 0·53[a] | 2·05 | — | 1·08[b] | 4·63 | 10·54 | $P_2O_5$<br>[0·12 = 99·72 |

[a] $Al_2O_3$. [b] Incl. SrO.

Genth, discussing anal. 11, arrives at the conclusion that it represents a mixture of uranium hydrate (40 p. c.), uranotile (33·4), lead uranate (22·7), and barium uranate (4·3).

**Pyr., etc.**—Yields much water and a bituminous odor. With salt of phosphorus in O.F. gives a yellow bead, becoming green in R.F. (due to uranium), leaving an undissolved skeleton of silica.

**Obs.**—From Johanngeorgenstadt, with uraninite. *Eliasite* and *pittinite* are from Joachimsthal, where they occur with pitchblende. Eliasite is somewhat resin-like in aspect; G. = 4·087–4·237 Zeph. Color dull reddish brown. Pittinite is black in color; streak olive-green; luster greasy submetallic; G. = 4·8–5·0 Breith.; 5·16 Herm.

Gummite is also abundant at the Flat Rock mine, Mitchell Co., N. C.; crystals examined by Foullon consisted of a lemon-yellow granular or earthy exterior (uranophane) inclosing the orange-red gummite and often in the center a nucleus of uraninite. Also at many other localities with uraninite, as at Branchville, etc. On coracite see p. 892.

YTTROGUMMITE *A. E. Nordenskiöld*, G. För. Förh., 4, 31, 1878. Occurs with cleveite (p. 890) and is probably a final decomposition-product of it. It has the appearance of orangite. Luster brilliant. Color black to yellow. Translucent· fracture conchoidal. Optically anisotropic. H. = 5. A hydrous compound containing yttrium and uranium oxides. Between the black opaque cleveite and the translucent honey-yellow yttrogummite occur many intermediate products.

THOROGUMMITE *Hidden* and *Mackintosh*, Am. J. Sc., 38, 480, 1889. Occurs with fergusonite, cyrtolite, and other species at the gadolinite locality in Llano Co., Texas. Usually massive, sometimes in groups of crystals near zircon in form. H. = 4–4·5. G. = 4·43–4·54. Color dull yellowish brown. Easily soluble in nitric acid. After ignition becomes of a dull greenish hue. Anal.:

| $UO_3$ | $ThO_2$ | $SiO_2$ | $(Ce,Y)_2O_3$ | PbO | $Al_2O_3$ | $Fe_2O_3$ | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|
| 22·43 | 41·44 | 13·08 | 6·69[a] | 2·16 | 0·96 | 0·85 | 0·41 | 7·88 | $P_2O_5$ 1·19, hygr. $H_2O$ 1·23 [= 98·32 |

[a] At. wght. 135.

The formula calculated for the above is $UO_3.3ThO_2.3SiO_2.6H_2O$.

CHLOROTHORITE *Hidden*, Trans. N. Y. Acad. Sc., 8, 185, May 27, 1889. A name provisionally suggested for "a tetragonal thorium silico-uranate." Apparently the same as the above, thorogummite. So named because it turns green upon ignition.

**713. URANOSPHÆRITE.** *Weisbach*, Jb. Berg-Hütt. Sachs., and Jb. Min., 315, 1873.

In half-globular aggregated forms, sometimes with a dull or a slightly lustrous surface, sometimes rough and drusy, made up of minute acutely-terminated crystals. Structure concentric, also radiated.

H. = 2·3, G. = 6·36. Color orange-yellow, brick-red (Winkler). Luster greasy. Streak yellow.

**Comp.**—$(BiO)_2U_2O_7.3H_2O$ or $Bi_2O_3.2UO_3.3H_2O$ = Uranium trioxide 52·7, bismuth trioxide 42·4, water 4·9 = 100.

**Anal.**—1, 2 Winkler: 1, impurities (11 p. c.) deducted, 2, perfectly pure material, J. pr. Ch., 7, 5, 1873.

| | $UO_3$ | $Bi_2O_3$ | $H_2O$ | | |
|---|---|---|---|---|---|
| 1. | 50·32 | 44·12 | 5·56 | = | 100 |
| 2. | 50·88 | 44·34 | 4·75 | = | 99·97 |

**Pyr., etc.**—Decrepitates on heating, and falls to pieces to a mass of crystalline needles, with silky luster, homogeneous and of brown color.

**Obs.**—Occurs with other related uranium minerals at the mine Weisser Hirsch, near Schneeberg, Saxony.

# Oxygen Salts.

## 6. SULPHATES, CHROMATES, TELLURATES.

A. Anhydrous Sulphates, etc.

B. Acid and Basic Sulphates.

C. Hydrous Sulphates.

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### A. Anhydrous Sulphates, etc.

| | | | | |
|---|---|---|---|---|
| | | | | $\breve{a} : \bar{b} : \dot{c}$ |
| **714.** | **Mascagnite** | $(NH_4)_2SO_4$ | Orthorhombic | 0·5642 : 1 : 0·7309 |
| **715.** | **Taylorite** | $(NH_4)_2SO_4.5K_2SO_4$ | | |
| **716.** | **Thenardite** | $Na_2SO_4$ | Orthorhombic | $\breve{a} : \bar{b} : \dot{c}$ = 0·5976 : 1 : 1·2524 |
| **717.** | **Aphthitalite** | $(K,Na)_2SO_4$ | Rhombohedral | $\dot{c}$ = 1·2839 |
| | | | | $\grave{a} : \overset{\mid}{b} : \dot{c}$ |
| **718.** | **Glauberite** | $Na_2Ca(SO_4)_2$ | Monoclinic | 1·2200 : 1 : 1·0275 β = 67° 49′ |

**Barite Group.** $RSO_4$. Orthorhombic.

| | | | |
|---|---|---|---|
| | | | $\breve{a} : \bar{b} : \dot{c}$ |
| **719.** | **Barite** | $BaSO_4$ | 0·8152 : 1 : 1·3136 |
| **720.** | **Celestite** | $SrSO_4$ | 0·7790 : 1 : 1·2801 |
| **721.** | **Anglesite** | $PbSO_4$ | 0·7852 : 1 : 1·2894 |
| **722.** | **Anhydrite** | $CaSO_4$ | 0·8933 : 1 : 1·0008 |
| **723.** | **Zinkosite** | $ZnSO_4$ (artif.) | 0·8925 : 1 : 1·4137 |
| **724.** | **Hydrocyanite** | $CuSO_4$ | 0·7971 : 1 : 1·1300 |

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| | | | | | |
|---|---|---|---|---|---|
| | | | | $\grave{a} : \overset{\mid}{b} : \dot{c}$ | β |
| **725.** | **Crocoite** | $PbCrO_4$ | Monoclinic | 0·9603 : 1 : 0·9159 | 77° 33′ |
| **726.** | **Phœnicochroite** | $Pb_3Cr_2O_9$ | Orthorhombic? | | |
| **727.** | **Vauquelinite** | $2(Pb,Cu)CrO_4.(Pb,Cu)_3P_2O_8$ | Monoclinic | $\grave{a} : \bar{b} : \dot{c}$ = 0·7498 : 1 : 1·3908; β = 69° 3′ | |

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**714. MASCAGNITE.** *Mascagni*, Dei Lagoni, etc., in Siena, 1779. Sel ammoniac vitriolique, Sel ammoniac secret de Glauber (fr. Solfatara near Naples), *Sage*, Min., 1, 62, 1777. Ammoniaque sulfatée *Fr.* Sulphate of Ammonia. Maskagnin *Karst.*, Tab., 40, 75, 1800. Schwefelsaures Ammoniak *Germ.*

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·5642 : 1 : 0·7309 Mitscherlich[1].
100 ∧ 110 = 29° 26′, 001 ∧ 101 = 52° 20′, 001 ∧ 011 = 36° 10′.

**Forms:** *a* (100, *i*-ī), *b* (010, *i*-ĭ), *c* (001, *O*); *m* (110, *I*), *f* (130, *i*-3̄); *u* (011, 1-ĭ), *v* (021, 2-ĭ); *o* (111, 1).

Angles: *mm‴* = *58° 52′, *ff′* = 61° 8′, *uu′* = 72° 20′, *vv′* = *111° 15′, *co* = 56° 5′, *oo′* = 92° 34′, *oo‴* = 48° 8′.

Twins: tw. pl. *m*, pseudo-hexagonal, like the artificial potassium sulphate. Usually in mealy crusts and stalactitic forms.

Cleavage: *c* distinct. H. = 2–2·5. G. = 1·76–1·77. Luster when crystallized, vitreous. Color yellowish gray, lemon-yellow. Translucent. Taste pungent and bitter.

Optically +. Ax. pl. ‖ *b*. Bx ⊥ *a*. Dispersion weak, $\rho < v$. Ax. angles: $2E_r$ = 87° 44′, $2E_{bl}$ = 88° 47′. The angle is increased by rise of temperature, Dx.[2]

**Comp.**—Ammonium sulphate, $(NH_4)_2SO_4$ = Sulphur trioxide 60·6, ammonium oxide 39·4 = 100.

**Pyr., etc.**—In the closed tube yields water and is sublimed; with lime gives off ammonia vapors. Dissolves readily in water.

**Obs.**—Occurs about volcanoes, in the fissures of the lava, as at Etna, Vesuvius, and the Lipari Isles, and is also one of the products of the combustion of mineral coal. Also found in the guano of the Guañape Islands, Peru.

Named after Professor Mascagni.

**Ref.**—[1] Artif. cryst., Pogg., **18**, 169, 1830; Rg., Kr. Ch., 387, 1871. [2] Propr. Opt., **2**, 24, 1859, N. R., 96, 1867.

**715. TAYLORITE.** Sulphate of Potash and Ammonia *W. J. Taylor*, Proc. Ac. Philad., 309, 1859. Taylorite *Dana*, Min., 614, 1868.

In small compact lumps or concretions; structure crystalline.

H. = 2. Color yellowish white. Taste pungent and bitter. Unalterable in the air.

**Comp.**—$5K_2SO_4.(NH_4)_2SO_4$ = Sulphur trioxide 47·8, potash 46·9, ammonium oxide 5·2 = 100.

**Anal.**—1, 2, W. J. Taylor, l. c.

| | $SO_3$ | $Na_2O$ | $K_2O$ | $(NH_4)_2O$ | | |
|---|---|---|---|---|---|---|
| 1. | 48·40 | 1·68 | 43·45 | 5·37 | org. matter *tr.* | = 98·90 |
| 2. | 48·30 | 46·49 | | 5·10 | “ “ *tr.* | = 99·89 |

**Pyr., etc.**—B.B. on platinum foil blackens and fuses with difficulty, leaving a white bead, which is soluble in water and tastes a little saline and bitter. Heated in a platinum crucible becomes first black and then snow-white, not fusing at a high heat (Taylor).

**Obs.**—From the guano beds of the Chincha Islands.

An artificial sulphate of potassium and ammonium was described by Link as early as 1796. According to Lang the salt $10K_2SO_4.(NH_4)_2SO_4$ is isomorphous with potassium sulphate and like that occurs in pseudohexagonal forms, both twins and trillings, Ber. Ak. Wien, **31**, 97, 1858.

**716. THENARDITE.** *J. L. Casaseca*, Ann. Ch. Phys., **32**, 308, 1826. Pyrotechnite *Scacchi*, Mem. Incend. Vesuv., Napoli, 1855. Makite *Adam*, Tabl. Min., 61, 1869.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·5976 : 1 : 1·2524 Bärwald[1].

100 ∧ 110 = 30° $51\frac{3}{4}'$, 001 ∧ 101 = 64° $29\frac{1}{2}'$, 001 ∧ 011 = 51° $23\frac{2}{3}'$.

**Forms**[2]: *c* (001, *O*); *b* (010, *i*-ĭ); *m* (110, *I*); *r* (101, 1-ī) and *e* (011, 1-ĭ)[4] as tw. pl.; *t* (106, $\frac{1}{6}$ ī)[4], *o* (111, 1), *s* (131, 3-3̆).

Angles: *mm‴* = 61° $43\frac{1}{2}'$, *tt′* = 38° $30\frac{1}{2}'$, *rr′* = 128° 59′, *ee′* = 102° 47′, *co* = 67° $43\frac{1}{4}'$, *cs* = 76° 55′, *oo′* = *105° 11′, *oo‴* = *56° 41′, *ss′* = 56° 39′, *ss‴* = 116° 34′.

Twins: tw. pl. (1) *r* (101)[3]; (2) *e* (011), cruciform twins[4] (f. 3), the vertical axes inclined 102° 47′ and 77° 13′. Habit pyramidal, *o* with *c*; also short prismatic (*m*) or tabular with *c* rough and striated.

Cleavage: *c* distinct. Fracture uneven. Brittle. H. = 2–3. G. = 2·68–2·69. Luster vitreous. Color white to brownish. Transparent to translucent.

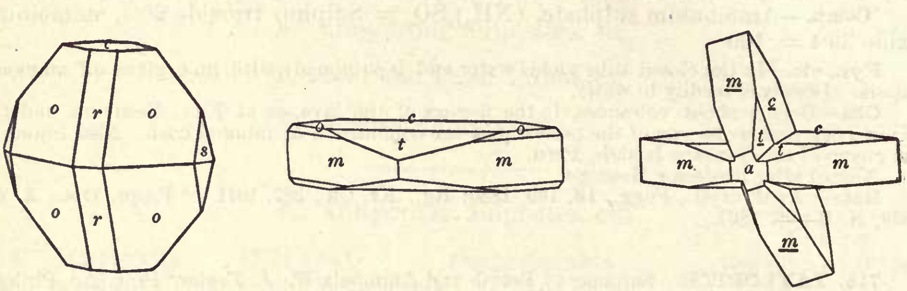
Optically +. Ax. pl. ‖ *c*. Bx ⊥ *a*. Dispersion weak, $\rho > v$ (oil). Axial angles, Bärwald[5]:

$2H_{a.r} = 83° 36'$ Li $2H_{a.y} = 83° 35'$ Na $2H_{a.gr} = 83° 35'$ Tl $\therefore\ 2V_r = 89° 59'$
$2H_{o.r} = 96° 20'$ $2H_{o.y} = 96° 25'$ $2H_{o.gr} = 96° 31'$ $\therefore\ 2V_{gr} = 90° 0\frac{1}{2}'$

Also Des Cloizeaux[6]:

$2E_r = 152° 42'$; and (from $H_a$ and $H_o$) $2V_r = 83° 5'$ $2V_{bl} = 82° 39'$ $\beta_r = 1{\cdot}470$ $\beta_{bl} = 1{\cdot}483$

Thenardite probably goes over to a hexagonal form on heating[7].



Figs. 1, Atacama. 2, 3, California, Ayres.

**Comp.**—Sodium sulphate, $Na_2SO_4$ = Sulphur trioxide 43·7, soda 56·3 = 100.

**Anal.**—1, Dunham, Am. J. Sc., **22**, 204, 1881. 2, Bärwald, l. c., containing a little glauberite. Also 3, Darapsky, Jb. Min., **1**, 66, 1890. Also 5th Ed., p. 616.

| | | $SO_3$ | $Na_2O$ | CaO | |
|---|---|---|---|---|---|
| 1. Arizona | G. = 2·681 | $\frac{2}{2}$ 56·36 | [43·02] | 0·12 | MgO 0·02, Cl 0·10, insol. 0·38 = 100 |
| 2. Aguas Blancas | | 54·34 | 41·91 | 2·66 | $H_2O$ 0·93 = 99·84 |
| 3. Atacama | | 54·24 | 41·66 | 0·23 | $Al_2O_3$ 0·06, $Fe_2O_3$ 0·20, MgO 0·07, Cl 0·36, insol. 2·45, $H_2O$ 0·73 = 100 |

**Pyr., etc.**—Colors the blowpipe flame deep yellow. Wholly soluble in water.

**Obs.**—Often observed in connection with salt lakes, as in Central Asia, Africa, etc.; thus in lakes north of the Caspian; in the Caucasus; on the shores of Lake Balkhash, Central Asia. Also in Spain, at Espartinas, 5 leagues from Madrid and 2½ from Aranjuez. The water exudes during winter from the bottom of a basin, and becoming concentrated in the summer season, deposits crystals of thenardite. Also in S. America in Tarapacá, Chili (called Sal de San Sebastian), also near Aguas Blancas, at Salinas and other points in the desert of Atacama (cf. Darapsky). Also on the scoria of Vesuvius (*pyrotechnite*) of the eruption of 1855; on solution and evaporation, octahedral crystals were obtained by Scacchi with the planes *m*, *r*, *o*, *s*, with *mm'''* = 61° 23', *rr'* = 128° 58', etc.

In the U. S. forms extensive deposits on the Rio Verde, Arizona (anal. 1). In California, at Borax Lake, San Bernardino Co., with hanksite, glauberite, etc. With ulexite, etc., at Rhodes Marsh, Esmeralda Co., Nevada.

Pseudomorphs of calcite or less often quartz after thenardite, in part twins with *r* as tw. pl., occur in volcanic tufa of the hill Rosenegg in the Hegau, southern Würtemberg.

**Ref.**—[1] Aguas Blancas, Zs. Kr., **6**, 36, 1881. The position is that suggested by Hausmann (Pogg., **83**, 577, 1851) to show the isomorphism with the corresponding potash salt; see also Mitsch., Pogg., **12**, 139, 1828 (artif. cryst.); Scc., l. c.: Rg., Kr. Ch., 394, 1881; Mügge, Jb. Min., **2**, 1, 1884. [2] Cf. Scc. [3] Cf. Dx., N. R., 100, 1867, Bärwald, etc. [4] E. F. Ayres, Am. J. Sc., **37**, 235, 1889. [5] On pseudomorphs from the Rosenegg, Leuze, Jahresheft. Ver. Württ., 319, 1889. [6] L. c. [7] Cf. Mügge, l. c.

**Dihydro-thenardite** [J. Russ. Phys.-Ch. Ges., **19**, 252, **22**, 26, 27], Ber. Ch. Ges., **20**, 546 ref., 1887, Jb. Min., **1**, 16 ref., 1890, J. Ch. Soc., **60**, 156, 1891.

Described by Markovnikov as a hydrous sodium sulphate, $Na_2SO_4.2H_2O$, from L. Gori, Gov't Tiflis. Form monoclinic with *c* (001), *m* (110), *l* (210), *p* (111) with $a : b : c = 0{\cdot}4651 : 1 : 0{\cdot}7194$, $\beta = 78° 55'$ Wyrouboff. Cleavage ‖ *c*. Later stated to be only blödite (astrakanite) containing thenardite in considerable amount.

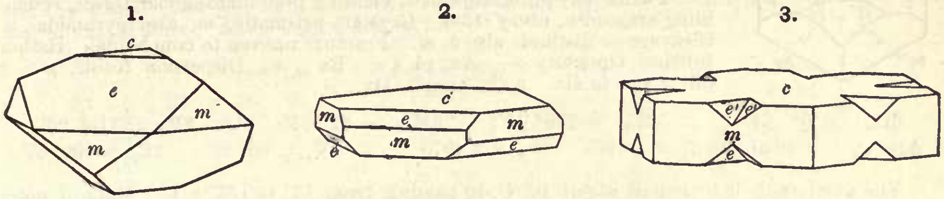
**717. APHTHITALITE.** Vesuvian Salt *Smithson*, Phil. Trans., 256, 1813. Aphthalose *Beud.*, Tr., **2**, 477, 1832. Aphthitalite, *Shepard*, Min., 1, 36, 1835. Aftalosa. Aftalosio, Sofato potassico, *Ital.*

Arcanite *Haid.*, Handb., 492, 1845. Glaserite *Hausm.*, Handb., 1137, 1847. Sulphate of Potash. Schwefelsaures Kali, Kalisulphat, *Germ.* Potasse sulfatée *Fr.*

Rhombohedral. Axis $\dot{c} = 1{\cdot}2839$; $0001 \wedge 10\bar{1}1 = {}^*56° \; 0'$ Mitscherlich[1].

**Forms:** *c* ($0001$, *O*); *m* ($10\bar{1}0$, *I*); *a* ($11\bar{2}0$, *i*-2), *e* ($10\bar{1}2$, $\frac{1}{2}$), *r* ($10\bar{1}1$, *R*), *d* ($01\bar{1}4$, $-\frac{1}{4}$), *ϵ* ($01\bar{1}2$, $-\frac{1}{2}$), *y* ($01\bar{1}1$, $-1$).

**Angles:** $ce = 36° \; 33'$, $ry = 48° \; 59'$, $ee' = 62° \; 6'$, $rr' = 91° \; 46\frac{1}{2}'$.



Figs. 1-3, Douglashall, Bücking.

Occurs in rhombohedral crystals, often thin tabular; also in distorted forms which appear to be orthorhombic in symmetry, and again united in groups resembling the pseudohexagonal twins of aragonite (f. 3), but throughout optically uniaxial (Bkg.). Also in blades made up of aggregated crystals; massive, or imperfectly mammillary, and in crusts.

Cleavage: *m* rather distinct; *c* imperfect. H. = 3–3·5. G. = 2·63–2·656 Bkg. Luster vitreous, inclined to resinous. Color white, sometimes tinged with blue or green. Transparent to translucent, or opaque. Taste saline and bitter, disagreeable. Unalterable in the air. Optically +. Indices:

$\omega = 1{\cdot}493$ $\qquad \epsilon = 1{\cdot}501$ Senarmont (Dx.).
For Na, $\omega = 1{\cdot}4907$ $\qquad \epsilon = 1{\cdot}4993$ Bücking.

**Comp.**—Sulphate of potassium and sodium, $(K,Na)_2SO_4$; if K : Na = 3 : 1, as found by Scc. (l. c.) the percentage composition is: Sulphur trioxide 48·2, potash 42·5, soda 9·3; or, Potassium sulphate 78·6, sodium sulphate 21·4 = 100.

Geserick (quoted by Bücking) found that crystals from Douglashall near Westeregeln, containing 10 to 14 p. c. of sodium chloride as impurity, consisted of $K_2SO_4$ and $Na_2SO_4$ in the ratio of 5 : 2, and 3 : 1. An analysis of the Rocalmuto salt gave Rath, Pogg. Ann., Erg.-Bd., **6**, 360, 1873:

$SO_3$ 49·50 $\qquad$ $K_2O$ 33·24 $\qquad$ $Na_2O$ [17·26] = 100

This corresponds nearly to $4K_2SO_4 + 3Na_2SO_4$.

**Pyr., etc.**—Fuses before the blowpipe without intumescence. Soluble in water.

**Obs.**—Found at Vesuvius, upon lava, in delicate crystallizations, and also in masses an inch or more in thickness. Occurs at Douglashall near Westeregeln in blödite, which with the halite forms a deposit between kainite and halite in the kieserite region. Also at Rocalmuto, Sicily. These crystals were regarded by Rath as orthorhombic, but Strüver shows (Rend. Acc. Linc., **5**, 750, 1889) that it is throughout optically uniaxial and identical with aphthitalite of Scacchi. Bücking earlier proved the same for the Westeregeln crystals as above noted.

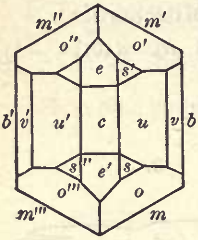
The artificial salt $(K,Na)_2SO_4$ is dimorphous. Cf. Mitscherlich, l. c., or Rg., Kr. Ch., 401, 1881. Scc., Mem. Acc. Napoli, **1**, read May 12, 1863 (Polisimm. Crist., p. 11 *et seq.*), also **5**, Mch. 12, 1870; **6**. Dec. 13, 1873. Rath, Pogg. Erg., **6**, 362, 1873. Mld., Bull. Soc. Min., **5**, 226, 1882; also arcanite beyond.

Named *aphthalose* by Beudant, in 1832, from ἄφθιτος, *unalterable*, and ἅλς, *salt;* and changed, by Shepard, to the less incorrect form from these Greek words, *aphthitalite. Arcanite* of Haidinger was derived from one of its alchemistic names, *Arcanum duplicatum. Glaserite* given by Hausmann in 1847, after the chemist Christoph Glaser (1664), the salt having been early called *Sal polychrestum Glaseri.*

**Ref.**—[1] Artif. cryst., Pogg. Ann., **58**, 468, 1843. The rhombohedral nature of the Vesuvian mineral was shown by Scacchi. Bücking obtained for the Douglashall crystals, $0001 \wedge 10\bar{1}2 = 36° \; 38'$, whence $\dot{c} = 1{\cdot}2879$, Zs. Kr., 15, 561, 1889.

The following description is based upon the artificial potassium sulphate, which thus far has not been identified in nature, although formerly supposed to be represented by the mineral from Rocalmuto.

ARCANITE. Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·5727 : 1 : 0·7464 Mitscherlich.
100 ∧ 110 = 29° 48′, 001 ∧ 101 = 52° 30′, 001 ∧ 011 = 36° 44¼′.



**Forms**: *a* (100, *i*-ī), *b* (010, *i*-ĭ), *c* (001, *O*); *m* (110, *I*), *f* (130, *i*-3̆); *e* (102, $\frac{1}{2}$-ī); *u* (011, 1-ĭ); *v* (021, 2-ĭ), *s* (112, $\frac{1}{2}$), *o* (111, 1).

Angles: $mm'''$ = *59° 36′, $ff'$ = 60° 24′, $ee'$ = 66° 11′, $uu'$ = 73° 28½′, $vv'$ = *112° 22′, $cs$ = 36° 54′, $co$ = 56° 21′, $ss'$ = 62° 49′, $ss'''$ = 34° 43½′, $oo'$ = 92° 29′, $oo'''$ = 48° 52′.

Twins: tw. pl. *m*, repeated, yielding pseudohexagonal forms, resembling aragonite; also *f* (130). Crystals prismatic, *m*, also pyramidal, *o*. Cleavage: *c* distinct; also *b*, *m*. Fracture uneven to conchoidal. Rather brittle. Optically +. Ax. pl. ∥ *a*. Bx ⊥ *c*. Dispersion feeble, $\rho > v$ oil, $\rho < v$ in air. Axial angles, Dx.:

$2H_{a.r}$ = 68° 3½′ ∴ $2E_r$ = 110° 15′; $2H_{a.bl}$ = 67° 31′ ∴ $2E_{bl}$ = 110° 26′
Also $\alpha_y$ = 1·4920 $\beta_y$ = 1·4935 $\gamma_y$ = 1·4970 ∴ $2V_y$ = 66° 30′ $2E_y$ = 109° 57′

The axial angle is increased about 10° C. in passing from 17° to 155°·8 C. Mallard notes that crystals are uniaxial and negative above 650°.

Composition: Potassium sulphate, $K_2SO_4$ = Sulphur trioxide 46·0, potash 54·0 = 100; also $(K,Na)_2SO_4$.

On artif. cryst., Pogg., **18**, 169, 1830; **58**, 468, 1843. Rg., Kr. Ch., 389, 401, 1871; also Baumhauer, Zs. Kr., **12**, 308, 1886, Tf. VI. Cf. also Scc., etc., references under aphthitalite. Dx., Propr. Opt., **2**, 23, 1859; N. R., 98, 1867. See also Mld., on the effect of heat, Bull. Soc. Min., **5**, 219, 1882.

### 718. GLAUBERITE.

Glauberite *Brongniart*, J. Mines, **23**, 5, 1808. Brongniartin *Leonh.*, Handb., 270, 1826.

Monoclinic. Axes $\grave{a} : \bar{b} : \dot{c}$ = 1·21998 : 1 : 1·02749; $\beta$ = 67° 49′ 7″ = 001 ∧ 100 Zepharovich[1].
100 ∧ 110 = *48° 29′ 6″, 001 ∧ 101 = 30° 36′ 54″, 001 ∧ 011 = 43° 34′ 30″.

**Forms**[2]:
*a* (100, *i*-ī)
*c* (001, *O*)
*m* (110, *I*)
*z* (3̄02, $\frac{3}{2}$-ī)
*t* (2̄01, 2-ī)
*f* (023, $\frac{2}{3}$-ì)[5]
*g* (021, 2-ì)[5]
*β* (113, − $\frac{1}{3}$)[6]
*δ* (112, − $\frac{1}{2}$)[5]
*α* (334, − $\frac{3}{4}$)[4]
*ϵ* (445, − $\frac{4}{5}$)[4]
*s* (111, − 1)
*ξ* (661, − 6)[3]
*v* (1̄13, $\frac{1}{3}$)
*u* (1̄12, $\frac{1}{2}$)[3]
*n* (1̄11, 1)
*x* (3̄31, 3)
*e* (3̄11, 3-3)

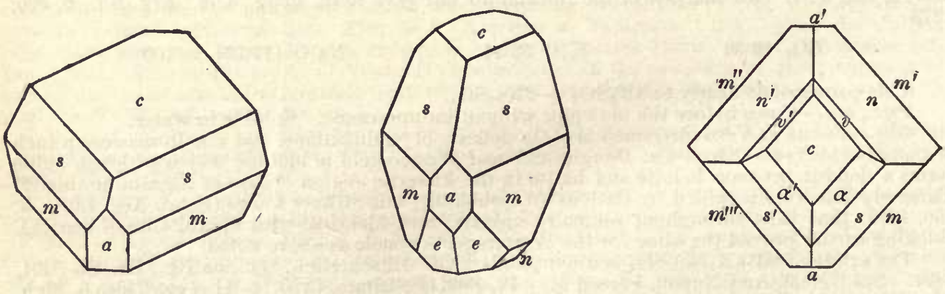


Fig. 1, Common form. 2, Aranjuez, Laspeyres. 3, Westeregeln, after Zepharovich.

$mm'''$ = 96° 58′
$cz$ = 65° 55′
$ct$ = 76° 52′
$ff'$ = 64° 46½′
$gg'$ = 124° 33′
$c\beta$ = 20° 20½′
$c\delta$ = 27° 57′
$c\alpha$ = 36° 41′
$c\epsilon$ = 38° 7′
$cs$ = 43° 2′
$cm$ = *75° 30′ 30″
$ms$ = *32° 28′ 45″
$cv$ = 24° 38½′
$cu$ = 36° 11′
$cn$ = 61° 0′
$cx$ = 89° 17′
$\beta\beta'$ = 31° 11½′
$\delta\delta$ = 42° 31′
$\alpha\alpha'$ = 55° 2′
$\epsilon\epsilon'$ = 57° 2′
$ss'$ = 63° 42′
$nn'$ = 87° 7½′
$ee'$ = 44° 15′

Crystals tabular ‖ *c*, the prism *m* sometimes wanting; also prismatic by extension of *s* (111). Faces *c* and *s* often striated ‖ edges with *c*/*s*.

Cleavage: *c* perfect. Fracture conchoidal. Brittle. H. = 2·5–3. G. = 2·7–2·85. Luster vitreous. Color pale yellow or gray; sometimes brick-red. Streak white. Taste slightly saline.

Optically −. Ax. pl. ⊥ *b*; also ‖ *b*. Axial angles very variable with change of temperature. $Bx_{a.r} \wedge \dot{c} = -31° 3'$, $Bx_{a.y} = -30° 46'$, $Bx_{a.bl} \wedge \dot{c} = -30° 10'$.

The optical character (−) and the position of the axes of elasticity remain sensibly constant between 0° and 100°. The ax. pl., however, at first ⊥ *b* with horizontal dispersion and $v < \rho$ becomes on rise of temperature ‖ *b* with inclined dispersion and $v > \rho$. The axial angle accordingly diminishes to 0° at a temperature depending upon the wave-length and then increases in the new plane. In white light, therefore, the interference-figures are abnormal and change with rise in temperature. Axial angles, Laspeyres[7]:

| | | red (Li) | yellow (Na) | green (Tl) | blue |
|---|---|---|---|---|---|
| At 5° | 2E = | 16° 6′ | 14° 8′ | 11° 42′ | 8° 51′ |
| 22° | “ = | 13° 30′ | 11° 8′ | 8° 14′ | 0° (at 18°) |
| 36° | “ = | 11° 1′ | 8° 9′ | 0° | 8° 42′ |
| 46° | “ = | 8° 40′ | 0° | 7° 8′ | 11° 8′ |
| 58° | “ = | 0° | 7° 14′ | 10° 32′ | 13° 2′ |
| 85° | “ = | 10° 47′ | 13° 14′ | 15° 15′ | 17° 7′ |

**Comp.**—$Na_2SO_4.CaSO_4$ = Sulphur trioxide 57·6, lime 20·1, soda 22·3 = 100; or, Sodium sulphate 51·1, calcium sulphate 48·9 = 100. Analyses agree closely, see 5th Ed., p. 628.

**Pyr., etc.**—B.B. decrepitates, turns white, and fuses at 1·5 to a white enamel, coloring the flame intensely yellow. On charcoal fuses in O.F. to a clear bead; in R.F. a portion is absorbed by the charcoal, leaving an infusible hepatic residue. With soda on charcoal gives the reaction for sulphuric acid. Soluble in hydrochloric acid. In water it loses its transparency, is partially dissolved, leaving a residue of calcium sulphate and in a large excess this is completely dissolved. On long exposure absorbs moisture and falls to pieces.

**Obs.**—In crystals in rock salt at Villa Rubia, near Ocana, in New Castile; also at Aussee, in Upper Austria; Berchtesgaden, in Bavaria; at Douglashall, Westeregeln, also at Leopoldshall, Stassfurt, sometimes in large crystals 3 × 2 inches across; at the salt mines of Vic, in France; at Varengeville, near Nancy, a red variety in salt with polyhalite and anhydrite; with thenardite, hanksite, etc., Province of Tarapacá, Chili, with ulexite; at the Mayo salt mines in Punjab, India. In the volcanic tufa of the hill Rosenegg, Rielasingen, Hegau, crystals changed to calcite.

In crystals in the Rio Verde Valley, Arizona, with thenardite, mirabilite, etc.; the crystals are tabular ‖ *c* with the prism nearly wanting; they are sometimes altered to calcite, cf. Blake, l. c. Borax lake, San Bernardino Co., California.

**Alt.**—Occurs altered to calcite, as above noted.

**Artif.**—On the artificial preparation of glauberite, J. Fritzsche, J. pr. Ch., **72**, 291, 1857; Rg., ibid., **35**, 105, 1887.

**Ref.**—[1] Westeregeln, Ber. Ak. Wien, **69** (1), 16, 1874. [2] Mlr., Min. p. 532, cf. also Zeph., l. c. [3] Senarmont, Iquique, Chili, Ann. Ch. Phys., **36**, 157, 1852. [4] Zeph., l. c. [5] Schimper, Punjab, India, Zs. Kr., **1**, 70, 1877. [6] E. S. D., Arizona, quoted by Blake, Am. J. Sc., **39**, 43, 1890. [7] Lasp., Zs. Kr., **1**, 529, 1877.

Sulphatite. This name has been given to liquid sulphuric acid which is present in water in some volcanic regions and at other points. Cf. 5th Ed., p. 614.

## **Barite Group.** Orthorhombic.

**719. BARITE.** Lapis Bononiensis, Litheosphorus, *F. Licetus*, Utini, 1640; *Mentzel*, in Misc. Ac. N. Cur., 1673, 1674, and Lap. Bon. in obscuro lucens, 1675. (1) Lysesten, Bononiensisksten, Gypsum irregulare, lamellosum, etc., *Wall.*, Min., 56, 1747; (2) Marmor metallicum, Spatum tessulare (G. = 4·266), *id*, 58, 1747. (1) Gypsum spatosum pt., Marmor metallicum, Spatum Bononiense (G = 4·5), Tungspat, *Cronst.*, Min., 21, 1758; (2) Terra calcarea phlogisto et acido vitrioli mixta, Leswersten, Lapis hepaticus, *id.*, 25) 1758. Gypsum ponderosum *v. Born*, Lithoph., 1, 14, 1772. Spath pesant ou séléniteux *de Lisle*, Crist., 1772, with figs.; ib., 1783. Heavy Spar; Bolognian Spar; Cauk, Calk, Cawk, *Derbysh. Miners*, Withering, Phil. Tr., 1784. Schwerspath *Wern.*, etc. Spathum ponderosum = Terra ponderosa vitriolata *Bergm.*, Sciagr., 1782. Sulphate of Baryta. Baryte sulfatée *Fr.* Schwefelsaures Baryt *Germ.* Stangenspath *Wern* Strahlbaryt. Baroselenite *Kirw.*, Min., 1, 136, 1794. Barytite *Delameth.*, T. T., 2, 8,

1797. Baryt *Karst.*, Tab., 38, 75, 1800. Baryte *H.*, Tr., 2, 1801. Barytine *Beud.*, Tr., 441, 1824. Barytes. Michel-lévyte *Lacroix*, C. R., **108**, 1126, 1889. Schwerspath *Germ.* Tungspat *Swed.* Spato pesato *Ital.* Baritina *Ital.*, *Span.*

Hepatit *Karst.*, Tab., 38, 75, 1800; = Lapis hepaticus *Cronst.*, v. supra; = Terr. pond. vit. petroleo imbuta *Bergm.*, Sciagr., 1782; = Leberstein pt. *Germ.*; = Fetid Heavy Spar. Allomorphit *Breith.*, J. pr. Ch., **15**, 322, 1838. Calstronbarite *Shep.*, Am. J. Sc., **34**, 161, 1838. Barytocölestin *Waltersh.*, Pogg., **94**, 137, 1855.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·81520 : 1 : 1·31359$ Helmhacker[1].
$100 \wedge 110 = 39° 11' 13''$, $001 \wedge 101 = 58° 10' 36''$, $001 \wedge 011 = 52° 43' 8''$.

**Forms**$^2$:
*a* (100, $i$-ī)
*b* (010, $i$-ĭ)
*c* (001, *O*)

*τ* (410, $i$-$\bar{4}$)
*β* (310, $i$-$\bar{3}$)
*λ* (210, $i$-$\bar{2}$)
*Π* (530, $i$-$\bar{\tfrac{5}{3}}$)
*η* (320, $i$-$\bar{\tfrac{3}{2}}$)
*h* (540, $i$-$\bar{\tfrac{5}{4}}$)$^8$
*m* (110, *I*)
*N* (230, $i$-$\breve{\tfrac{3}{2}}$)
*n* (120, $i$-$\breve{2}$)
*χ* (130, $i$-$\breve{3}$)
*L* (140, $i$-$\breve{4}$)
*E* (150, $i$-$\breve{5}$)$^{16}$

*K* (109, $\frac{1}{9}$-ī)$^{14}$
*W* (108, $\frac{1}{8}$-ī)
*w* (106, $\frac{1}{6}$-ī)

*σ* (105, $\frac{1}{5}$-ī)
*l* (104, $\frac{1}{4}$-ī)
*g* (103, $\frac{1}{3}$-ī)
*q* (308, $\frac{3}{8}$-ī)$^{12}$
*κ* (205, $\frac{2}{5}$-ī)
*d* (102, $\frac{1}{2}$-ī)
*V* (508, $\frac{5}{8}$-ī)$^{11}$
*Z* (203, $\frac{2}{3}$-ī)
𝔯 (405, $\frac{4}{5}$-ī)$^{15}$
*u*$_1$ (23·0·24, $\frac{23}{24}$-ī)$^3$
*u* (101, 1-ī)
*D* (302, $\frac{3}{2}$-ī)$^4$
*U* (201, 2-ī)$^4$

𝔞 (0·1·12, $\frac{1}{12}$-ĭ)
*α* (018, $\frac{1}{8}$-ĭ)
S (014, $\frac{1}{4}$-ĭ)$^{13}$
*A* (013, $\frac{1}{3}$-ĭ)$^7$
*φ* (012, $\frac{1}{2}$-ĭ)
*y* (023, $\frac{2}{3}$-ĭ)$^{15}$
*B* (056, $\frac{5}{6}$-ĭ)?

*ε* (089, $\frac{8}{9}$-ĭ)?
*o* (011, 1-ĭ)
*i* (021, 2-ĭ)
*Ψ* (031, 3-ĭ)$^{16}$
*x* (041, 4-ĭ)$^9$
*Ω* (051, 5-ĭ)$^{16}$
𝔠 (0·11·2, $\frac{11}{2}$-ĭ)?
𝔰 (071, 7-ĭ)$^{12}$
𝔤 (0·10·1, 10-ĭ)$^6$

*e* (1·1·20, $\frac{1}{20}$)$^6$
*H* (119, $\frac{1}{9}$)
*k* (118, $\frac{1}{8}$)
*P* (116, $\frac{1}{6}$)$^4$
*v* (115, $\frac{1}{5}$)
*q* (114, $\frac{1}{4}$)
*f* (113, $\frac{1}{3}$)
*r* (112, $\frac{1}{2}$)
*R* (223, $\frac{2}{3}$)
𝔷 (334, $\frac{3}{4}$)

*z* (111, 1)
*p* (441, 4)$^6$

*π* (916, $\frac{3}{2}$-$\bar{9}$)$^5$
𝔫 (718, $\frac{7}{8}$-$\bar{7}$)$^3$
𝔩 (14·2·9, $\frac{14}{9}$-$\bar{7}$)$^3$
*X* (15·3·10, $\frac{3}{2}$-$\bar{5}$)$^3$
*δ* (414, 1-$\bar{4}$)
𝔟 (28·7·24, $\frac{7}{6}$-$\bar{4}$)$^3$
*t* (11·3·6, $\frac{11}{6}$-$\frac{11}{3}$)$^5$
*ω* (313, 1-$\bar{3}$)$^3$
*γ* (312, $\frac{3}{2}$-$\bar{3}$)
*Δ* (524, $\frac{5}{4}$-$\bar{\tfrac{5}{2}}$)$^5$
𝔬 (213, $\frac{2}{3}$-$\bar{2}$)$^{12}$
*τ* (324, 3-$\bar{\tfrac{3}{4}}$)$^{12}$
*ν* (212, 1-$\bar{2}$)

𝔡 (344, 1-$\breve{\tfrac{4}{3}}$)$^{12}$
𝔥 (128, $\frac{1}{4}$-$\breve{2}$)$^{16}$
*μ* (124, $\frac{1}{2}$-$\breve{2}$)
*y* (122, 1-$\breve{2}$)

𝔣 (364, $\frac{3}{2}$-$\breve{2}$)
*Σ* (121, 2-$\breve{2}$)
*Λ* (362, 3-$\breve{2}$)
*ι* (136, $\frac{1}{2}$-$\breve{3}$)
*J* (133, 1-$\breve{3}$)
*s* (132, $\frac{3}{2}$-$\breve{3}$)
*Φ* (131, 3-$\breve{3}$)$^3$
𝔪 (276, $\frac{7}{6}$-$\breve{\tfrac{7}{2}}$)$^5$
F (146, $\frac{2}{3}$-$\breve{4}$)$^7$
*ρ* (144, 1-$\breve{4}$)$^5$
*ξ* (142, 2-$\breve{4}$)$^3$
*T* (141, 4-$\breve{4}$)$^3$
*Q* (155, 1-$\breve{5}$)
*ζ* (154, $\frac{5}{4}$-$\breve{5}$)$^5$
*G* (153, $\frac{5}{3}$-$\breve{5}$)$^{7,8}$
*Ξ* (151, 5-$\breve{5}$)$^3$
*Ψ* (166, 1-$\breve{6}$)$^5$
*Θ* (176, $\frac{7}{6}$-$\breve{7}$)$^5$
*Γ* (1·8·12, $\frac{2}{3}$-$\breve{8}$)

The above list includes all common forms and some others. Recent investigations have added a large number to these, some of which can be accepted without question, others are doubtful, and still others are simply vicinal planes. These additions are as follows:

(10·1·0)$^{18}$, (710)$^{18}$, (610)$^{18}$, (740)$^{15}$, (13·7·0)$^{18}$, (320)$^{22}$, (450)$^{20}$, (650)$^{23}$, (7·11·0)$^{18}$, (370)$^{18}$, (130)$^{22}$, (4·11·0)$^{23}$, (290)$^{18}$, (1·22·0)$^{23}$, (1·30·0)$^{23}$, (1·44·0)$^{23}$, (1·50·0)$^{23}$?

(1·0·40)$^{18}$, (1·0·30)$^{18}$, (1·0·13)$^{18}$, (107)$^{18}$, (307)$^{17}$, (19·0·48)$^{18}$, (307)$^{17}$, (22·0·15)$^{18}$, (405)$^7$, (18·0·7)$^{18}$.

(0·2·5)$^{20}$, (0·5·12)$^{18}$, (035)$^{20}$, (079)$^{15}$, (0·16·1)$^{23}$, (0·20·1)$^{23}$.

(1·1·27)$^{18}$, (1·1·25)$^{17}$, (1·1·10)$^{19}$, (117)$^{21}$, (6·6·13)$^{15}$.

(10·1·7)$^{10}$, (56·8·35)$^{10}$, (55·11·30)$^{10}$, (12·4·9)$^{17}$, (11·5·55)$^{12}$, (322)$^{13}$?, (28·16·7)$^{23}$, (455)$^{13}$?, (3·4·10)$^{13}$? (1·2·44)$^{18}$, (1·2·40)$^{17}$, (137)$^{18}$, (159)$^{18}$, (177)$^{17}$, (1·23·20)$^{20}$.

Also other forms in etching-figures, cf. Valentine[22] (36·35·0), (750), (1·0·50), (1·0·20), (905), (22·20·55), (2·21·21).

*ττ'''* = 23° 2'
*ββ'''* = 30° 24'
*λλ'''* = 44° 21'

*ηη'''* = 57° 3'
*mm'''* = *78° 22' 26"
*NN'* = 78° 33'
*nn'* = 63° 3'
*χχ'* = 44° 29'
*LL'* = 34° 6'

*ww'* = 30° 4'
*ll'* = 43° 53'
*gg'* = 56° 29'

*dd'* = *77° 42' 56"
*uu'* = 116° 21'
*UU'* = 145° 31'

*αα'* = 18° 39'
*φφ'* = 66° 36'
*oo'* = 105° 26'
*ii'* = 138° 19'

*ck* = 14° 34'
*cv* = 22° 35'
*cq* = 27° 28'
*cf* = 34° 43'
*cr* = 46° 6'

*cz* = 64° 19'
*cp* = 83° 9'

*cγ* = 68° 14'
*cν* = 60° 7'
*cy* = 57° 1'
*cs* = 64° 50'
*cρ* = 53° 57'
*cQ* = 53° 31'

*vv'* = 34° 37'
*ff'* = 53° 24'
*rr'* = 67° 55'
*zz'* = 88° 37'

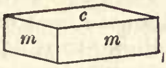
*νν'* = 106° 49'
*yy'* = 52° 2'
*ss'* = 40° 4'

*rr'''* = 54° 10½'
*zz'''* = 69° 25'
*νν'''* = 38° 12'
*yy'''* = 91° 18'
*ss'''* = 113° 49'

*md* = 60° 54'
*mo* = 59° 49'
*do* = 61° 51'

Twins[24]: (1) *m*, only as tw. lamellæ, developed by pressure and producing a structure somewhat similar to that of a triclinic feldspar. (2) (601) also as tw. lamellæ, forming striations on *c* and *m*, the latter inclined about 19° to the vertical edge; (3) *o* (011) as polysynthetic tw. lamellæ, also producing fine striations which on *m* are inclined about 45° to the basal edge. Crystals commonly tabular ∥ *c*, and united in diverging groups having the axis $\bar{b}$ in common; also prismatic, most frequently ∥ axis $\bar{b}$, *d* (102) predominating, but also ∥ axis $\dot{c}$, *m* prominent, or again ∥ $\breve{a}$ with *o* (011) prominent. Rarely apparently hemimorphic[25] in direction of axes

**1.**



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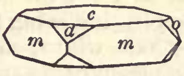

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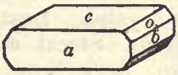

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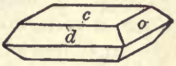

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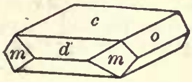

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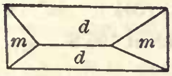

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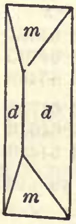

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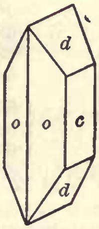

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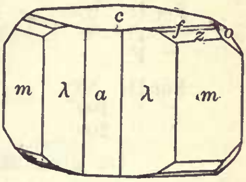

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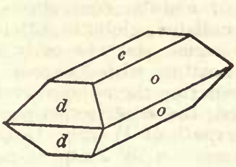
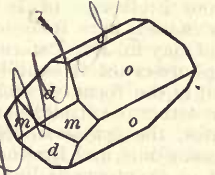


**11.**



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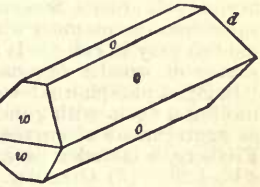

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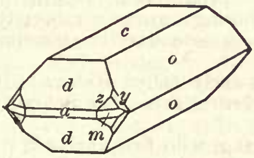
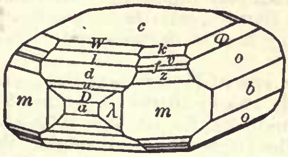
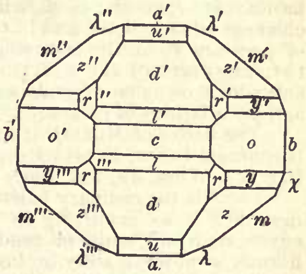


**14.**



**15.**



Figs. 1–8, 10, 11, Simple forms. 9, Buckingham Co., Va. 12, De Kalb, N. Y., Chester. 13, Colorado. 14, Cheshire. 15, Vernasca, Sansoni.

ă (f. 12) or ć, but only as a result of secondary development, not properly a molecular hemimorphism as concluded, after pyroelectrical experiments, by Hankel, and also by Valentin on the ground of the symmetry of the etching-figures. Also in globular forms, fibrous or lamellar, crested; coarsely laminated, laminæ convergent and often curved; also granular, resembling white marble, and earthy; colors sometimes banded as in stalagmite.

Cleavage: *c* perfect; *m* also perfect, fig. 1 the form yielded by cleavage; also *b* imperfect. Fracture uneven. Brittle. H. = 2·5–3·5. G. = 4·3–4·6; 4·486, G. Rose, a pure colorless crystal. Luster vitreous, inclining to resinous; sometimes pearly on *c*, less often on *m*. Streak white. Color white; also inclining to yellow, gray, blue, red, or brown, dark brown. Transparent to translucent to opaque. Sometimes fetid, when rubbed.

Optically +. Ax. pl. ‖ *b*. Bx ⊥ *a*. Refractive indices, etc., Arzruni[26]:

| | | $\alpha$ | $\beta$ | $\gamma$ | 2E | 2V |
|---|---|---|---|---|---|---|
| For C | 20° | 1·63351 | 1·63457 | 1·64531 | | |
| " D | " | 1·63609 | 1·63712 | 1·64795 | 64° 1′ | 37° 28′ |
| " F | " | 1·64254 | 1·64357 | 1·65469 | | |
| For D | 50° | 1·63575 | 1·63678 | 1·64726 | | 38° 43′ |
| " " | 100° | 1·63512 | 1·63612 | 1·64643 | 68° 51′ | 40° 15′ |
| " " | 200° | 1·63344 | 1·63474 | 1·64426 | 77° 16′ (204°) | 44° 18′ |

Dx. gives $2E_r$ = 63° 5′ at 12° C., = 69° 49′ at 95°·5, = 74° 42′ at 195·8°.

**Var.**—1. *Ordinary.* (*a*) Crystals usually broad or stout; sometimes very large, weighing 100 lbs.; again in slender needles. (*b*) *Crested;* massive aggregations of tabular crystals, the crystals projecting at surface into crest-like forms. (*c*) *Columnar;* the columns often coarse (*Stangenspath*) and loosely aggregated, and either radiated (*Strahlbaryt*) or parallel; rarely fine fibrous. Werner's *Stangenspath* was from Freiberg. (*d*) In globular or nodular concretions, subfibrous or columnar within. *Bologna Stone* is here included, being radiated, globular, often reddish gray in color. It is from a bed of clay in Mt. Paterno, near Bologna, and was early a source of wonder because of the phosphorescence it exhibited after heating with charcoal. "Bologna phosphorus" was made from it in the form of sticks, by powdering the mineral and uniting it again with gum. (*e*) Lamellar, either ($\alpha$) straight or ($\beta$) curved; the latter sometimes as aggregations of curved scale-like plates; the *krummschaliger Schwerspath* of Werner, from Freiberg, is included here; it contained some lime, and Breithaupt gives $mm'''$ = 78° 7′ and G. = 4·02–4·29. (*f*) Granular. (*g*) Compact or cryptocrystalline. (*h*) Earthy. (*i*) Stalactitic and stalagmitic; similar in structure and origin to calcareous stalactites and stalagmites and of much beauty when polished.

*Michel-lévyte* from Perkin's Mill, Templeton, Quebec, was described by Lacroix as a monoclinic form of barium sulphate, but shown by the author (Am. J. Sc., **39**, 61, 1890) to be simple barite. It is peculiar in showing a strong pearly luster parallel usually to one face of prismatic cleavage (also to both) and in this direction separates easily into thin laminæ. This is the result of pressure from the inclosing crystalline limestone, which has also produced polysynthetic twinning ‖ *m* (110) and *o* (011). Cf. Bauer[24], who has studied the twinning structure minutely and who shows that crystals standing free in cavities are without these secondary tw. lamellæ and peculiarities of cleavage.

The barite of Muzsaj, Hungary, and of Betler, near Rosenau, was early called *Wolnyn*. It is common barite, in crystals, usually oblong in the direction of the vertical axis. See Schrauf, Ber. Ak. Wien, **39**, 286, 1860; Schmidt, Zs. Kr., **3**, 428, 1879, *et al.*

*Cawk* is the ordinary barite of the Derbyshire lead mines. Withering, who first analyzed it, describes it as occurring in roundish forms, consisting of rhomboidal laminæ confusedly aggregated and white or reddish in color, with G. = 4·330; and a second variety as radiated fibrous, somewhat silky in luster, and at times concentric in structure, yellowish white, and opaque, with G. = 4·00. Greg & Lettsom (1858) confine the term to an opaque earthy variety of the Derbyshire lead mines.

2. *Fetid;* so called from the odor given off when struck or when two pieces are rubbed together, which odor may be due to carbonaceous matters present; a highly fetid variety is obtained in Berks Co., Pennsylvania.

3. *Allomorphite* Breith., a kind having the form and cleavage of anhydrite, and found at Unterwirbach, near Rudolstadt; G. = 4·36–4·48. Probably pseudomorphous; Breithaupt regarded it as a case of dimorphism.

4. *Calcareobarite* Thomson, Min., 1, 105. A white barite from Strontian in Argyleshire, containing, probably as mixture, 6·6 p. c. of lime, and some silica and alumina.

5. *Celestobarite;* the variety containing much strontium sulphate, as that of the Binnenthal, Switzerland, to which von Waltershausen applied the name *barytocelestine;* also from other localities. See further p. 906.

6. *Calstronbarite*, from Schoharie, N. Y., has the aspect of a mere mixture. Shepard made it a compound of *carbonates* of strontium and calcium, with 65·55 p. c. of sulphate of barium, and says it is partly *soluble in hydrochloric acid with effervescence.* Von Hauer found a specimen from Schoharie labeled *calstronbarite* to consist of sulphate alone.

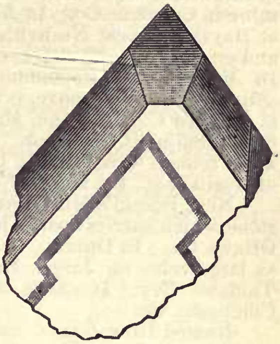
*Schoarite* Adam, Tabl. Min., 62, is a barite containing some 10 p. c. of silica.

**Comp.**—Barium sulphate, $BaSO_4$ = Sulphur trioxide 34·3, baryta 65·7 = 100.

Strontium sulphate is often present, also calcium sulphate and rarely ammonium sulphate (as noted below); further, as impurities, silica, clay, bituminous or carbonaceous substances. Analyses, see 5th Ed., p. 618.

A barite from Pettis Co., Missouri, has been described by Luedeking & Wheeler (Am. J. Sc., **42**, 495, 1891) which showed thin white or yellowish bands parallel to the edges of the tabular crystals (f. 16). These bands consist of a mixture of the sulphates of barium and strontium with small amounts of the sulphates of calcium and ammonium. An analysis of the white barite gave:

16.



Pettis Co., Mo., L. & W.

$BaSO_4$ 87·2 $SrSO_4$ 10·9 $CaSO_4$ 0·2 $(NH_4)_2SO_4$ 0·2 $H_2O$ 2·4 = 100·9

The ammonium sulphate is present to somewhat greater extent in the yellow than in the white kinds.

**Pyr., etc.**—B.B. decrepitates and fuses at 3, coloring the flame yellowish green; the fused mass reacts alkaline with test paper. On charcoal reduced to a sulphide. With soda gives at first a clear pearl, but on continued blowing yields a hepatic mass, which spreads out and soaks into the coal. If a portion of this mass be removed, placed on a clean silver surface, and moistened, it gives a black spot of silver sulphide. Should the barite contain calcium sulphate, this will not be absorbed by the coal when treated in powder with soda. Insoluble in acids.

**Obs.**—Occurs commonly in connection with beds or veins of metallic ores, especially of lead, also copper, silver, cobalt, manganese, as part of the gangue of the ore; also often accompanies stibnite. Sometimes present in massive forms with hematite deposits. It is met with in secondary limestones and sandstones, sometimes forming distinct veins, and in the former often in crystals along with calcite and celestite; in the latter often with copper ores. Sometimes occupies the cavities of amygdaloid, porphyry, etc.; forms earthy masses in beds of marl. Occurs as the petrifying material of fossils and occupying cavities in them, cf. Roth, Allg. Ch. Geol., **1**, 608, 1879.

Barium sulphate as a cement in sandstone occurs near Nottingham. It is deposited by mine-water in boxes and pipes at the coal mines of Newcastle-on-Tyne in layers, white and brown, rather soft; they contain 90 p. c. $BaSO_4$, 8 $SrSO_4$, 1 $CaSO_4$, also $SiO_2$, $Al_2O_3$, $Fe_2O_3$; the mine waters contain some $BaCl_2$. Clowes, Proc. Roy. Soc., **46**, 363, 368, 1889.

At the Dufton and Silverband lead mines, in Westmoreland, England, large transparent crystals occur, sometimes of gigantic dimensions; some were found lying in the mud at the bottom of a cavern, and one weighed 100 lbs. Other English localities are in the Gwennap and Liskeard districts, Cornwall; in Cumberland and Lancashire; in Derbyshire, Staffordshire, etc.—thus beautiful blue crystals come from the Gillfoot hematite mine near Egremont in Cumberland; also Frizington; Cleator Moor; Alston Moor; fine stalactitic at Newhaven; also from Middleton near Matlock, Derbyshire. In Scotland, in Argyleshire, at Strontian; in Perthshire, of a bright yellow color at Ballindean; at the Cumberland lead mine; in Ireland, in thick veins in old red sandstone, at Ballynascreen in Londonderry.

The septaria of Durham, England, which are cut and polished for tables, etc., have the veinings lined with brown heavy spar, adding much to their beauty. Some of the most important of the many European localities are at Felsőbánya, Nagybánya, Schemnitz, and Kremnitz, in Hungary, often with stibnite; Hüttenberg, Carinthia; at Freiberg, Marienberg, in Saxony; Clausthal in the Harz; Příbram, Bohemia; with the manganese ores of Ilefeld, Œhrenstock, etc.; at Royal and Roure in Auvergne.

In the United States, in *N. Hamp.*, at Piermont. In *Mass.*, at Hatfield and Leverett. In *Conn.*, at Cheshire, large crystals, sometimes transparent, intersecting the red sandstone in veins with chalcocite and malachite; at Berlin, Farmington, and Southington. In *N. York*, at Pillar Point, opposite Sackett's Harbor, massive, 2–3 ft. thick, in compact limestone, affording large slabs, beautiful when polished; at Scoharie, a fibrous variety with calcite, the two often mechanically mingled; in St. Lawrence Co., fine tabular or prismatic crystals at De Kalb, the crystals often opaque and earthy white on the surface; at Fowler with hematite, at the Parish ore bed, and on the farm of J. Morse, in Gouverneur, with calcite and hematite, and on the banks of Laidlaw lake in Rossie; the crested variety at Hammond, with crystals of pyrite; at Wolcott, Wayne Co., near the stratum of lenticular iron ore, and on the S. side of the Mohawk, opposite Little Falls.

In *Penn.*, in crystals at Perkiomen lead mine. In *Virginia*, at Eldridge's gold mine in Buckingham Co.; 3 m. S.W. from Lexington, in Rockbridge Co.; a beautiful white variety on the plantation of J. Hord, Esq., Fauquier Co. In *N. Carolina*, a vein of white massive barite occurs at Crowders Mt., Gaston Co.; also another in Madison Co.; in crystals at the Phœnix mine in Cabarrus Co. In *Kentucky*, near Paris, in a large vein. In *Tenn.*, on Brown's Creek; at Haysboro', near Nashville; in large veins in sandstone on the W. end of I. Royale, L. Superior, and on Spar Id., N. shore, one vein (containing also calcite) 14 ft. wide, sometimes in crystals. In *Missouri*, not uncommon with the lead ores; a peculiar variety, containing ammonium sulphate, as noted above, occurs at Smithton and Sedalia, Pettis county; also interesting crystals at the Last Chance mine, Morgan Co.; in earthy form near St. Louis; in concretionary forms at Salina, Saline Co., Kansas. In *Colorado*, at Sterling, Weld Co.; Apishapa Creek; also in El Paso and Fremont Cos. In the Bad Lands of S. Dakota, wine-yellow crystals occupying the cavities of fossils, e.g., the tooth of a Brontotherium. In fine crystals near Fort Wallace, New Mexico.

Near Perkin's Mill, Templeton, Quebec (*Michel-lévyte*, p. 902), embedded in granular limestone which carries apatite in the neighborhood; in a vein cutting Laurentian limestone at Hall, Ottawa Co. In Ontario, in Bathurst, and N. Burgess, Lanark Co.; Galway, Peterborough Co.; as large veins on Jarvis, McKellar's, and Pie islands, in L. Superior, and near Fort William, Thunder Bay. In Nova Scotia, in veins in the slates of East River of the Five Islands, Colchester Co.

Named from *βάρος*, *weight*, or *βάρυς*, *heavy*.

**Alt.**—Occurs altered to calcite, siderite, cerussite, quartz, limonite, hematite, pyrite, psilomelane, göthite.

**Artif.**—Obtained crystallized by Gorgeu from a solution of the sulphate in the fused chloride. Bull. Soc. Min., **10**, 284, 1887.

**Ref.**—[1] Svárov, Denkschr. Ak. Wien, **32**, pt. 2, 1, 1872; the variation for crystals of different localities is not inconsiderable. Cf. Dbr., Pogg., **108**, 440, 1859; Hkr., l. c.; also Kk., Min. Russl., **7**, 25, 58, 1875. This is the common position, which the cleavage makes natural; some authors make the cleavage planes 010 and 101, then $d = 120$, etc.

[2] See Mlr., Min., 529, 1852; Hkr., l.c., and Min. Mitth., 71, 1872; Schrauf, Atlas, Tf. xxx, xxxi, 1872; Kk., l. c.; Trechmann, Min. Mag., **7**, 49, 1886; Gdt., Index, **1**, 279, 1886; Herschenz, ref. [17] below.

[3] Hkr., l. c. [4] Strüver, Val Alvernia, etc., Att. Acc. Torino, **6**, 371, 1871. [5] Schrauf, Přibram, Ber. Ak. Wien, **64**, 199, 1871, and l. c. [6] Schmidt, Telekes, Hungary. Zs. Kr., **6**, 554, 1881. [7] Miers. La Croix, ib., **6**, 600, 1881. [8] Id., ib., **7**, 651. [9] Grünling, Binnenthal, ib., **8**, 243, 1883. [10] Busz, Mittelagger, ib., **10**, 32, 1884. [11] Fényes [Term. Füz., **8**, 288, 1884], Zs. Kr., **10**, 89. [12] Trechmann, Addiewell, Midlothian, l. c. [13] Schmidt, wolnyn, Zs. Kr., **12**, 105, 1886. [14] Beckenkamp, Kaiserstuhl, Zs. Kr., **13**, 25, 1887. [15] Artini, Mem. Acc. Linc., **4**, 89, 1887. [16] Traube, Neurode, Jb. Min., **2**, 69, 1887

[17] Herschenz, Harz, Inaug. Diss., Halle, 1888, and Zs. Nat. Halle, **61**, 143, 1888. [18] Düsing, Zs. Kr., **14**, 481, 1888. [19] Cathrein, Valsugana, Vh. G. Reichs., 107, 1889. [20] Hamberg, Harstig mine, G. För. Förh., **11**, 224, 1889. [21] Graeff, Waldshut. Zs. Kr., **15**, 380, 1889. [22] Valentin, Kronthal, Zs. Kr., **15**, 576, 1889. [23] Brunlechner, Hüttenberg, Min. Mitth., **12**, 62, 1891.

[24] On twinning lamellæ ‖ (601) see Bauer, Jb. Min., **1**, 37, 1887; also ‖ (110) and (011), Id., Perkin's Mill, ibid., **1**, 250, 1891, on massive specimens; the crystals (with the form (0·1·12)) are free from twinning. Gonnard notes crystals crossing with lateral axes at right angles as if twins with tw. pl 9·11·0 (100 $\wedge$ 9·11·0 = 44° 54′), Bull. Soc. Min., **13**, 351, 1890.

[25] On the supposed hemimorphic character, cf. Reuss, Ber. Ak. Wien, **59**, 623, 1869; Chester, Am. J. Sc., **33**, 288, 1887. Cf. Schrauf, Atlas, f. 4, 12, 15. Also Hankel, l. c., and Valentin (and etching-figures), Zs. Kr., **15**, 576, 1889.

[26] *Refractive indices*, Arzruni, Zs. Kr., **1**, 171, 1877. Cf. also Heusser, Pogg., **87**, 462, 1852; Dx., N. R., 43, 1867; Mallard and Chatelier, Bull. Soc. Min., **13**, 123, 1890. On *hardness*, Exner, Unt. Härte, 60, 1873. On constants of *elasticity*, Voigt, Nachr. Ges. Gött., 561, 1887; Niedmann, Zs. Kr., **13**, 362, 1887. *Pyroelectricity*, Hankel, Abh. Sächs. Ges., **10**, 281, 1874.

LEEDSITE *Thomson*. A mixture of $CaSO_4$ 71·9, $BaSO_4$ 28·1, from near Leeds.

DREELITE. Dréelite *Dufrénoy*, Ann. Ch. Phys., **60**, 102, 1835. Dreeit *Glocker*, Syn., 261, 1847.

Supposed to be rhombohedral and in composition between barite and anhydrite, $3BaSO_4.CaSO_4$, with G. = 3·2–3·4. Dufrénoy obtained on analysis:

| $BaSO_4$ | $CaSO_4$ | $CaCO_3$ | $SiO_2$ | $Al_2O_3$ | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 61·73 | 14·27 | 8·05 | 9·71 | 2·40 | 1·52 | 2·31 | = 100 |

Occurs in small unmodified crystals, disseminated on the surface and in the cavities of a quartzose rock, at Beaujeu, France, Dept. of the Rhone; also at Badenweiler, Baden. Named by Dufrénoy after M. de Drée, a liberal patron of science.

Shown by Lacroix (Bull. Soc. Min., **8**, 435, 1885) to be simply barite, the crystals orthorhombic and not rhombohedral.

Eggonite *Schrauf*, Zs. Kr., 3, 352, 1879. Described as occurring in minute crystals resembling barite, but assumed to be triclinic by Schrauf. In composition supposed to be essentially a cadmium silicate. Later shown (priv. contr.) to be simply barite. It occurs on and implanted in crystallized calamine at Altenberg (natural association?), which in turn fills cavities in smithsonite; so called from *ἔγγονος*, *grandson*, as being supposed to be the third generation in the series of zinc-cadmium compounds.

**720. CELESTITE.** Fasriger Schwerspath [=Fibrous Heavy Spar] (fr. Pennsylvania, Pa.) *Schütz*, Beschr. Nordamer. Foss., 12, Leipz., 1791. Schwefelsaurer Strontianit aus Pennsylvanien *Klapr.*, Beitr., **2**, 92, 1797. Strontiane sulfatée (fr. Sicily) (after Vauquelin's anal.) *Dolomieu*, J. Phys., **46**. 203, 1798 (disc. by D. in S. in 1781). Cœlestin *Wern.*, Min. Syst., 1798; *Lenz*, Min., 233, 1800; *Karst.*, Tab., 54, 95, 1808. Sicilianite *Lenz*, Min., 233, 1800. Schützit *Gerhard. G. Karst.*, Tab., 36, 75, 1800. Zölestin *other Germ. orthogr.* Calciocelestine *Wicke*, Arch. Pharm., **152**, 32, .

Barytosulphate of Strontian *Thom.*, Min., **1**, 111, 1836.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}77895 : 1 : 1{\cdot}28005$ Auerbach[1].
$100 \wedge 110 = 37° \ 55'$, $001 \wedge 101 = 58° \ 40\frac{2}{3}'$, $001 \wedge 011 = 52° \ 0\frac{1}{6}'$.

**Forms**[2]:
$a$ (100, $i$-$\bar{i}$)
$b$ (010, $i$-$\breve{i}$)
$c$ (001, $O$)
$\Lambda$ (10·3·0, $i$-$\overline{\frac{10}{3}}$)[7]?
$p$ (210, $i$-$\bar{2}$)
$t$ (530, $i$-$\overline{\frac{5}{3}}$)
$u$ (320, $i$-$\overline{\frac{3}{2}}$)
$\omega$ (750, $i$-$\overline{\frac{7}{5}}$)
$\gamma$ (650, $i$-$\overline{\frac{6}{5}}$)
$m$ (110, $I$)
$n$ (120, $i$-$\breve{2}$)
$\delta$ (108, $\frac{1}{8}$-$\bar{i}$)
$\lambda$ (2·0·11, $\frac{2}{11}$-$\bar{i}$)[4]
$l$ (104, $\frac{1}{4}$-$\bar{i}$)
$\nu$ (207, $\frac{2}{7}$-$\bar{i}$)[4]
$g$ (103, $\frac{1}{3}$-$\bar{i}$)
$d$ (102, $\frac{1}{2}$-$\bar{i}$)
$e$ (304, $\frac{3}{4}$-$\bar{i}$)
$X$ (908, $\frac{9}{8}$-$\bar{i}$)[8]
$k$ (101, 1-$\bar{i}$)
$\xi$ (0·1·12, $\frac{1}{12}$-$\breve{i}$)
$\rho$ (018, $\frac{1}{8}$-$\breve{i}$)
$r$ (015, $\frac{1}{5}$-$\breve{i}$)
$i$ (013, $\frac{1}{3}$-$\breve{i}$)
$h$ (012, $\frac{1}{2}$-$\breve{i}$)
$\zeta$ (023, $\frac{2}{3}$-$\breve{i}$)
$o$ (011, 1-$\breve{i}$)
$\epsilon$ (021, 2-$\breve{i}$)
$\alpha$ (115, $\frac{1}{5}$)
$q$ (114, $\frac{1}{4}$)
$f$ (113, $\frac{1}{3}$)
$s$ (112, $\frac{1}{2}$)[4]
$z$ (111, 1)
$\sigma$ (221, 2)
$V$ (524, $\frac{5}{4}$-$\overline{\frac{5}{2}}$)[8]
$D$ (215, $\frac{2}{5}$-$\bar{2}$)[5]
$v$ (324, $\frac{3}{4}$-$\overline{\frac{3}{2}}$)
$\vartheta$ (124, $\frac{1}{2}$-$\breve{2}$)[6]
$y$ (122, 1-$\breve{2}$)
$\beta$ (121, 2-$\breve{2}$)
$K$ (253, $\frac{5}{3}$-$\frac{5}{2}$)
$w$ (5·12·10, $\frac{6}{5}$-$\frac{12}{5}$)
$x$ (135, $\frac{3}{5}$-$\breve{3}$)
$\psi$ (133, 1-$\breve{3}$)
$\mu$ (132, $\frac{3}{2}$-$\breve{3}$)
$\Theta$ (131, 3-$\breve{3}$)
$\eta$ (277, 1-$\frac{7}{2}$)[4]
$E$ (146, $\frac{2}{3}$-$\breve{4}$)
$\chi$ (144, 1-$\breve{4}$)
$A$ (143, $\frac{4}{3}$-$\breve{4}$)
$\tau$ (142, 2-$\breve{4}$)
$B$ (153, $\frac{5}{3}$-$\breve{5}$)[8]
$L$ (155, 1-$\breve{5}$)[8]
$G$ (169, $\frac{2}{3}$-$\breve{6}$)
$\phi$ (166, 1-$\breve{6}$)
$F$ (187, $\frac{8}{7}$-$\breve{8}$)
$J$ (1·16·24, $\frac{2}{3}$-$\breve{16}$)
$\pi$ (1·16·16, 1-$\breve{16}$)
$H$ (1·24·23, $\frac{24}{23}$-$\breve{24}$)

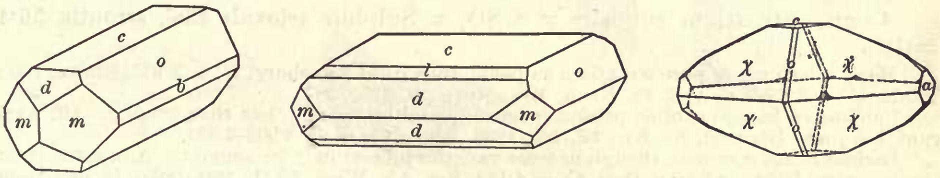
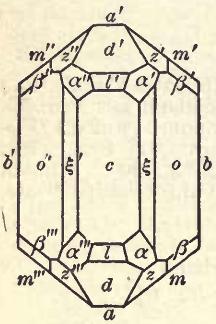

1. 2. 3.

Fig. 1, Sicily. 2, L. Erie. 3, W. Virginia, G. H. Williams (with *b* (010) in front).

$pp''' = 42° \ 34'$
$mm''' = {}^*75° \ 50'$
$nn' = 65° \ 23'$
$ll' = 44° \ 40'$
$gg' = 57° \ 25\frac{1}{2}'$
$dd' = {}^*78° \ 49'$
$kk' = 117° \ 21'$
$\xi\xi' = 12° \ 11'$
$\rho\rho' = 18° \ 11'$
$ii' = 46° \ 13'$
$hh' = 65° \ 14'$
$oo' = 104° \ 0'$
$\epsilon\epsilon' = 137° \ 20'$
$c\alpha = 22° \ 37'$
$cq = 27° \ 30\frac{1}{2}'$
$cf = 34° \ 46\frac{1}{2}'$
$cs = 46° \ 10'$
$cz = 64° \ 21'$
$c\sigma = 76° \ 30'$
$cy = 56° \ 41'$
$c\mu = 64° \ 25'$
$c\tau = 69° \ 36'$
$zz' = 90° \ 40'$
$yy' = 53° \ 40'$
$\mu\mu' = 41° \ 34'$
$\beta\beta' = 61° \ 45'$
$\psi\psi' = 37° \ 16'$
$\chi\chi' = 28° \ 23'$
$\phi\phi' = 19° \ 8\frac{1}{2}'$
$\alpha\alpha''' = 27° \ 20'$
$zz''' = 67° \ 17'$
$yy''' = 89° \ 22'$
$\mu\mu''' = 112° \ 2'$
$\beta\beta''' = 106° \ 9'$
$\psi\psi''' = 96° \ 37'$
$\chi\chi''' = 99° \ 38'$
$md = 59° \ 57'$
$mo = 61° \ 2'$
$do = 61° \ 36'$

Crystals resembling those of barite (q.v.) in habit; commonly tabular ‖ *c* or prismatic ‖ axis *a* or *b*; also more rarely pyramidal by the prominence of the forms *ψ* (133) or *χ* (144); in the latter the faces often rounded and the crystals lenticular in shape (f. 3). Also fibrous and radiated; sometimes globular; occasionally granular.

4.



Herrengrund, after Schrauf.

Cleavage: *c* perfect; *m* nearly perfect; *b* less distinct. Fracture uneven. H. = 3–3·5. G. = 3·95–3·97; 3·959, crystals, Beudant; 3·973 Tharand, Breith.; also below. Luster vitreous, sometimes inclining to pearly. Streak white. Color white, often faint bluish, and sometimes reddish. Transparent to subtranslucent.

Optically +. Ax. pl. ‖ *b*. Bx ⊥ *a*. Axial angles, indices, etc., Arzruni[9]:

| | | α | β | γ | $2E_y$ | 2V |
|---|---|---|---|---|---|---|
| For C, | 20° | 1·61954 | 1·62120 | 1·62843 | | |
| " D, | " | 1·62198 | 1·62367 | 1·62092 | 89° 13′ | 51° 12′ |
| " F, | " | 1·62790 | 1·62960 | 1·63697 | | |
| For D, | 50° | 1·62162 | 1·62346 | 1·63053 | 92° 0′ | 52° 23½′ |
| " | 100° | 1·62107 | 1·62297 | 1·62976 | 95° 44′ | 54° 19′ |
| " | 200° | 1·61958 | 1·62168 | 1·62790 | 105° 26′ | 58° 35′ |

Also, Dx.[10]:

At 20° C. $2E_r = 88° 30'$ $\beta_r = 1·623$ $2E_y = 89° 36'$ $\beta_y = 1·625$ $2E_{bl} = 92° 49'$ $\beta_{bl} = 1·635$
Also $2E_r = 89° 15'$ at 6°·6, 92°·4 at 47°, 93° 42′ at 76°·5, 95° 56′ at 100°·5.

Also (measured), Arzruni[9]:

$2E_r = 87° 2'$ Li $2E_y = 88° 38'$ Na $2E_{gr} = 89° 55\frac{1}{2}'$ Tl

**Var.**—1. *Ordinary.* (*a*) In crystals of varied habit as noted above, and giving varying fundamental angles, cf. ref. [1]; a tinge of a delicate blue is very common and sometimes belongs to only a part of a crystal.

The variety from Montmartre, called *apotome* by Haüy (Min., 2, 33, 1822), was prismatic by extension of *o* (011) and doubly terminated by the pyramid *ψ* (133); his *dioxynite* (p. 35) was similar with also *d* (102), from Meudon.

(*b*) Fibrous, either parallel or radiated. (*c*) Lamellar; of rare occurrence. (*d*) Granular. (*e*) Concretionary. (*f*) Earthy; impure usually with carbonate of lime or clay.

2. *Calciocelestite.* Containing much calcium.

3. *Barytocelestite.* Contains much barium. Cf. below.

**Comp.**—Strontium sulphate = $SrSO_4$ = Sulphur trioxide 43·6, strontia 56·4 = 100.

Many celestites are pure strontium sulphate, thus from Lüneburg, G. = 3·975 Hintze, l. c.; Torda, G. = 3·89–3·94 A. & Fr. Koch, Min. Mitth., 9, 416, 1887.

Calcium is, however, often present in small quantities, usually less than 0·5 p. c. Cf. Arzruni, l. c.; also Bärwald, Zs. Kr., 12, 228, 1886, who gives G. = 3·902–3·931.

Barium is less common, though in some varieties present in large amount. A celestite from Greiner gave Ullik 48·9 p. c. BaO, G. = 4·133, Ber. Ak. Wien, 57 (1), 929, 1868; in one from Lairdsville, N. Y., Chester found 7·28 BaO, 2·01 CaO, Am. J. Sc., 33, 286, 1887. Collie found in Clifton barytocelestite varying amounts of BaO, Min. Mag., 2, 220, 1879. The barytocelestite from Werfen, Salzburg, contains $BaSO_4$ and $SrSO_4$ in the ratio of 4 : 1, Hatle and Tauss., Min. Mitth., 9, 227, 1887.

General analyses, besides those noted above, see 5th Ed., p. 620.

Wittstein attributes the blue color of the celestite of Jena to a trace of iron phosphate.

**Pyr., etc.**—B.B. frequently decrepitates, fuses at 3 to a white pearl, coloring the flame strontia-red; the fused mass reacts alkaline. On charcoal fuses, and in R.F. is converted into a difficultly fusible hepatic mass; this treated with hydrochloric acid and alcohol gives an intensely red flame. With soda on charcoal reacts like barite. Insoluble in acids.

**Obs.**—Celestite is usually associated with limestone, or sandstone of Silurian, Devonian, Jurassic, and other geological formations; occasionally with metalliferous ores, as with galena and sphalerite at Condorcet, France. Occurs also in beds of gypsum, rock salt, and clay; sometimes fills cavities in fossils, e.g., ammonites; and with sulphur in some volcanic regions, sometimes incloses sulphur in crystals, in one case 14 p. c., Johnston-Lavis. Observed as a recent formation at Bourbonne d'Archambault.

Sicily, at Girgenti and elsewhere, affords splendid groups of crystals along with sulphur and gypsum. Fine specimens are met with at Bex in Switzerland, and Conil in Spain; at Dornburg, near Jena, fibrous and bluish; in the department of the Garonne, France; in the Paris basin at Montmartre and elsewhere; in Tyrol; Rezbánya, Hungary; at Northen, Lüneburg, in Hannover; in rock salt, at Ischl, Austria. Also found at Aust Ferry, near Bristol; in trap rocks near Tantallan, in East Lothian; at the Calton Hill, Edinburgh; near Knaresborough, in Yorkshire; at Popayan, U. S. Colombia.

Specimens, finely crystallized, of a bluish tint, are found in limestone about Lake Huron, particularly on Drummond Island, also on Strontian Is., Put in Bay, L. Erie, and at Kingston in Ontario, Canada; Chaumont Bay, L. Ontario, Schoharie, and Lockport, N. Y., have afforded good specimens; also the Rossie lead mine; Depauville and Stark (farm of James Coill), N. Y. A blue fibrous celestite occurs at Bell's Mills, Blair Co., Penn., associated with pearl spar and anhydrite, and this was the celestite taken to Europe by Schütz, and named by Werner after an analysis by Klaproth.

In Mineral Co., W. Virginia, a few miles south of Cumberland, Md., in pyramidal blue crystals up to 3 inches in length, f. 3, also 5–9. They are found in small cavities in an argillaceous limestone used for cement. The cavities apparently represent former concretions, but are now partially empty and in part filled with clay (G. H. Williams, Am. J. Sc., **39**, 183, 1890). In cavities in limestone at Nashville, Tenn. In Brown Co., Kansas, a red variety in large crystals. In Texas, at Lampasas, in very large crystals. At Glen Eyrie, Colorado. In fine clear crystals with the colemanite of Death Valley, San Bernardino Co., California.

In Canada, in crystalline masses at Kingston, Frontenac Co.; Lansdowne, Leeds Co.; in radiating fibrous masses in the Laurentian of Renfrew Co.; also a red variety in dolomite at Caledon, Peel Co.

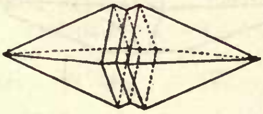
The dark blue fibrous celestite of Jena is peculiarly pleochroic; and its color also varies with the angle between the principal cleavage and the direction of the fibers; the color with the angle 86°, dark blue; 67°, sky-blue; 46°, pale blue (Schmid, Pogg., **120**, 637. 1867).

Named from *cœlestis, celestial,* in allusion to the faint shade of blue often present.

**Alt.**—Pseudomorphs of calcite, occurring in acute pyramidal forms (f. 10, 11) from Obersdorf, near Sangerhausen, Thuringia—the so-called barleycorn (Gerstenkörner) pseudomorphs—have been referred to gay-lussite (Breith.), to celestite, Haüy's apotome (Dx.), gypsum (Kenng.), anhydrite (Groth). They occur as complete crystals, often in interpenetrating groups, up to two inches or more in length, embedded in clay. Color pale yellow, the exterior usually smooth and hard; the interior, cavernous with loosely coherent calcite grains. They have been called *natrocalcite* on the idea that they contained soda.

Similar pseudomorphs, but not all of like origin, have been noted from a number of other localities. For a list of these cf. E. S. D., U. S. G. Surv., Bull. **12**, p. 25, 1884; also Blum, Pseudomorphosen, 18, 1843; Roth, Allg. Ch. Geol., **1**, 201, 1879.

**5.**



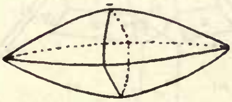
**7.**

**9.**

**10.**

**11.**

**6.**



**8.**

Figs. 5–9, *Celestite,* Mineral Co., W. Va., Williams. 10, 11, Pseudomorphs, Sangerhausen.

The recent discovery by G. H. Williams of celestite in pyramidal crystals (f. 3, also 5–9) resembling closely the pseudomorphs and occurring like them embedded in clay makes it almost certain that Des Cloizeaux's explanation was correct. The apparently related forms from the thinolite of Lake Lahontan (p. 271) cannot, however, be explained in this way.

**Artif.**—Cf. Gorgeu, Bull. Soc. Min., **10**, 284, 1887; Bourgeois, ib., p. 323.

**Ref.**—[1] Bex and Herrengrund, Ber. Ak. Wien, **59** (1), 549, 1869, the axial ratio varies widely for different localities. Cf. Dbr., Pogg., **108**, 447, 1859; Kk., Min. Russl., **5**, 5, 1866; Arzruni, Zs. G. Ges., **24**, 477, 484, 1872.

[2] Cf. Hugard, Ann. Mines, **18**, 3, 1850; Mlr., Min., 527, 1852; Websky, Zs. G. Ges., **9**, 303, 1857; Auerbach, l. c.; Schrauf, Atlas XLVIII, 1877; Gdt., Index, **1**, 447, 1886.

[3] Arzruni, l. c. [4] Schmidt, Zs. Kr., **6**, 99, 1882. [5] Panebianco, Att. Soc. Veneto, **9**, 1, 1884, also (1·0·10) doubtful. [6] Hintze, Lüneburg, also vicinal planes, Zs. Kr., **11**, 220, 1885. [7] Zimányi, Zs. Kr., **17**, 512, 1890. [8] Stuber, Scharfenberg, Saxony, Zs. Kr., **19**, 437, Oct. 1891. [9] Arzruni, Zs. Kr., **1**, 177, 1877. [10] Dx., N. R., 47, 1867; also Bärwald, Zs. Kr., **12**, 228, 1886. *Pyroelectricity,* Hankel, Wied. Ann., **6**, 54, 1879.

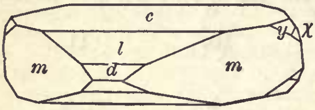
**721. ANGLESITE.** Vitriol de Plomb *Monnet,* Syst. Min., 371, 1779. Plumbum acido vitriolico mineralisatum *Bergm.,* Sciagr., 116, 1782. Lead mineralized by vitriolic acid *Withering,* Trl. Bergm. Sciagr., 1783. Lead mineralized by vitriolic acid and iron (on I. Anglesea "in immense quantities") *Withering,* ib. Vitriol de Plomb (fr. Andalusia) *Proust.,* J. Phys., **30**, 394, 1787. Bleiglas (fr. the Harz) *Lasius*, Beob. Harzgeb., **2**, 355, 1789. Nat. Bleivitriol *Karsten*, Tab., 24, 1791. Lead Vitriol, Sulphate of Lead. Vitriolbleierz *Germ.* Plomb sulfaté *Fr.* Anglesite *Beud.*, Tr., **2**, 459, 1832. Sardinian *Breith.*, B. H. Ztg., **24**, 320, 1865, **25**, 194, 1866.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}78516 : 1 : 1{\cdot}28939$ Koksharov[1].
$100 \wedge 110 = 38^\circ\ 8\tfrac{1}{4}'$, $001 \wedge 101 = 58^\circ\ 39\tfrac{2}{3}'$, $001 \wedge 011 = 52^\circ\ 12\tfrac{1}{4}'$.

**Forms**[2]:
$a$ $(100,\ i\text{-}\bar{\imath})$
$b$ $(010,\ i\text{-}\breve{\imath})$
$c$ $(001,\ O)$
$M$ $(410,\ i\text{-}\bar{4})^6$
$N$ $(310,\ i\text{-}\bar{3})^5$
$\lambda$ $(210,\ i\text{-}\bar{2})$
$P$ $(740,\ i\text{-}\bar{\tfrac{7}{4}})^5$
$i$ $(320,\ i\text{-}\bar{\tfrac{3}{2}})^4$
$Q$ $(430,\ i\text{-}\bar{\tfrac{4}{3}})^5$
$m$ $(110,\ I)$
$T$ $(780,\ i\text{-}\breve{\tfrac{8}{7}})$
$U$ $(790,\ i\text{-}\breve{\tfrac{9}{7}})$
$h$ $(340,\ i\text{-}\breve{\tfrac{4}{3}})$
$\delta$ $(230,\ i\text{-}\breve{\tfrac{3}{2}})$
$V$ $(580,\ i\text{-}\breve{\tfrac{8}{5}})^5$
$n$ $(120,\ i\text{-}\breve{2})$
$\kappa$ $(130,\ i\text{-}\breve{3})$
$W$ $(270,\ i\text{-}\breve{\tfrac{7}{2}})$
$k$ $(1{\cdot}0{\cdot}24,\ \tfrac{1}{24}\text{-}\bar{\imath})^8$
$J$ $(107,\ \tfrac{1}{7}\text{-}\bar{\imath})^7$
$K$ $(106,\ \tfrac{1}{6}\text{-}\bar{\imath})^5$
$l$ $(104,\ \tfrac{1}{4}\text{-}\bar{\imath})$
$e$ $(103,\ \tfrac{1}{3}\text{-}\bar{\imath})^3$
$d$ $(102,\ \tfrac{1}{2}\text{-}\bar{\imath})$
$\alpha$ $(018,\ \tfrac{1}{8}\text{-}\breve{\imath})$
$j$ $(0{\cdot}2{\cdot}11,\ \tfrac{2}{11}\text{-}\breve{\imath})^4$
$B$ $(029,\ \tfrac{2}{9}\text{-}\breve{\imath})^5$
$v$ $(013,\ \tfrac{1}{3}\text{-}\breve{\imath})^4$
$\phi$ $(012,\ \tfrac{1}{2}\text{-}\bar{\imath})$
$x$ $(035,\ \tfrac{3}{5}\text{-}\breve{\imath})^5$
$o$ $(011,\ 1\text{-}\breve{\imath})$
$\vartheta$ $(021,\ 2\text{-}\breve{\imath})$
$\beta$ $(031,\ 3\text{-}\breve{\imath})$
$\theta$ $(116,\ \tfrac{1}{6})$
$f$ $(114,\ \tfrac{1}{4})^5$
$g$ $(113,\ \tfrac{1}{3})^3$
$r$ $(112,\ \tfrac{1}{2})$
$z$ $(111,\ 1)$
$\tau$ $(221,\ 2)$
$\xi$ $(331,\ 3)^5$
$\varDelta$ $(441,\ 4)^{10}$ ?
$\omega$ $(214,\ \tfrac{1}{2}\text{-}\bar{2})$
$\nu$ $(212,\ 1\text{-}\bar{2})$
$p$ $(324,\ \tfrac{3}{4}\text{-}\bar{\tfrac{3}{2}})$
$\mathfrak{t}$ $(435,\ \tfrac{4}{5}\text{-}\bar{\tfrac{4}{3}})^8$
$\mathfrak{e}$ $(892,\ \tfrac{9}{2}\text{-}\bar{\tfrac{9}{8}})^5$
$\mathfrak{n}$ $(781,\ 8\text{-}\bar{\tfrac{8}{7}})^5$
$\mathfrak{h}$ $(561,\ 6\text{-}\bar{\tfrac{6}{5}})^5$
$\mathfrak{q}$ $(8{\cdot}10{\cdot}1,\ 10\text{-}\breve{\tfrac{5}{4}})^5$
$\rho$ $(342,\ 2\text{-}\bar{\tfrac{4}{3}})$
$\mathfrak{o}$ $(7{\cdot}10{\cdot}1,\ 10\text{-}\breve{\tfrac{10}{7}})^5$
$\iota$ $(233,\ 1\text{-}\breve{\tfrac{3}{2}})^6$
$w$ $(128,\ \tfrac{1}{4}\text{-}\breve{2})^4$
$\mu$ $(124,\ \tfrac{1}{2}\text{-}\breve{2})$
$\gamma$ $(123,\ \tfrac{2}{3}\text{-}\breve{2})$
$y$ $(122,\ 1\text{-}\breve{2})$
$t$ $(121,\ 2\text{-}\breve{2})$
$\psi$ $(133,\ 1\text{-}\breve{3})$
$s$ $(132,\ \tfrac{3}{2}\text{-}\breve{3})$
$u$ $(146,\ \tfrac{2}{3}\text{-}\breve{4})^{5,8}$
$\chi$ $(144,\ 1\text{-}\breve{4})$
$\zeta$ $(142,\ 2\text{-}\breve{4})$
$\pi$ $(155,\ 1\text{-}\breve{5})^{4,7}$
$q$ $(166,\ 1\text{-}\breve{6})^7$
$\mathfrak{r}$ $(1{\cdot}12{\cdot}12,\ 1\text{-}\breve{12})^7$

Sella[5] adds the following, observed once only and needing confirmation: 520, 10·9·0, 9·10·0, 1·0·22, 1·0·15, 108, 2·0·15; 0·1·16; 11·12·2, 10·11·2, 9·10·2, 782, 671, 562, 792, 236, 126, 131, 143, 295, 168, 1·10·20, 1·11·13. Also vicinal, 1·0·94[2].

1.



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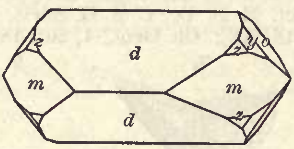

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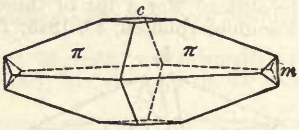

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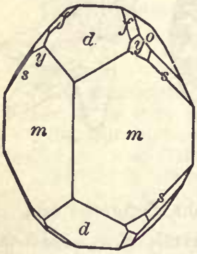

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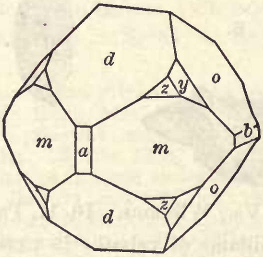

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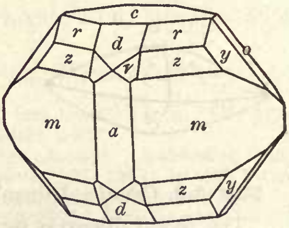

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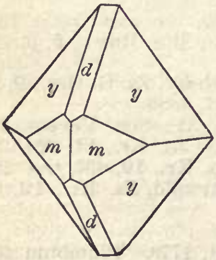

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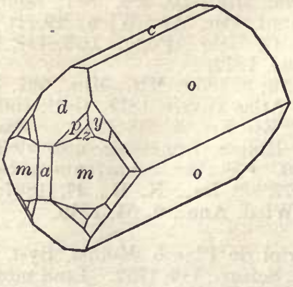

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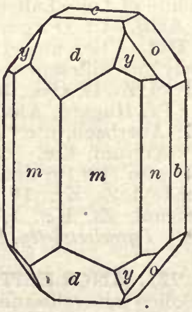


Figs. 1, 5, 8, Phœnixville. 2, Anglesea, Lang. 3, Felsöbánya, Knr. (*b*, 010, in front). 4, 7, Siegen, Lang. 6, 9, Müsen.

$\lambda\lambda'''$ = 42° 52′
$mm'''$ = *76° 16½′
$hh'$ = 87° 23′
$nn'$ = 64° 59′

$ll'$ = 44° 38½′
$dd'$ = 78° 47′

$vv'$ = 46° 31′
$\phi\phi'$ = 65° 37′
$oo'$ = *104° 24½′
$\vartheta\vartheta'$ = 137° 37′

$cr$ = 46° 14′
$cz$ = 64° 24½′
$c\tau$ = 76° 32′
$c\nu$ = 60° 27′
$cp$ = 54° 16′
$cy$ = 56° 48½′
$ct$ = 71° 53′
$cs$ = 64° 33′
$c\zeta$ = 69° 43′

$rr'$ = 69° 13′
$zz'$ = 90° 22′
$\tau\tau'$ = 99° 48′

$yy'$ = 53° 25′
$tt'$ = 61° 24′
$ss'$ = 41° 19′
$\psi\psi'$ = 37° 5½′
$\chi\chi'$ = 28° 15′
$\zeta\zeta'$ = 33° 4′
$\pi\pi'$ = 22° 46′
$qq'$ = 19° 8′

$rr'''$ = 52° 58′
$zz'''$ = 67° 42′
$pp'''$ = 44° 14′

$yy'''$ = 89° 48′
$tt'''$ = 106° 35′
$ss'''$ = 112° 26′
$\psi\psi'''$ = 97° 2′
$\chi\chi'''$ = 100° 3′
$\zeta\zeta'''$ = 126° 43′
$\pi\pi'''$ = 101° 33′

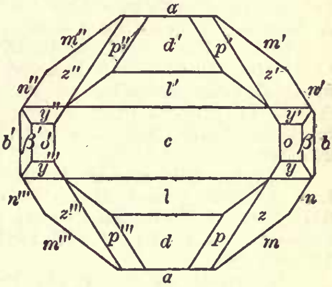
$md$ = 60° 3½′
$mo$ = 60° 47½′
$do$ = 61° 44′

Lang (l. c.) gives a long list of calculated angles.

Crystals sometimes tabular ‖ *c*; more often prismatic in habit, and in all the three axial directions, *m*, *d*, *o*, predominating in the different cases; also thick and stout. Also pyramidal of varied types. Faces *m*, *a* often vertically striated; *d* horizontally. Also massive, granular to compact. Sometimes stalactitic; in nodular forms, often inclosing a nucleus of galena, with concentric structure, being made up of layers of different color.

Cleavage: *c*, *m* distinct, but interrupted. Fracture conchoidal. Very brittle. H. = 2·75–3. G. = 6·12–6·39; 6·35 Phenixville, Smith. Luster highly adamantine in some specimens, in others inclining to resinous and vitreous. Color white, tinged yellow, gray, green, and sometimes blue. Streak uncolored. Transparent to opaque.

10.



Anglesea, after Lang.

Optically +. Ax. pl. ‖ *b*. Bx ⊥ *a*. Ax. angles and indices, Dx.[11]

$2H_{a.r} = 89° 44'$ ∴ $2V_r = 66° 45'$ $2H_{a.y} = 89° 52'$ $2V_y = 66° 47'$ $2H_{a.bl} = 90° 59$

At 15° $\alpha_r = 1·8740$ $\beta_r = 1·8795$ $\gamma_r = 1·8924$ ∴ $2V_r = 66° 40'$
" $\alpha_y = 1·8770$ $\beta_y = 1·8830$ $\gamma_y = 1·8970$ ∴ $2V_y = 60° 50'$

Also, Arzruni[11]:

| | $\alpha$ | $\beta$ | $\gamma$ | 2V | 2V (calc.) from $\alpha$, $\beta$, $\gamma$ |
|---|---|---|---|---|---|
| For C at 20° | 1·86981 | 1·87502 | 1·88630 | | |
| D " | 1·87709 | 1·88226 | 1·89365 | 75° 24′ | 68° |
| F " | 1·89549 | 1·90097 | 1·91263 | | |
| D at 50° | 1·87636 | 1·88166 | 1·89281 | 77° 40′ | 69½° |
| " 100° | 1·87529 | 1·88080 | 1·89134 | 82° 44′ | 72° |
| " 200° | 1·87260 | 1·87833 | 1·88754 | 89° 17′ | 77° |

**Comp.**—Lead sulphate, $PbSO_4$ = Sulphur trioxide 26·4, lead oxide 73·6 = 100. Analyses, 5th Ed., p. 624.

**Pyr., etc.**—B.B. decrepitates, fuses in the flame of a candle (F. = 1·5). On charcoal in O.F. fuses to a clear pearl, which on cooling becomes milk-white; in R.F. is reduced with effervescence to metallic lead. With soda on charcoal in R.F. gives metallic lead, and the soda is absorbed by the coal; when the surface of the coal is removed and placed on bright silver and moistened with water it tarnishes the metal black. Difficultly soluble in nitric acid. Soluble in citrate of ammonia (J. L. Smith). Soluble in 22,816 parts of water of 11° C. (Fresenius). Soluble in 30,062 parts of water (Rodwell).

**Obs.**—First observed by Monnet as a result of the decomposition of galena, and often found in its cavities; also surrounds a nucleus of galena in concentric layers. At Leadhills it occurs, occupying the cubical cavities of galena, or disposed on the surface of the ore; and this locality, and also that of Wanlockhead, formerly afforded large and beautiful crystals, some transparent and several inches in diameter. First found in England at Pary's mine in Anglesea. Occurs also at Melanoweth in Cornwall; in Derbyshire and in Cumberland in crystals; Clausthal, Zellerfeld, and Giezenbach, in the Harz; near Siegen in Prussia; Schapbach and Badenweiler in

Baden; Schwarzenbach and Mies in Carinthia; Felsöbánya and elsewhere in Hungary; Nerchinsk in Siberia; and at Monte Poni, Sardinia in small but perfect transparent crystals; Fondon in Granada; massive in Siberia, Andalusia, Alston Moor in Cumberland; in Australia, whence it is exported by the ton to England. In the Sierra Mojada, Mexico, in immense quantities, mostly massive.

In the United States it occurs in large crystals at Wheatley's mine, Phenixville, Pa.; less well crystallized in Missouri lead mines; at the lead mine of Southampton, Mass.; at Rossie, N. Y.; with galena at the Walton gold mine, Louisa Co., Va. In fine crystals of varied habit at the Mountain View mine, near Union Bridge, Carroll Co., Maryland, associated with galena, also cerussite and native sulphur (G. H. Williams, Johns Hopkins Univ. Bulletin, April, 1891). In Colorado at various points, but less common than cerussite. At the Cerro Gordo mines of California (argentiferous galena), with other lead minerals, also mimetite, chrysocolla, smithsonite, etc. In Arizona, in the mines of the Castle Dome district, Yuma Co., and elsewhere.

Named from the locality, Anglesea, where it was first found by Dr. Withering.

**Alt.**—Anglesite occurs altered to cerussite (lead carbonate); also to a hydrous anglesite, according to Breith. Cf. ref. [6], also Slg., Vh. Ver. Rheinl., **33**, 253, 1876. Pseudomorphs of mimetite (cf. p. 772), perhaps after anglesite from Mexico, are described by Genth and Rath, Proc. Am. Phil. Soc., **24**, 33, 1887.

**Artif.**—Obtained in crystals at a temperature of 300° C. from solution in water (Dr. Sullivan); in lamellar crystals by fusing a mixture of gypsum and common salt, and treating with water; A. Gages. A recent formation at Bourbonnes-les-Bains.

**Ref.**—[1] Min Russl., **1**, 34, 1853, **2**, 167, 1854; cf. Lang, also Dbr., Pogg., **108**, 444, 1859. [2] Cf. Mlr., Min., 526, 1852; Lang, Ber. Ak. Wien, **36**, 241, 1859, an exhaustive monograph with many figures; Helmhacker, ref. under barite, p. 904; Schrauf, Ber. Ak. Wien, **39**, 913, 1860; Atlas, Tf. XI–XV, 1871; Zeph., ibid., **50** (1), 369, 1864; Hbg., Min. Not., **5**, 31, 1863; Sella, Sardinia, Trans. Acc. Linc., **3**, 150, 1879, also Mem. Acc. Linc., **2**, 199, 1885; Gdt., Index, **1**, 205, 1886.

[3] Zeph., Hüttenberg, Lotos, Dec., 1874. [4] Knr., Hungary, Zs. Kr., **1**, 321, 1877. [5] Sella, l. c. [6] Erem., pseud. altered to cerussite, Nerchinsk, Vh. Min. Ges., **18**, 108, 1883, Zs. Kr., **7**, 637, 1883. [7] Franzenau [Term. Füzetek, **8**, 77, 119, 1884], Zs. Kr., **10**, 88, 1884. [8] Liweh, Badenweiler, Zs. Kr., **9**, 498, 1884. [9] Slg., Zs. Kr., **9**, 420, 1884. [10] Cf. Goldschmidt, Zs. Kr., **18**, 287, 1890.

[11] Arzruni, Zs. Kr., **1**, 182, 1877. Cf. also Ramsay, ibid., **12**, 217, 1886; Dx., N. R., pp. 30, 204, 1867. On *Pyroelectricity*, Hankel, Wied. Ann., **6**, 54, 1879.

**722. ANHYDRITE.** Muriazit, Salzsaurer Kalk (fr. Hall, Tyrol) *Abbé Poda*, Fichtel's Min. Aufsätze. Wien, 228, 1794. Würfelspath *Wern.*, 1800, Ludwig's Min., **1**, 51, 166, 1803 = Cube Spar. Soude muriatée gypsifère (of Hall) (from Klapr. anal. in Beitr., **1**, 307, 1795) *H.*, Tr., **2**, 1801. Chaux sulfatée anhydre (fr. Bex) *Vauq.*, *H.*, Tr., **4**, 1801. Anhydrit *Wern.*, 1803, Ludw., **2**, 212, 1804. Würfelgyps *Ludwig*, **2**, 169. Anhydrous Sulphate of Lime, Anhydrous Gypsum. Karstenit *Hausm.*, Handb., 880, 1813.

Gekrösstein (fr. Bochnia and Wieliczka) *Wern.*; Tripe Stone *Engl.*; Pierre de tripes *Fr.*; = Anhydrit *Klapr.*, Beitr., **4**, 231, 1807. Pierre de Vulpino; Marmor Bardiglio di Bergamo; Bardiglione; Chaux sulfatée quartzifère *Vauq.*, *H.*, Tr., **4**, 251, 1801; Siliceous Anhydrous Gypsum. Kieselgyps, Vulpinit, *Ludwig*, **2**, 170, 1804.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}89325 : 1 : 1{\cdot}0008$ Hessenberg[1].

$100 \wedge 110 = 41° \, 46\frac{1}{3}'$, $001 \wedge 101 = 48° \, 15'$, $001 \wedge 011 = 45° \, 1\frac{1}{3}'$.

**Forms**[2]:
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)
*c* (001, *O*)
*w* (105, $\frac{1}{5}$-ī)[2]
*t* (104, $\frac{1}{4}$-ī)[2]

*v* (103, $\frac{1}{3}$-ī)[2]
*e* (205, $\frac{2}{5}$-ī)[3]
*u* (102, $\frac{1}{2}$-ī)[2]
*q* (203, $\frac{2}{3}$-ī)[2]
*β* (509, $\frac{5}{9}$-ī)[4]
*g* (305, $\frac{3}{5}$-ī)[3]

*x* (304, $\frac{3}{4}$-ī)[3]
*l* (405, $\frac{4}{5}$-ī)[2]
*r* (101, 1-ī)
*k* (403, $\frac{4}{3}$-ī)[2]
*χ* (503, $\frac{5}{3}$-ī)[4]
*i* (201, 2-ī)[2]

*h* (502, $\frac{5}{2}$-ī)[2]
*ε* (501, 5-ī)[3]
*d* (012, $\frac{1}{2}$-ĭ)[2,5]
*τ* (045, $\frac{4}{5}$-ĭ)
*s* (011, 1-ĭ)

*μ* (053, $\frac{5}{3}$-ĭ)
*σ* (031, 3-ĭ)
*o* (111, 1)
*n* (121, 2-2̆)
*f* (131, 3-3̆)

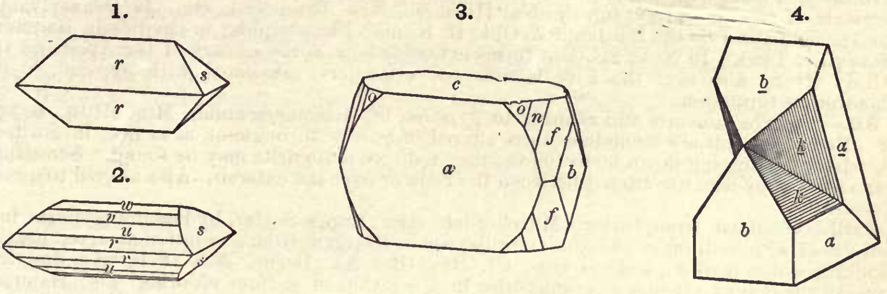
*mm'''* = 83° 33′
*ww'* = 25° 16′
*tt'* = 31° 18′
*vv'* = 40° 57½′
*uu'* = 58° 31′
*qq'* = 73° 31′

*rr'* = 96° 30′
*ii'* = 131° 54′
*dd'* = 53° 10′
*ss'* = 90° 3
*σσ'* = 143° 9½′
*co* = 56° 21′

*cn* = 66° 27′
*cf* = 72° 40′
*oo'* = 76° 45′
*nn'* = 53° 12′
*ff'* = 39° 0′
*bo* = 56° 19′

*bn* = 36° 53′
*bf* = 26° 34′
*oo'''* = 67° 22′
*nn'''* = 106° 14′
*ff'''* = 126° 51′

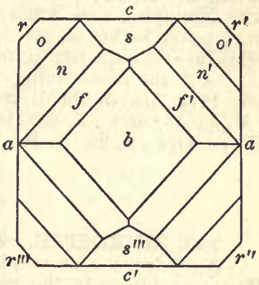
Twins: 1, tw. pl.[5] *d* (012) with $b\underline{b} = 53^\circ\ 10'$ and $k\underline{k}' = 76^\circ\ 29'$ Hbg.; 2, tw. pl. *r* (101) occasionally as tw. lamellæ, which may be developed by heat[6]. Crystals not common, thick tabular, also prismatic ‖ axis $\bar{b}$, often terminated by a horizontally striated brachydome, probably *d* (012) in oscillatory combination[7] with *b*. Also massive, cleavable, and then somewhat resembling an isometric mineral with cubic cleavage; fibrous, lamellar, granular, and sometimes impalpable. The lamellar and columnar varieties often curved or contorted.



Figs. 1, 2, Stassfurt, Hbg. 3, Aussee, Id. 4, Santorin, Id.

Cleavage: in the three pinacoidal directions yielding rectangular fragments but with varying ease, thus, *c* very perfect; *b* also perfect; *a* somewhat less so. Fracture uneven, sometimes splintery. Brittle. H. = 3–3·5. G. = 2·899–2·985; 2·956 Aussee; 2·985 Stassfurt. Luster: *c* pearly, especially after heating in a closed tube; *a* somewhat greasy; *b* vitreous; in massive varieties, vitreous inclining to pearly. Color white, sometimes a grayish, bluish, or reddish tinge; also brick-red. Streak grayish white.

**5.**



Optically +. Ax. pl. ‖ *b*. Bx ⊥ *a*. Axial angles, Grailich[8]:

$2E_r = 71^\circ\ 24'–71^\circ\ 42'$ Dx. $2E_r = 70^\circ\ 18'$ $2E_v = 72^\circ\ 42'$

Indices $\alpha = 1·571$ $\beta = 1·576$ $\gamma = 1·614$ Miller[9]

**Var.**—1. *Ordinary.* (*a*) Crystallized; crystals rare, more commonly massive and cleavable in its three rectangular directions (*Würfelanhydrit* Germ.) as noted above. (*b*) Fibrous; either parallel, radiated or plumose. (*c*) Fine granular. (*d*) Scaly granular. *Vulpinite* is a scaly granular kind from Vulpino in Lombardy; it is cut and polished for ornamental purposes. It does not ordinarily contain more silica than common anhydrite. A kind in contorted concretionary forms is the tripestone (*Gekrösstein* or *Schlangenalabaster*).

2. *Pseudomorphous;* in cubes after rock-salt.

**Comp.**—Anhydrous calcium sulphate, $CaSO_4$ = Sulphur trioxide 58·8, lime 41·2 = 100.

**Pyr., etc.**—B.B. fuses at 3, coloring the flame reddish yellow, and yielding an enamel-like bead which reacts alkaline. On charcoal in R.F. reduced to a sulphide; with soda does not fuse to a clear globule, and is not absorbed by the coal like barite; is, however, decomposed, and yields a mass which blackens silver; with fluorite fuses to a clear pearl, which is enamel-white on cooling, and by long blowing swells up and becomes infusible. Soluble in hydrochloric acid.

One hundred parts of water, at 18·75° C., dissolve 0·2 part of anhydrite. Cf. further under gypsum, p. 935.

**Obs.**—Occurs in rocks of various ages, especially in limestone strata, and often the same that contain ordinary gypsum, and also very commonly in beds of rock-salt. It was first discovered at the salt mine near Hall in Tyrol, by Abbé Poda; and next that of Bex, Switzerland. Other localities are at Aussee, both crystallized and massive, the former sometimes in splendid geodes, the latter brick-red; at Sulz on the Neckar, in Würtemberg; Himmelsberg, near Ilefeld; Andreasberg; Bleiberg in Carinthia; Lüneburg, Hannover; Lauterberg in the Harz; Kapnik in

Hungary; Wieliczka in Poland; Ischl in Upper Austria; Berchtesgaden in Bavaria; at Rienthal and elsewhere in the Alps, crystals, or other cavities. within quartz crystals; Stassfurt, in fine crystals, embedded in kieserite. in cavities in lava at Santorin.

In the U. States, at Lockport, N. Y., fine blue, in geodes of black limestone, accompanied by crystals of calcite and gypsum; also at Hillsboro, New Brunswick, etc. In Pennsylvania, at the Darby Tunnel on the Baltimore & Ohio R. R. near Philadelphia; in cavities in limestone at Nashville, Tenn. In Nova Scotia it forms extensive beds at the estuary of the Avon and the St. Croix rivers, also near the Five Islands and elsewhere, associated with gypsum, in the Carboniferous formation.

**Alt.**—Absorbs moisture and changes to gypsum, cf. Hammerschmidt, Min. Mitth., **5**, 245, 1882 Extensive beds are sometimes thus altered in part or throughout, as at Bex, in Switzerland, where, by digging down 60 to 100 ft., the unaltered anhydrite may be found. Sometimes specimens of anhydrite are altered between the folia or over the exterior. Also altered to quartz and siderite.

**Artif.**—Obtained from fusion (Mitscherlich), also (Hoppe-Seyler) by heating gypsum in a closed vessel with sodium or calcium chloride; again (Gorgeu) from a solution at a red heat in the chlorides of potassium, sodium, etc. Cf. Rose (Ber. Ak. Berlin, 363, 1871), who describes the transformation of gypsum into anhydrite in a solution of sodium chloride; also Hammerschmidt, l.c. Spezia (Att. Acc. Torino, **21**, 912, 1886) shows that, contrary to earlier statements, pressure alone, even up to 500 atmospheres, is not sufficient to cause the formation of anhydrite instead of gypsum.

**Ref.**—[1] Min Not, **10**, 1, 1871. This is the position of Grailich and von Lang, Ber. Ak. Wien, **27**, 25, 1857; with Mlr. and Dx., $a = 100$, $b$ (above) $= 001$, $c = 010$, $r = 110$, $f = 113$; with Naumann and Schrauf, $a = 001$, $b = 100$, $c = 010$, $r = 011$, $f = 311$. The dissimilarity in cleavage makes an attempt to obtain correspondence in angle between this species and barite, celestite and anglesite quite unsatisfactory.

[2] Cf. the monograph of Hbg.; he adds as probable 706, 708, 067. [3] Mlr., Phil. Mag., **47**, 124, 1874; also doubtful 021, 023. [4] Groth, Min.-Samml., 141, 1878. [5] Hbg., Santorin, l. c. [6] Mgg., Jb. Min., **2**, 258, 1883. [7] Vater, Stassfurt, Zs. Kr., **10**, 390, 1885. [8] Grailich, l. c., Dx., Propr. Opt., **2**, 23, N. R., 70, 1867. [9] Mlr., Phil. Mag., **19**, 177, 1841, also cf. l. c., 1874.

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**723. ZINKOSITE.** Zinkosit *Breith.*, B. H. Ztg., **11**, 100, 1852. Almagrerite.

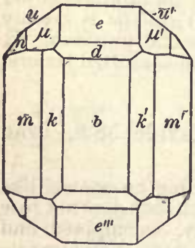
Anhydrous zinc sulphate, $ZnSO_4$, according to Breithaupt, occurring at the mine of Barranco Jaroso in the Sierra Almagrera, Spain. In crystals isomorphous with anglesite and barite. G. = 4·331. Needs confirmation.

Artificial crystals of $ZnSO_4$, with 001, 101, 011, gave de Schulten: $101 \wedge 10\bar{1} = 64° 32'$, $011 \wedge 01\bar{1} = 70° 33'$. G. = 3·74. Ax. pl. ∥ $b$. C. R., **107**, 405, 1888.

**724. HYDROCYANITE.** Idrociano *A. Scacchi*, Note Min., **1**, p. 26, 1873; from Atti Accad. Sci. Napoli, **5**, read March 12, 1870. Hydrocyan.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·7971 : 1 : 1·1300$ A. Scacchi[1].

$100 \wedge 110 = 38° 33\frac{1}{2}'$, $001 \wedge 101 = 54° 48'$, $001 \wedge 011 = 48° 29\frac{1}{2}'$.



After Scacchi.

**Forms:**
*b* (010, *i*-ĭ)
*m* (110, *I*, 1, Scc.)
*k* (120, *i*-$\bar{2}$)
*u* (102, $\frac{1}{2}$-ĭ)
*e* (012, $\frac{1}{2}$-ĭ)
*d* (011, 1-ĭ)
*μ* (112, $\frac{1}{2}$)
*n* (212, 1-$\bar{2}$)

$mm''' = 77° 7'$
$kk' = 64° 12'$
$bk = {}^*32° 6'$
$uu' = 70° 39\frac{1}{2}'$
$ee' = 58° 56'$
$be = {}^*60° 32'$
$dd' = 96° 59'$
$\mu\mu' = 63° 21\frac{1}{2}'$
$\mu\mu'' = 84° 23'$
$\mu\mu''' = 49° 30'$
$nn' = 101° 58'$
$nn'' = 113° 32'$
$nn''' = 36° 5'$

Color pale green, brownish or yellowish, also sky-blue. Translucent.

**Comp.**—Cupric sulphate, $CuSO_4$ = Sulphur trioxide 50·3, cupric oxide 49·7 = 100.

**Anal.**—Scacchi, l. c.

$SO_3$ 50·30 CuO 49·47 = 99·77

**Pyr., etc.**—Completely soluble in water. Effloresces very readily in contact with the air. When preserved in the matrix untouched the crystals will remain two or three days without sensible alteration, but upon being detached, or even touched, they change color almost immediately. In the alteration the crystals first show a blue color, then split to pieces slowly, and separate into minute granules, which seem to be crystals, though too small to allow of their form being determined. The cause of the efflorescence in this case is the absorption of the water from the atmosphere, not the loss of water, as is generally true. The change when complete results in the production of chalcanthite.

**Obs.**—Found at Vesuvius, having been produced by sublimation at the time of the eruption of October, 1868. The name is derived from *ὕδωρ*, *water*, *κύανος*, *azure blue*, in allusion to the change of color noted above.

**Ref.**—[1] L. c.; the position here taken is that which brings out the relation in form to barite, etc.

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**725. CROCOITE.** Nova minera Plumbi *J. G. Lehmann*, Acad. Petrop., 1766; Pallas, Voyages, **2**, 235, 1770. Minera Plumbi rubra *Wall.*, Min., 1778. Rothes Bleierz *Wern.*, Auss. Kennz., 296, 1774. Plomb rouge *Macquart*, J. Phys., **34**, 1789; *Vauquelin*. Bull. Soc. Philomath., and J. Phys., **45**, 393, 1794, **46**, 152, 311, 1798. Plomb chromaté *H.*, Tr., **3**, 1801. Chromate of Lead. Chromsaures Blei, Bleichromat, Chrombleispath, *Germ.* Kallochrom *Hausm*, Handb., 1086, 1813. Crocoise *Beud.*, Tr., **2**, 669, 1832. Crocoisit *Kbl.*, Grundz., 282, 1838. Krokoit *Breith.*, Handb., **2**, 262, 1841. Lehmannite *B. & M.*, 557, 1852.

Monoclinic. Axes $\grave{a} : \bar{b} : \dot{c} = 0·960342 : 1 : 0·915856$; $\beta = 77° 32' 50'' =$ 001 ∧ 100 Dauber-Koksharov[1].

100 ∧ 110 = 43° 9′ 36′, 001 ∧ 101 = 37° 40′ 57″, 001 ∧ 011 = 41° 48′ 23″.

**Forms**[2]:
*a* (100, *i*-$\bar{\imath}$)
*b* (010, *i*-$\grave{\imath}$)
*c* (001, *O*)

*α* (310, *i*-$\bar{3}$)
*d* (210, *i*-$\bar{2}$)
*g* (320, *i*-$\bar{\frac{3}{2}}$)[3]
*m* (110, *I*)
*ζ* (350, *i*-$\grave{\frac{5}{3}}$)
*f* (120, *i*-$\grave{2}$)

*h* (101, — 1-$\bar{\imath}$)
*ρ* (502, — $\frac{5}{2}$-$\bar{\imath}$)

*n* (401, — 4-$\bar{\imath}$)
*χ* (801, — 8-$\bar{\imath}$)
*k* ($\bar{1}$01, 1-$\bar{\imath}$)
*x* ($\bar{3}$01, 3-$\bar{\imath}$)
*l* ($\bar{4}$01, 4-$\bar{\imath}$)
*ϵ* ($\bar{5}$01, 5-$\bar{\imath}$)
*ϑ* ($\bar{6}$01, 6-$\bar{\imath}$)

*w* (012, $\frac{1}{2}$-$\grave{\imath}$)
*z* (011, 1-$\grave{\imath}$)
*y* (021, 2-$\grave{\imath}$)

*t* (111, — 1)
*π* (221, — 2)

*ϑ* (331, — 3)
*s* (441, — 4)
*λ* ($\bar{1}$12, $\frac{1}{2}$)
*γ* ($\bar{2}$23, $\frac{2}{3}$)
*v* ($\bar{1}$11, 1)

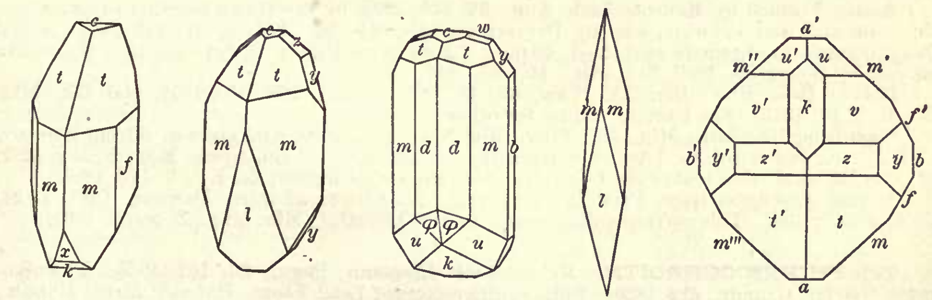
*e* (11·1·1, — 11-$\bar{1}\bar{1}$)
*ψ* (911, — 9-$\bar{9}$)
*G* (812, — 4-$\bar{8}$)
*N* (711, — 7-$\bar{7}$)
*η* (412, — 2-$\bar{4}$)
*q* (12·4·1, — 12-$\bar{3}$)
*L* (2·1·10, — $\frac{1}{5}$-$\bar{2}$)

*g* (841, — 8-$\bar{2}$)
*Q* (953, — 3-$\bar{\frac{9}{5}}$)
*H* (435, — $\frac{4}{5}$-$\bar{\frac{4}{3}}$)
*δ* (11·10·1, — 11-$\bar{\frac{11}{10}}$)

*p* ($\bar{1}\bar{3}$·1·5, $\frac{13}{5}$-$\bar{1}\bar{3}$)
*τ* ($\bar{9}$11, 9-$\bar{9}$)
*r* ($\bar{6}$12, 3-$\bar{6}$)
*A* ($\bar{5}$11, 5-5)
*R* ($\bar{1}\bar{8}$·4·1, 18-$\bar{\frac{9}{2}}$)
*ξ* ($\bar{4}$11, 4-$\bar{4}$)
*β* ($\bar{3}$12, $\frac{3}{2}$-$\bar{3}$)
*φ* ($\bar{3}$11, 3-$\bar{3}$)

*F* ($\bar{6}$21, 6-$\bar{3}$)
*Y* ($\bar{9}$31, 9-$\bar{3}$)
*B* ($\bar{5}$21, 5-$\bar{\frac{5}{2}}$)
*u* ($\bar{2}$11, 2-$\bar{2}$)
*E* ($\bar{3}$28, $\frac{3}{8}$-$\bar{\frac{3}{2}}$)
*o* ($\bar{8}$·7·10, $\frac{4}{5}$-$\bar{\frac{8}{7}}$)

*M* (6·10·9, — $\frac{10}{9}$-$\grave{\frac{5}{3}}$)
*σ* (352, — $\frac{5}{2}$-$\grave{\frac{5}{3}}$)
*i* (123, — $\frac{2}{3}$-$\grave{2}$)
*μ* (154, — $\frac{5}{4}$-5)
*D* ($\bar{2}$65, $\frac{6}{5}$-$\grave{3}$)



Figs. 1–5, after Dauber; 1–3, Siberia; 4, Brazil.

Dauber adds the following as *probable:* 230, 601, 443, $\bar{6}$65, 10·3·4, 16·5·4, 532, 852, 652, $\bar{5}$12, $\bar{9}$22, $\bar{1}\bar{1}$·3·4, $\bar{7}$22, $\bar{9}$32, $\bar{1}\bar{3}$·5·2, $\bar{1}\bar{2}$·5·4, $\bar{1}\bar{5}$·7·5, 532, $\bar{1}\bar{3}$·8·6, $\bar{1}\bar{1}$·10·10, $\bar{7}$83, $\bar{3}$·4·12, $\bar{3}$48, $\bar{5}$88, $\bar{1}$23, $\bar{3}$·8·12; and the following as *doubtful:* 530, 450, 340, 380, 501, $\bar{8}$03, $\bar{7}$02, 085, 554, 332, 11·3·1, 13·5·1, 12·9·4, $\bar{1}\bar{3}$·1·4, $\bar{1}\bar{2}$·1·4, $\bar{1}\bar{5}$·2·3, $\bar{7}$13, $\bar{2}\bar{1}$·3·5, $\bar{1}\bar{8}$·3·4, $\bar{1}\bar{7}$·5·4, $\bar{4}$16, $\bar{1}\bar{2}$·3·2, $\bar{1}\bar{1}$·5·1, $\bar{7}$43, $\bar{1}\bar{0}$·9·10, $\bar{1}\bar{1}$·10·6, 456, $\bar{3}$62.

$\alpha\alpha'''$ = 34° 43'
$dd'''$ = 50° 14½'
$mm'''$ = 86° 19'
$ff'$ = 57° 8'

$cn$ = 63° 56'
$ck$ = 49° 32'
$cx$ = 82° 11½'
$cl$ = 87° 16'

$ww'$ = 48° 11'
$zz'$ = 83° 37'
$yy'$ = 121° 35'

$ct$ = 46° 58'
$c\vartheta$ = 67° 20½'
$cs$ = 70° 34'
$cm$ = 80° 57'

$c\lambda$ = 35° 44'
$cv$ = 58° 24'

$at$ = 48° 33'
$a'v$ = 60° 52'

$tt'$ = 60° 50'
$\vartheta\vartheta'$ = 79° 28'
$ss'$ = 81° 34'

$qq'$ = 34° 0'
$vv'$ = 72° 18'
$uu'$ = 49° 12'
$a'u$ = 38° 3'
$\beta\beta'$ = 32° 1'
$m'l$ = 45° 15'
$mu$ = 106° 50'

Crystals usually prismatic (*m*, rarely *t* (111)), but habit very varied; sometimes resembling acute rhombohedral forms (f. 4). Faces mostly smooth and brilliant; *m* vertically striated. Also imperfectly columnar and granular.

Cleavage: *m* rather distinct; *c*, *a* less so. Fracture small conchoidal to uneven. Sectile. H. = 2·5–3. G. = 5·9–6·1. Luster adamantine to vitreous. Color various shades of bright hyacinth-red. Streak orange-yellow. Translucent.

Optically +. Ax. pl. ‖ *b*. $Bx_a \wedge \dot{c} = +5° 30'$. Dispersion inclined, very large (oil). Axial angle large:

$2H_r = 97° 35$ $2H_y = 97° 0'$ $n_y = 1·468$ ∴ $2V_y = 54° 3'$ $\beta_y = 2·42$ approx., Dx.[4]

**Comp.**—Lead chromate, $PbCrO_4$ = Chromium trioxide 31·1, lead protoxide 68·9 = 100.

**Anal.**—1, Bärwald, Zs. Kr., **7**, 170, 1883. Also Pfaff, Berzelius, 5th Ed.

1. Berezov $CrO_3$ 31·16 PbO 68·82 = 99·98

Vauquelin discovered the metal *chromium* in this mineral in 1797.

**Pyr., etc.**—In the closed tube decrepitates, blackens, but recovers its original color on cooling. B.B. fuses at 1·5, and on charcoal is reduced to metallic lead with deflagration, leaving a residue of chromium oxide, and giving a lead coating. With salt of phosphorus gives an emerald-green bead in both flames.

**Obs.**—First found at Berezov, in crystals in quartz veins, or intersecting gneiss or granite; also occurs at Mursinka and near Nizhni Tagilsk in the Ural, in narrow veins, traversing decomposed gneiss, and associated with gold, pyrite, galena, quartz, and vauquelinite; in Brazil, at Congonhas do Campo, in fine crystals in decomposed granite; at Rezbánya in Hungary, at the mine of St. Anthony; Moldawa in Hungary; on Luzon, one of the Philippines, whence crystals were received by J. D. Dana in 1842, from El Señor Roxas of Manila, and understood to be from the northern peninsula of Luzon; according to Dr. Hochstetter, at the mines of Labo, in the Province of North Camarines, on the southeastern peninsula of Luzon (Dauber). Occurs in limited quantities with vanadinite, wulfenite, etc., in some of the mines of the Vulture district, Maricopa Co., Arizona.

This species was first noticed by Lehmann (l.c.). The name *Crocoite* is from κρόκος, *saffron*. Berthier, in 1832, gave the word the bad form *Crocoise*, which von Kobell altered, in 1838, to *Crocoisite*, and Breithaupt, in 1841, to *Crocoite* (Krokoit), and v. Kobell also to this last-mentioned form in his later works.

**Artif.**—Formed by Manross (Lieb. Ann., **82**, 359, 1852) by the fusion together of potassium chromate and lead chloride; also by Drevermann (ib., **89**, 36, 1854) by the diffusion method using potassium chromate and lead nitrate. Also more simply in crystals like the native mineral by Bourgeois, Bull. Soc. Min., **10**, 187, 1887.

**Ref.**—[1] Ural. Dbr., Ber. Ak. Wien, **42**, 19, 1860; Pogg., **106**, 150, 1859, and Kk., Min. Russl., **7**, 97, 1875. See Dbr. for values for other localities.

[2] See Dbr., l. c.; Mlr., Min., 557; Hbg., Min. Not., **3**, 27, 1860, who gives $\alpha$, $\beta$ from Berezov. [3] Mlr., l. c., not noted by Dbr., but requiring confirmation. [4] Bull. Soc. Min., **5**, 103, 1882; Cf. also Bärwald, who makes the refractive index somewhat higher, Zs. Kr., **7**, 170, 1882.

A lead chromate from Pretoria, Transvaal, S. Africa, afforded Dawson: $CrO_3$ 25·24, PbO 74·76 = 100. This corresponding nearly to $4PbO.3CrO_3$. Min. Mag., **6**, xviii, 1885.

**726. PHŒNICOCHROITE.** Melanochroit *Hermann*, Pogg., **28**, 162, 1833. Phœnikochroit *Glocker*, Grundr., 612, 1839. Subsesquichromate of Lead *Thom.* Phönicit *Haid.*, Handb., 504, 1845.

Orthorhombic? Crystals usually tabular, and reticularly interwoven. Also massive.

Cleavage in one direction, perfect. H. = 3–3·5. G. = 5·75. Luster resinous or adamantine, glimmering. Color between cochineal- and hyacinth-red; becomes lemon-yellow on exposure. Streak brick-red. Subtranslucent to opaque.

**Comp.**—A basic lead chromate, $3PbO.2CrO_3$ = Chromium trioxide 23·2, lead protoxide 76·8 = 100.

**Anal.**—Hermann, l. c.

$CrO_3$ 23·31 PbO 76·69 = 100

**Pyr., etc.**—B.B. on charcoal fuses readily to a dark mass, which is crystalline when cold. In R.F. on charcoal gives a coating of lead oxide, with globules of lead and a residue of chromium oxide. Gives the reaction for chromium with fluxes. Dissolves in hydrochloric acid with the separation of lead chloride.

**Obs.**—Occurs in limestone at Berezov in the Ural, with crocoite, vauquelinite, pyromorphite, and galena.

Named *Melanochroite* by Hermann, from *μέλας, black*, and *χρόα, color*. But, as the color is red, and not black, and the name is therefore false to the species, Glocker changed it to *Phœnicochroite*, from *φοίνικος, deep red*, and *χρόα*; and in this he is followed by Hausmann. The abbreviated form *phœnicite* is bad, because it is too much like the name of another mineral, *phenacite*.

**Artif.**—Meunier obtained phœnicocroite by the action of a solution of potassium dichromate on galena, C. R., **87**, 656, 1878. Cf. earlier, Drevermann, Lieb. Ann., **89**, 36, 1854.

**727. VAUQUELINITE.** Vauqueline *Berz.*, Afh., **6**, 246, 1818. Vauquelinite *Berz.*, N. Syst. Min. Paris, 202, 1819. Chromate of Lead and Copper *Phillips*. Laxmannite *A. E. Nordenskiöld*, Öfv. Ak. Stockh., **24**, 655, 1867; Pogg. Ann., **137**, 299, 1869. Phosphochromite *Hermann*, J. pr. Ch., **1**, 447, 1870.

Monoclinic. Axes $\grave{a} : \bar{b} : \dot{c} = 0·74977 : 1 : 1·39083$; $\beta = {}^*69° 3' = 001 \wedge 100$ Koksharov[1].

$100 \wedge 110 = 35° 0'$, $001 \wedge \bar{1}01 = {}^*79° 0'$, $001 \wedge 011 = 52° 24\frac{1}{3}'$.

**Forms**[2]:
*a* (100, $i$-$\bar{i}$)
*c* (001, *O*)
*s* (410, $i$-$\bar{4}$)
*w* (940, $i$-$\frac{9}{4}$)?
*z* (320, $i$-$\frac{3}{2}$)
*m* (110, *I*)
*f* (120, $i$-$\grave{2}$)
*g* (370, $i$-$\frac{7}{3}$)?
*e* (102, $-\frac{1}{2}$-$\bar{i}$)
*x* (304, $-\frac{3}{4}$-$\bar{i}$)
*n* ($\bar{1}02$, $\frac{1}{2}$-$\bar{i}$)
*p* ($\bar{3}04$, $\frac{3}{4}$-$\bar{i}$)
*h* ($\bar{1}01$, 1-$\bar{i}$)
*d* (011, 1-$\grave{i}$)
*u* ($\bar{9}31$, 9-$\bar{3}$)?
*y* ($\bar{1}46$, $\frac{2}{3}$-$\grave{4}$)

$ss''' = 19° 51\frac{1}{2}'$
$zz''' = 50° 3'$
$mm''' = {}^*70° 0'$
$ff' = 71° 3\frac{1}{2}'$
$ce = 33° 2\frac{1}{2}'$
$cx = 40° 57'$
$cn = 52° 21'$
$cp = 68° 51'$
$dd' = 104° 49'$
$cu = 72° 49'$
$cy = 45° 44\frac{1}{2}'$
$uu' = 26° 47'$
$yy' = 85° 36'$

Twins: tw. pl. *e* (102)[3]. Crystals usually minute, often wedge-shaped; irregularly aggregated, and in mammillary forms. Also reniform or botryoidal, and granular; amorphous.

Fracture uneven. Brittle. H. = 2·5–3. G. = 5·8–6·1. Luster adamantine to resinous, often faint. Color green to brown, apple-green, siskin-green, olive-green, ocher-brown, liver-brown; sometimes nearly black. Streak greenish or brownish. Faintly translucent to opaque.

**Comp.**—A phospho-chromate of lead, perhaps, as suggested by Rammelsberg, $2(Pb,Cu)CrO_4.(Pb,Cu)_3P_2O_8$ = Chromium trioxide 15·0, phosphorus pentoxide 10·6, lead protoxide 69·5, cupric oxide 4·9 = 100.

**Anal.**—1, 2, Nordenskiöld, l. c. 3, Hermann, l. c. 4, Pisani, Bull. Soc. Min., **3**, 196, 1880. 5, Nicolayev, Min. Russl., **8**, 353.

| | | $P_2O_5$ | $CrO_3$ | PbO | CuO | $Fe_2O_3$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. *Laxmannite* | G. = 5·77 | 8·05 | 15·26 | 61·26 | 12·43 | 1·09 | 1·31 | = 99·40 |
| 2. " | | 8·57 | 16·76 | 61·06 | 10·85 | 1·28 | 0·90 | = 99·42 |
| 3. *Phosphochromite* | G. = 5·80 | 9·94 | 10·13 | 68·33 | 7·36 | 2·80 | 1·16 | = 99·72 |
| 4. " | | 9·78 | 15·80 | 70·60 | 4·57 | — | — | = 100·75 |
| 5. "*Vauquelinite*" | G. = 6·06 | 9·23 | 11·95 | 62·70 | 9·58 | — | 3·00 | = 96·46 |

Berzelius gave for the original vauquelinite: $CrO_3$ 28·33, PbO 60·87, Cu 10·80 = 100, which correspond to $3(Pb,Cu)O.2CrO_3$; he probably overlooked the phosphoric acid, for the observations of Des Cloizeaux and Koksharov make it almost certain that vauquelinite and laxmannite are identical, although Nordenskiöld argues for the presence of a pure chromate, free from phosphoric acid, with his laxmannite. All the crystals examined by Koksharov proved to contain $P_2O_5$, but varying somewhat in amount (8 to 10 p. c.) as explained by the associated pyromorphite. Some authors give the name laxmannite to the above phospho-chromate, the existence of which is sufficiently proved, and retain vauquelinite for the still hypothetical chromate, assumed to have the composition given above. This, by the way, is identical with that of phœnicochroite except in the presence of copper.

**Pyr., etc.**—B.B. on charcoal slightly intumesces and fuses to a gray submetallic globule, yielding at the same time small globules of metal. With borax or salt of phosphorus affords a green transparent glass in the outer flame, which in the inner after cooling is red to black, according to the amount of mineral in the assay; the red color is more distinct with tin. Partly soluble in nitric acid.

**Obs.**—Occurs with crocoite at Berezov in the Ural, generally in mammillated or amorphous masses, or thin crusts; early reported at Pontgibaud in the Puy-de-Dôme (but needs confirmation, Dx.); also with the crocoite of Brazil.

At the lead mine near Sing Sing it has been reported by Dr. Torrey in green and brownish green mammillary concretions, and also nearly pulverulent; and at the Pequa lead mine in Lancaster Co., Pa., in minute crystals and radiated aggregations on quartz and galena, of siskin- to apple-green color, with cerussite. Probably also with crocoite, vanadinite, wulfenite at some of the mines in the Vulture district in Maricopa Co., Arizona. All these American localities require revision.

Named after Vauquelin, the discoverer of the metal chromium, and also the first one to notice the crystals of this species (J. Mines, **6**, 737). Laxmannite is for the chemist Prof. E. Laxmann, who early traveled extensively in Siberia, and (Nd.) first called attention to the minerals of Berezov.

John describes a greenish or brownish *chromo-phosphate of lead and copper* (Chrom-Phosphorkupferbleispath) from Berezov, Siberia, as occurring in small crystalline concretions, having the surface covered with capillary prisms; H. = 2–3; opaque to subtranslucent; fracture uneven; powder dull greenish. Analysis afforded (Jb. Min., 67, 1845): $PbCrO_4$ 45·0, PbO 19·0, CuO 11·20, $P_2O_5$ 4·10, $CrO_3$ 7·50, manganese *tr.*, $H_2O$ 1·78, impurities 11·42. To a large extent soluble in nitric or hydrochloric acid. It is probably only an impure vauquelinite.

**Ref.**—[1] Crystals with the composition given in anal. 5, Min. Russl., **8**, 345, 1878. See also Nd., l. c., and Dx., Bull. Soc. Min., **5**, 53, 1882, whose angles vary rather widely from these. [2] Kk., p. 357, also Dx. [3] Haid.; the specimen supposed to be from Pontgibaud, cf. Dx., l. c., p. 56.

JOSSAITE *Breithaupt*, B. H. Ztg., **17**, 54, 1858. From Berezov, occurring in small orange-yellow crystals with vauquelinite. Described as orthorhombic, with a prismatic angle of 62°–70°, and traces of prismatic cleavage; the luster between vitreous and waxy; streak dull yellowish white; H. = 3·0; G. = 5·2. According to Plattner, it gives the reactions of chromic acid and oxides of lead and zinc.

TARAPACAITE *Raimondi*, Minéraux du Pérou, p. 274, 1878. Occurs in minute fragments of a brilliant yellow color, in the midst of soda niter (the variety called *caliche azufrado*, p. 871). Essentially a potassium chromate, but mixed with a little sodium chloride, sodium nitrate, and sodium and potassium sulphates. From the province of Tarapacá, Chili; also (Domeyko, Min. Chili, 3d Ed., 447) in the natural salt deposits of the desert of Atacama, Chili. It needs further examination.

CALCIUM CHROMATES. On the artificial formation and crystalline form of various calcium chromates, see H. B. v. Foullon, Jb. G. Reichs., **40**, 421, 1890. The salts described have the composition: $Ca_2CrO_5 + 3H_2O$, monoclinic; $CaCrO_4 + 2H_2O$, monoclinic and isomorphous with gypsum; $CaCrO_4 + H_2O$, orthorhombic.

SULPHATES OF MERCURY. Seyfriedsberger has described two sulphates of mercury from the mercury furnace at Idria, $Hg_2SO_4$ and $HgSO_4$. The former occurs in orthorhombic crystals, with *a* (100), *b* (010), *c* (001), *m* (110), *p* (230), *f* (102), *g* (203), *h* (101), *d* (011), *o* (111). Axial ratio $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}666 : 1 : 0{\cdot}707$. Angles: $mm''' = 67° 20'$, $hh' = 93° 30'$, $dd' = 70° 33'$, etc. Zs. Kr., **17**, 433, 1890.

## Sulphates with Chlorides, Carbonates, etc.—In part hydrous compounds.

| | | | | | |
|---|---|---|---|---|---|
| **728.** | **Sulphohalite** | $3Na_2SO_4.2NaCl$ | Isometric | | |
| | | | | $\breve{a} : \bar{b} : \acute{c}$ | |
| **729.** | **Caracolite** | $Na_2SO_4.Pb(OH)Cl$? | Orthorhombic | 0·5843 : 1 : 0·4213 | |
| | | | | $\grave{a} : \bar{b} : \acute{c}$ | $\beta$ |
| **730.** | **Kainite** | $MgSO_4.KCl + 3H_2O$ | Monoclinic | 1·2187 : 1 : 0·5863 | 85° 6′ |
| **731.** | **Connellite** | $Cu_{15}(Cl,OH)_4SO_{16} + 15H_2O$ | Hexagonal | $\acute{c}$ = 1·1562 | |
| **732.** | **Spangolite** | $(AlCl)Cu_6(OH)_{12}SO_4 + 3H_2O$ | Rhombohedral | $\acute{c}$ = 2·0108 | |

| | | | | |
|---|---|---|---|---|
| 733. **Hanksite** | $4Na_2SO_4.Na_2CO_3$ | Hexagonal | $\acute{c}$ = 1·0140 | |
| | | | $\grave{a} : \bar{b} : \acute{c}$ | β |
| 734. **Leadhillite** | $4PbO.SO_3.2CO_2.H_2O$? | Monoclinic | 1·7476 : 1 : 2·2154 | 89° 48′ |

Two double salts, sulphates and nitrates of sodium, are described on p. 873.

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**728. SULPHOHALITE.** *W. E. Hidden* and *J. B. Mackintosh*, Am. J. Sc., **36**, 463, 1888. Sulfohalit *Germ.*

Isometric. In dodecahedrons, also with cubic and octahedral faces; an apparent development of the latter according to tetrahedral symmetry has been noted[1]. H. = 3·5. G. = 2·489. Luster vitreous. Color faint greenish yellow. Transparent.

**Comp.**—$3Na_2SO_4.2NaCl$ = Sulphur trioxide 44·2, chlorine 13·0, soda 45·7 = 102·9; or, Sodium sulphate 78·5, sodium chloride 21·5 = 100.

**Anal.**—Mackintosh, l. c.

| $SO_3$ | Cl | $Na_2CO_3$ |
|---|---|---|
| 42·48 | 13·12 | 1·77 |

This is interpreted as $Na_2SO_4$ 75·41, NaCl 21·62, $Na_2CO_3$ 1·77 = 98·80. If the loss is regarded as $Na_2SO_4$ and the $Na_2CO_3$ is taken as replacing a small part of the sulphate, the above formula is obtained. Slowly soluble in water.

**Obs.**—Observed implanted upon crystals of hanksite from Borax lake, San Bernardino Co., California; obtained from a cavity reached in boring at a depth of 35 feet.

**Ref.**—[1] Cf. Hidden, Am. J. Sc., **41**, 438, 1891.

**729. CARACOLITE.** *Websky*, Ber. Ak. Berlin, p. 1045, 1886.

Orthorhombic (?) and pseudo-hexagonal by twinning. Axes $\breve{a} : \bar{b} : \acute{c}$ = 0·5843 : 1 : 0·4213 Websky[1].

100 ∧ 110 = 30° 17¾′, 001 ∧ 101 = 35° 47⅔′, 001 ∧ 011 = 22° 50½′.

Measured angles: $pp'''$ = *37° 44′, $pp^{iv}$ = *100° 16′, also $pp'$ = 67° 13′ (calc.).

As a crystalline incrustation; the crystals have the form of a hexagonal pyramid with base and prism, but are explained as trillings, analogous to aragonite, with the prism as twinning plane, $mm'''$ = 60° 35½′.

Cleavage not noted. H. = 4·5. Luster vitreous. Colorless.

**Comp.**—Perhaps $Pb(OH)Cl.Na_2SO_4$ = Sulphur trioxide 20·0, lead protoxide 55·5, soda 15·5, chlorine 8·8, water 4·5 = 104·3.

**Anal.**—Websky, l. c., on impure material.

| $SO_3$ | Cl | Pb | Cu | FeO | ZnO | |
|---|---|---|---|---|---|---|
| 16·70 | 10·18 | 50·88 | 2·51 | 0·33 | 0·29 | insol. 1·84 = 82·73 + 2·30 (O = Cl) = 85·03 |

Adding 12·46 $Na_2O$ = equiv. of $SO_3$ (diminished by equiv. of ZnO and FeO), 2·51 p. c. $H_2O$ remains. This is interpreted as consisting of 83·9 p. c. caracolite and 14·26 percylite (with 1·84 residue), but the result is very problematical.

**Pyr.**—Fuses in the Bunsen flame to a brown glass giving a strong soda flame with a blue spot close to the assay. Partially dissolved by water, the solution evaporated depositing cubes of sodium chloride, etc.

**Obs.**—Occurs intimately mixed with blue cubes of percylite as an incrustation and in crevices in a gangue consisting of galena, anglesite, and quartz. From Mina Beatriz, Sierra Gorda, Atacama, some 20 or 30 miles from Caracoles, Chili (cf. Fletcher, l. c., and Sandb., Jb. Min., **2**, 75, 1887.

**Ref.**—[1] L. c., it may prove that the crystals belong to the hexagonal system to which they approximate closely; cf. Fletcher, Min. Mag., 8, 172, 1889.

Chlorothionite. Clorotionite *A. Scacchi*, Att. Accad. Napoli, 6, 1873 (Contrib. Min., II, p. 59).

Occurs in thin crystalline mammillary crusts of a bright blue color. Analysis:

| $SO_4$ | Cl | Cu | K | loss |
|---|---|---|---|---|
| 32·99 | 20·04 | 19·56 | 26·29 | 1·12 = 100 |

Crystals obtained by recrystallization from a solution, and thus purer than the original material, gave essentially the same result. Formula $K_2SO_4.CuCl_2$ = $SO_4$ 31·2, Cl 23·0, Cu 20·5, K 25·3 = 100. From Vesuvius, as a result of the eruption of April, 1872. The name records the presence of chlorine and sulphur (θεῖον).

**730. KAINITE.** *Zincken*, B. H. Ztg., **24**, 79, 1865.

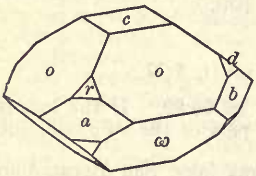
Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 1{\cdot}21866 : 1 : 0{\cdot}58635$; $\beta = 85° \, 5\frac{2}{3}' = 001 \wedge 100$ Groth[1].

$100 \wedge 110 = 50° \, 31\frac{1}{2}'$, $001 \wedge 101 = 24° \, 43\frac{1}{3}'$, $001 \wedge 011 = 30° \, 17\frac{2}{3}'$.

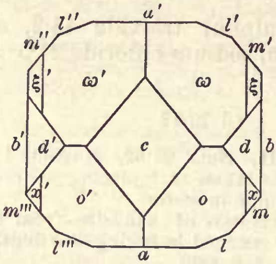
**Forms**[1]:
*a* (100, $i$-$\bar{i}$)
*b* (010, $i$-$\grave{i}$)
*c* (001, *O*)
*l* (310, $i$-$\bar{3}$)[2]
*s* (210, $i$-$\bar{2}$)[2]
*m* (110, *I*)
*t* (101, $-$ 1-$\bar{i}$)[3]
*r* (201, $-$ 2-$\bar{i}$)
*n* (401, $-$ 4-$\bar{i}$)[3]
*d* (021, 2-$\grave{i}$)[2]
*e* (334, $-$ $\frac{3}{4}$)[2]
*o* (111, $-$ 1)
*v* (221, $-$ 2)[2]
*ϵ* ($\bar{2}$23, $\frac{2}{3}$)[2]
*ω* ($\bar{1}$11, 1)
*w* (311, $-$ 3-$\bar{3}$)[3]
*x* (131, $-$ 3-$\grave{3}$)[2]
*ξ* ($\bar{1}$31, 3-$\grave{3}$)

Also[4] doubtful *π* (980), *ξ* ($\bar{4}$·18·7).

1.



2.



Figs. 1, 2, Loederburg, Luedecke.

*ll'''* = 44° 4'
*ss'''* = 62° 31'
*mm'''* = 101° 3'
*cr* = 41° 32'
*dd'* = 98° 53'
*co* = 35° 58'
*cv* = 60° 39'
*cω* = 38° 14½'
*cx* = 60° 11'
*ao* = *63° 52'
*a'ω* = *71° 5½'
*oω'''* = *105° 47'
*oo'* = 54° 1'
*ωω'* = 57° 11'
*xx'* = 113° 38'
*ξξ'* = 117° 6'

Crystals often tabular ∥ *c*; also prismatic (*ω*), pyramidal *o* and *ω*. Faces *c* uneven and broken. Also granular massive and in crystalline crusts.

Cleavage: *a* very distinct; *m* distinct; *b* less so; also *o*, *ω* Bkg. H. = 2·5–3. G. = 2·067–2·188. Luster vitreous. Color white or colorless to dark flesh-red.

Optically −. Ax. pl. ∥ *b*. $Bx_a \wedge \grave{c} = -8°$ Groth, − 10° 43' Zeph. Dispersion inclined, very distinct. Axial angles:

$2E_y = 141°$ approx. $2H_y = 86° \, 40'$ Groth

Also

$2H_{a.r} = 87° \, 8'$ Li $2H_{a.y} = 87° \, 3'$ Na $2H_{a.gr} = 87° \, 0'$ Tl $2H_{o.y} = 98° \, 30'$ $\therefore 2V_y = 84° \, 33'$

**Comp.**—$MgSO_4.KCl + 3H_2O$ = Sulphur trioxide 32·1, chlorine 14·3, magnesia 16·1, potassium 18·9, water 21·8 = 103·2; or, Magnesium sulphate 48·2, potassium chloride 30·0, water 21·8 = 100.

**Anal.**—1, Philipp, Zs. G. Ges., **17**, 649, 1865. 2, Frank, Ber. Ch. Ges., **1**, 121, 1868, Rg., Min. Ch., 261, 1875. 3, Hauer, Jb. G. Reichs., **20**, 141, 1871. 4, Tschermak, Ber. Ak. Wien, **63** (1), 311, 1871. 5, Linck, Zs. Kr., **15**, 572, 1889.

| | $SO_3$ | Cl | MgO | K | Na | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. Stassfurt | 32·98 | 14·52 | 16·49 | 13·54 | 1·30 | 21·00 | = 99·83 |
| 2. " | 33·54 | 14·15 | 16·41 | 16·29 | — | 19·47 | = 99·86 |
| 3. Kalusz | 32·24 | 15·03 | 16·12 | 15·25 | 0·69 | 21·37 | = 100·70 |
| 4. " | 32·34 | 14·56 | 16·75 | 15·66 | 0·03 | 20·73 | = 100 07 |
| 5. Douglashall | 34·30 | 13·97 | 16·61 | 14·99 | — | 21·11 | = 100·98 |

Does not deliquesce, but easily soluble in water. The solution yields crystals of picromerite leaving the potassium chloride behind, whence the earlier view that kainite of Zincken was nothing but the impure picromerite.(cf. 5th Ed., p. 642).

**Obs.**—Found in granular masses, less often in crystals, at Stassfurt; with picromerite (schœnite), halite, and sylvite at Aschersleben; at Kalusz, Galicia, in beds of considerable thickness (Tsch., l. c.).

**Artif.**—A. de Schulten (C. R., **111**, 928, 1890) describes the synthesis of kainite by the evaporation of a concentrated solution of 500 gr. of crystallized magnesium chloride with a solution containing 40 gr. potassium sulphate and 56 gr. of magnesium sulphate. An analysis of crystals obtained gave:

$SO_3$ 33·30 Cl 14·03 MgO 17·17 K 15·09 $H_2O$ 20·50 = 100·09

**Ref.**—[1] Stassfurt, Pogg., **137**, 442, 1869. [2] Zeph., Zs. Kr., **6**, 234, 1881. [3] Luedecke, Loederburg, Zs. Nat. Halle, **58**, 656, 1885. [4] Bkg., Zs. Kr., **15**, 569, 1889.

**731. CONNELLITE.** Copper Ore of an azure-blue color, composed of needle crystals (fr. Wheal Providence) *Rashleigh*, Brit. Min., **2**, 13, pl. 12, f. 1, 6, 1802. Sulphato-chloride of Copper *Connel*, Rep. Brit. Assoc., 1847. Connellite *Dana*, Min., 523, 1850.

Hexagonal. Axis $\dot{c}$ = 1·1562; 0001 ∧ $10\bar{1}1$ = 53° 10′ N. Story-Maskelyne[1].

**Forms**[1]: *c* (0001, *O*), *m* ($10\bar{1}0$, *I*), *a* ($11\bar{2}0$, *i*-2), *p* ($10\bar{1}1$, 1), *w* ($11{\cdot}2{\cdot}\bar{13}{\cdot}3$, $\frac{13}{3}$-$\frac{13}{11}$).

Angles: *mp* = 36° 50′, *pp′* = 47° 10¾′, *pp‴* = *106° 20′, *ww′* = 42° 48½′, $ww^{xi}$ = 21° 59′, $ww^{xii}$ = 21° 0′, *ap* = 46° 7′, *aw* = 24° 4½′, *mw* = 13° 18′.

Crystals slender, or acicular, usually hexagonal prisms, *a*, with the pyramid *p*; sometimes also with the dihexagonal pyramid *w*; also stout prisms, *a*, *m* with basal plane. In radiating groups, forming botryoidal or rounded masses.

H. = 3. G. = 3·364. Luster vitreous. Color fine blue; of the powder pale greenish blue. Translucent. Optically uniaxial, positive, Btd.

**Comp.** — Probably $Cu_{16}(Cl,OH)_4SO_{16}.15H_2O$. Neglecting the hydroxyl, regarded as replacing part of the chlorine, the percentage composition is: Sulphur trioxide 4·8, cupric oxide 72·1, chlorine 8·6, water 16·4 = 101·9.

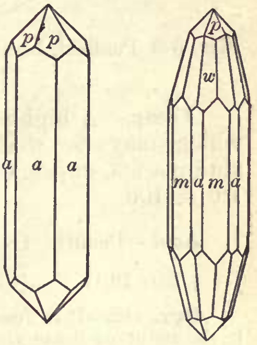
**Anal.**—Penfield, made on 0·074 gram, Am. J. Sc., **40**, 82, 1890.

$SO_3$ 4·9 Cl 7·4 CuO 72·3 $H_2O$ 16·8 (at 100° 0·4) = 101·8

**Pyr., etc.**—B.B. fuses at 2 to a black shining globule coloring the flame green. Gives acid water abundantly in the closed tube. Insoluble in water, but easily soluble in nitric or hydrochloric acid.

**Obs.**—In Cornwall, at Wheal Unity and Wheal Damsel, in slender crystals, not over $\frac{1}{200}$ in. in diameter and $\frac{1}{10}$ in. thick. Recently (1885) found in crystals up to 4 mm. in length at the Marke Valley mine in Eastern Cornwall with cuprite, malachite, and chalcophyllite, and in the Camborne district with cuprite, azurite, malachite, brochantite, etc. Also noted with cuprite, malachite, and quartz from Namaqualand, S. Africa (Prior. Min. Mag., **8**, 182, 1889).

1. 2.



Figs. 1, 2, Cornwall, Maskelyne.

**Ref.**—[1] Phil. Mag., **25**, 39, 1863. Penfield (l. c.) obtained *pp′* = 49° 39′ and Trechmann 47° 31′, Min. Mag., **6**, 171, 1885. Miers notes *c* (0001), ibid., p. 167.

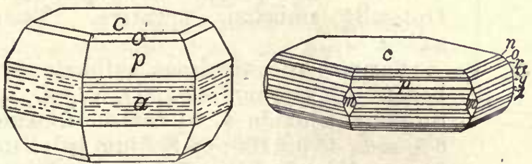
**732. SPANGOLITE.** *S. L. Penfield*, Am. J. Sc., **39**, 370, 1890.

Rhombohedral. Axis $\dot{c}$ = 2·0108; 0001 ∧ $10\bar{1}1$ = 66° 42′ Penfield.

**Forms:**
*c* (0001, *O*)
*m* ($10\bar{1}0$, *I*)
*a* ($11\bar{2}0$, *i*-2)
*k* ($11\bar{2}8$, ¼-2)
*n* ($11\bar{2}6$, ⅓-2)
*o* ($11\bar{2}4$, ½-2)
*ρ* ($33\bar{6}8$, ¾-2)
*l* ($33\bar{6}7$, $\frac{6}{7}$-2)
*p* ($11\bar{2}2$, 1-2)
*x* ($33\bar{6}4$, $\frac{3}{2}$-2)
*y* ($11\bar{2}1$, 2-2)
*z* ($33\bar{6}2$, 3-2)

*ck* = 26° 41′
*cn* = 33° 50′
*co* = 45° 9′
*cρ* = 56° 27′
*cl* = 59° 53′
*cp* = *63° 33½′
*cx* = 71° 39½′
*cy* = 76° 2′
*cz* = 80° 35′
*oo′* = 41° 31½′
*pp′* = *53° 11½′
*yy′* = 58° 3′
*mp* = 39° 9′

1. 2.

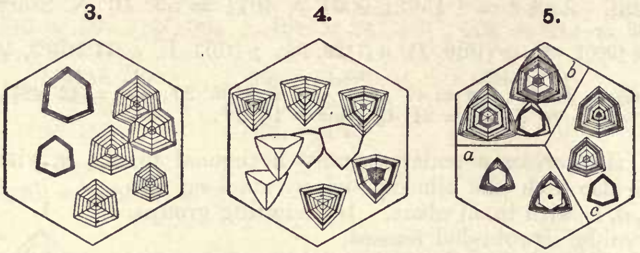


Figs. 1, 2, Penfield.

In hexagonal crystals with prominent basal plane; sometimes short prismatic with faces *a* horizontally striated; also flattened with a series of pyramids in oscillatory combination. These pyramids are shown to belong to the second series by the etching-figures.

Cleavage: basal, perfect. Fracture conchoidal. Etching-figures on *c* rhombohedral in symmetry, and corresponding to various scalenohedrons varying with the kind of acid or its degree of concentration. H. = 2 on *c*; on pyramidal faces = 3. G. = 3·141. Luster vitreous. Color dark green. Pleochroism not strongly marked, green (ω) and bluish green

($\epsilon$). Optically −. Double refraction strong. Indices: $\omega = 1{\cdot}694$, $\epsilon = 1{\cdot}641$ for $\lambda = 525$ approx.



Figs. 3–5, Penfield, basal sections showing etching-figures: 3, in dilute sulphuric acid; 4, in very dilute sulphuric acid; 5, in hydrochloric acid.

**Comp.**—A highly basic sulphate of aluminium and copper, $Cu_6AlClSO_{10}.9H_2O$ which may be written $(AlCl)SO_4.6Cu(OH)_2 + 3H_2O$ = Sulphur trioxide 10·1, alumina 6·3, cupric oxide 59·7, chlorine 4·5, water 20·4,= 101·0, deduct (O = 2Cl) 1·0 = 100.

**Anal.**—Penfield, l. c.

$\frac{4}{4}$ $SO_3$ 10·11 Cl 4·11 $Al_2O_3$ 6·60 CuO 59·51 $H_2O$ 20·41 = 100·74

**Pyr., etc.**—B.B. fuses at 3 to a black slaggy mass, coloring the flame green. On charcoal in the reducing flame yields globules of metallic copper. Yields acid water abundantly in the closed tube. Insoluble in water, but readily soluble in dilute acids.

**Obs.**—From the neighborhood of Tombstone, Arizona, but exact locality unknown; perhaps from the Globe district. Only a single specimen has thus far been preserved; this shows a mass of impure cuprite nearly covered with the fine hexagonal crystals of spangolite associated with a few crystals of azurite and a prismatic mineral, perhaps atacamite.

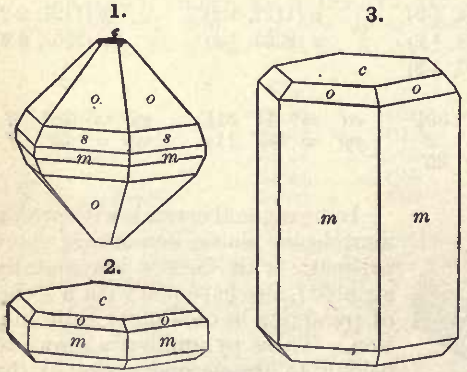
Named after Mr. Norman Spang of Etna, Allegheny Co., Penn.

**733. HANKSITE.** *W. E. Hidden*, Am. J. Sc., **30**, 133, 1885.

Hexagonal. Axis $\dot{c} = 1{\cdot}0140$; $0001 \wedge 10\bar{1}1 = {}^*49° 30'$ Hidden[1].

**Forms:** *c* (0001, *O*); *m* (10$\bar{1}$0, *I*); *p* (40$\bar{4}$5, $\frac{4}{5}$)[2], *o* (10$\bar{1}$1, 1), *s* (20$\bar{2}$1, 2).

Angles: *cp* = 43° 8′, *co* = 49° 30′, *cs* = 66° 52½′, *pp′* = 39° 58½′, *oo′* = 44° 41½′, *ss′* = 54° 45′.



Figs. 1–3, Ayres.

In hexagonal prisms, usually short prismatic to tabular; often in interpenetrating groups. Faces *m* striated horizontally. Also in quartzoids.

Cleavage: *c* distinct. Fracture uneven to subconchoidal. Brittle. H. = 3–3·5. G. = 2·562. Luster vitreous, rather dull. Color white, inclining to yellow. Transparent to translucent. Optically uniaxial, negative. Taste saline.

**Comp.**—An anhydrous sulphato-carbonate of sodium, $4Na_2SO_4.Na_2CO_3$ = Sulphur trioxide 47·5, carbon dioxide 6·5, soda 46·0=100; or, Sodium sulphate 84·3, sodium carbonate 15·7 = 100.

**Anal.**—1, J. B. Mackintosh, Am. J. Sc., **30**, 134, 1885. 2, S. L. Penfield, ib., p. 137.

| | $SO_3$ | $CO_2$ | $Na_2O$ | Cl | ign. | insol. | |
|---|---|---|---|---|---|---|---|
| 1. | 45·89 | 5·42 | 46·34 | 2·36 | — | — | = 100·01 |
| 2. | 43·59 | 5·42 | 40·86 | 2·13 | 1·32 | 4·41 | K 2·33 = 100·06 |

The bases in 1 were calculated as soda. In 2 the insoluble portion is admixed clay which rendered the crystal partially opaque; the chlorine is probably due to impurity (NaCl); inclusions of cubic crystals were observed microscopically.

**Pyr.**—Fuses easily with a yellow flame. Readily soluble in water. Effervesces with acids.

**Obs.**—Found with halite, thenardite, glauberite, trona, borax, etc., at Borax Lake, San Bernardino Co., California; cf. Hanks, Am. J. Sc., **37**, 63, 1889. Hanksite is sometimes inclosed in borax crystals. Also known from Death Valley, Inyo Co., and reported from Nevada. The crystal analyzed by Penfield was a low hexagonal prism, 75 mm. across; from California, but exact locality unknown.

Named after Henry G Hanks, formerly State Mineralogist of California.

**Ref.**—[1] L. c. Bodewig measured $oo' = 44° 31'$, $co = 49° 15\frac{1}{2}'$, Am. J. Sc., **38**, 165, 1889.

**734. LEADHILLITE.** Plomb carbonaté rhomboidal *Bourn.*, Cat., p. 343, 1817. Sulphato-tricarbonate of Lead *Brooke*, Ed. Phil. J., 3, 117, 1820. Leadhillite *Beud.*, Tr., 2, 366, 1832. Bleisulphotricarbonat, Ternärbleierz, *Weiss*. Psimythit *Glocker*, Syn., 256, 1847. Maxite *Laspeyres*, Jb. Min., 407, 508, 1872; 292, 1873.

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c} = 1{\cdot}74764 : 1 : 2{\cdot}21545$; $\beta = 89° 47' 38'' = 001 \wedge 100$ Laspeyres[1].

$100 \wedge 110 = 60° 13' 18''$, $001 \wedge 101 = 51° 36' 18''$, $001 \wedge 011 = 65° 42' 24''$.

**Forms**[2]:
$a$ (100, $i\text{-}\bar{i}$)
$b$ (010, $i\text{-}\grave{i}$)
$c$ (001, $O$)
$d$ (410, $i\text{-}\bar{4}$)
$\omega$ (310, $i\text{-}\bar{3}$) tw.pl.
$l$ (210, $i\text{-}\bar{2}$)
$L$ (430, $i\text{-}\frac{\bar{4}}{3}$)[3]

$m$ (110, $I$)
$i$ (203, $-\frac{2}{3}\text{-}\bar{i}$)
$w$ (101, $-1\text{-}\bar{i}$)
$z$ (302, $-\frac{3}{2}\text{-}\bar{i}$)[3]
$u$ (201, $-2\text{-}\bar{i}$)
$y$ (401, $-4\text{-}\bar{i}$)[3]
$f$ ($\bar{1}$01, $1\text{-}\bar{i}$)
$e$ ($\bar{2}$01, $2\text{-}i$)

$\alpha$ (014, $\frac{1}{4}\text{-}\grave{i}$)
$g$ (012, $\frac{1}{2}\text{-}\grave{i}$)
$h$ (034, $\frac{3}{4}\text{-}\grave{i}$)
$\beta$ (113, $-\frac{1}{3}$)[3]
$t$ (112, $-\frac{1}{2}$)
$x$ (111, $-1$)
$v$ ($\bar{1}$12, $\frac{1}{2}$)
$r$ ($\bar{1}$11, 1)

$\gamma$ (612, $-3\text{-}\bar{6}$)[3]
$\delta$ (418, $-\frac{1}{2}\text{-}\bar{4}$)[3]
$s$ (414, $-1\text{-}\bar{4}$)
$\epsilon$ (214, $-\frac{1}{2}\text{-}\bar{2}$)[3]
$k$ (212, $-1\text{-}\bar{2}$)
$\zeta$ (412, $-4\text{-}\bar{2}$)[3]
$\vartheta$ (434, $-1\text{-}\frac{\bar{4}}{3}$)[3]
$\lambda$ ($\bar{4}{\cdot}1{\cdot}12$, $\frac{1}{3}\text{-}\bar{4}$)[3]

$\mu$ ($\bar{4}$18, $\frac{1}{2}\text{-}\bar{4}$)[3]
$q$ ($\bar{4}$14, $1\text{-}\bar{4}$)
$\rho$ ($\bar{8}$14, $2\text{-}\bar{4}$)
$p$ ($\bar{2}$12, $1\text{-}\bar{2}$)
$\sigma$ ($\bar{4}$36, $\frac{2}{3}\text{-}\frac{\bar{4}}{3}$)[3]?
$o$ ($\bar{4}$34, $1\text{-}\frac{\bar{4}}{3}$)[3]
$\tau$ ($\bar{4}$77, $1\text{-}\frac{\bar{7}}{4}$)[3]
$n$ ($\bar{4}$74, $\frac{7}{4}\text{-}\frac{\bar{7}}{4}$)

$dd''' = 47° 12'$
$\omega\omega_{,} = 60° 27'$
$ll''' = 82° 18'$
$mm''' = 120° 27'$
$cu = 68° 18'$
$cf = 51° 51\frac{1}{2}'$
$ce = 68° 39'$

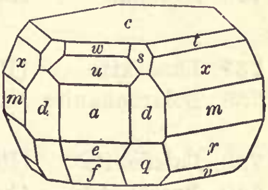
$bg = {}^{*}42° 4' 26''$
$gg' = 95° 51'$
$hh' = 117° 55'$
$ct = 51° 51'$
$cx = 68° 31'$
$cm = 89° 54'$
$cv = 51° 59'$

$cr = 68° 42'$
$cs = 54° 1'$
$ck = 59° 10\frac{1}{2}'$
$cq = 54° 16'$
$cp = 59° 24'$
$tt' = 86° 6'$
$xx' = 107° 44'$

$bx = {}^{*}36° 7' 54''$
$vv' = 86° 17'$
$rr' = 107° 55\frac{1}{2}'$
$ss' = 37° 48'$
$qq' = 37° 56'$
$gx = {}^{*}69° 15' 37''$

Twins: tw. pl. *m*, analogous to aragonite; also $\omega$ (310) as tw. lamellæ, sometimes developed by elevation of temperature. Crystals commonly tabular ∥ *c*.

Cleavage: *c* very perfect; *a* in traces. Fracture conchoidal, scarcely observable. Rather sectile. H. = 2·5. G. = 6·26–6·44. Luster of *c* pearly, other parts resinous, somewhat adamantine. Color white, passing into yellow, green, or gray. Streak uncolored. Transparent to translucent.



Sardinia, Laspeyres.

Optically −. Ax. pl. ∥ *a*. Bx sensibly ⊥ *c*. Dispersion $\rho < v$ rather large. Axial angle diminishes with increase of temperature, and finally a section becomes uniaxial and negative.

At 15° C., $2E_r = 20° 32'$. $2E_{bl} = 22° 22'$. $2E_r = 20° 28'$ at 21°·5, 6° 46′ at 47°, 0° at 121°. Again, $2E_r = 20° 54'$ at 12° C. and 0° at 146°·5. Again, $2E_r = 23° 16'$ at 12°, 10° 22′ at 47°, 8° 26′ at 175°·8 Dx.[4]

Hintze[5] found it uniaxial at 125°, Mügge[6] at 300°, previous tw. lamellæ having completely disappeared.

**Comp.**—Sulphato-carbonate of lead, perhaps (Groth) $4PbO.SO_3.2CO_2.H_2O$ = Sulphur trioxide 7·4, carbon dioxide 8·2, lead oxide 82·7, water 1·7 = 100.

Hintze wrote the formula $7PbO.2SO_3.4CO_2.2H_2O$.

**Anal.**—1, 2, Laspeyres, l. c.; 2, mean of several analyses. 3, Bertrand, Bull. Soc. Ch., **19**, **67**, 1873. 4, Hintze, l. c. 5–7, Collie, J. Ch. Soc., **55**, 91, 1889.

| | | | | $SO_3$ | $CO_2$ | PbO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | Leadhills | | | 8·42 | 7·98 | 81·78 | 1·82 | = | 100 |
| 2. | Sardinia, *Maxite* | | | 8·12 | 8·03 | 81·98 | 1·87 | = | 100 |
| 3. | " " | G. = 6·60 | | 7·14 | 12·12 | 80·72 | — | = | 99·98 |
| 4. | " " | G. = 6·547 | | 8·17 | 9·18 | 80·80 | 2·00 | = | 100·15 |
| 5. | Leadhills | | $\frac{3}{3}$ | 9·2 | 8·6 | 82·3 | 1·5 | = | 101·6 |
| 6. | " | | | 8·0 | 9·8 | 81·8 | 1·6 | = | 101·2 |
| 7. | " | | | 7·3 | 11·5 | 81·3 | 1·8 | = | 101·9 |

**Pyr., etc.**—B.B. intumesces, fuses at 1·5, and turns yellow; but becomes white on cooling. Easily reduced on charcoal. With soda affords the reaction for sulphuric acid. Effervesces briskly in nitric acid, and leaves white lead sulphate undissolved. Yields water in the closed tube.

**Obs.**—Found at Leadhills, with other ores of lead; also in crystals at Red Gill, Cumberland, and near Taunton in Somersetshire; at Matlock, Derbyshire. From the Mala-Calzetta lead mine near Iglesias, Sardinia (*maxite*), associated with galena, cerussite, anglesite; it was supposed at first to be an independent species (cf. App. II. 38, III, 67). Grenada is also stated to be a locality of it, and the island of Seriphos, Grecian Archipelago. The crystals seldom exceed an inch in length, and are commonly smaller.

Reported by C. U. Shepard from Newberry District, S. C., but there is some doubt as to the locality; also from the Morgan silver mine, Spartanburg District, S. C. Observed from Arizona, at the Schulz gold mine with wulfenite, vanadinite, cerussite; it is partly altered to cerussite (Pfd.).

The name *maxite* was given for the Belgian mining engineer, Max Braun.

**Ref.**—[1] Zs. Kr., **1**, 193, 1877; the form was first made monoclinic by Haidinger, later orthorhombic and hemihedral, cf. Haid., Trans. R. Soc. Edinb., **10**, 217, 1826 (1824); Mlr., 563, 1852. Artini (ref. below) calculates $\grave{a} : \bar{b} : \grave{c} = 1·75152 : 1 : 2·22608$; $\beta = 89° 31' 55'$.

[2] Cf. Lasp. and Mlr., Min. 563, 1852. [3] Artini, monograph of the Sardinian mineral, Giorn. Min., **1**, 1, 1890. [4] Dx., Propr. Opt., **2**, 38, N. R., 72, 1867. [5] Hintze, Pogg., **152**, 259, 1874; cf. also Bertrand, C. R., **86**, 348, 1878. [6] Mgg., Jb. Min., **1**, 63, 204, 1884.

SUSANNITE. Sulphato-tricarbonate of Lead pt. (fr. Susanna mine, Leadhills) *Brooke*, Ed. N. Phil. J., **3**, 117, 138, 1827. Suzannit *Haid.*, Handb., 505, 1845.

Regarded at one time as rhombohedral and dimorphous with leadhillite, but it is very probably only a modification of that species.

In attached crystals, described as acute rhombohedral, $rr' = 107\frac{1}{2}°$, at the Susanna mine, Leadhills, in Scotland; at Moldawa in Hungary; Nerchinsk in Siberia.

Cf. Leadhillite.

## B. Acid and Basic Sulphates.

| | | | | |
|---|---|---|---|---|
| **735. Misenite** | $HKSO_4$ | Monoclinic? | | |
| **736. Alumian** | $Al(AlO)(SO_4)_2$ | Rhombohedral? | | |
| | | | $\grave{a} : \bar{b} : \grave{c}$ | $\beta$ |
| **737. Lanarkite** | $(Pb_2O)SO_4$ | Monoclinic | 0·8681 : 1 : 1·3836 | 88° 11′ |
| **738. Dolerophanite** | $(Cu_2O)SO_4$ | " | 1·4813 : 1 : 1·4761 | 66° 8′ |
| | | | $\breve{a} : \bar{b} : \grave{c}$ | |
| **739. Caledonite** | $(Pb,Cu)_2(OH)_2SO_4$ | Orthorhombic? | 0·9163 : 1 : 1·4032 | |
| **740. Brochantite** | $Cu_4(OH)_6SO_4$ | " | 0·7739 : 1 : 0·4871 | |
| | | | $\grave{a} : \bar{b} : \grave{c}$ | $\beta$ |
| **741. Linarite** | $PbCu(OH)_2SO_4$ | Monoclinic | 1·7161 : 1 : 0·8296 | 77° 23′ |

**735. MISENITE.** *A. Scacchi*, Mem. G. sulla Campania, 98, 1849.

In silky fibers of a white color. Soluble; taste acid and bitter.

**Comp.**—Probably acid potassium sulphate, $HKSO_4$ or $K_2SO_4.H_2SO_4$ = Sulphur trioxide 58·8, potash 34·6, water 6·6 = 100.

**Anal.**—Scacchi, l. c.

| $SO_3$ | $K_2O$ | $H_2O$ | $Al_2O_3$ | | |
|---|---|---|---|---|---|
| 56·93 | 36·57 | 6·12 | 0·38 | = | 100 |

**Pyr., etc.**—Fuses easily in the flame of a Bunsen burner, imparting to it a violet color. Soluble in water.

**Obs.**—Occurs in a hot tufa cavern at Cape Misene near Naples.

The artificial salt is dimorphous, being obtained ordinarily in orthorhombic crystals, and also in silky fibrous forms and acicular crystals which are monoclinic. Cf. Marignac and Rg., Kr. Ch., 391, 1881. The monoclinic modification has been studied by Wyrouboff, who concludes that misenite belongs to this, the less stable form. It has: 110 ∧ 1$\bar{1}$0 = 68°, 001 ∧ 110 = 80°, 001 ∧ 101 = 62°, $\beta$ = 77° 55′, G. = 2·245. Bull. Soc. Min., **7**, 5, 1884.

**736. ALUMIAN.** *Breith.*, B. H. Ztg., **17**, 53, 1858.

Rhombohedral? Crystals microscopic. Also massive.

Cleavage, traces. H. = 2–3. G. = 2·702–2·781. Luster of small crystals vitreous; of masses weak. Color white. Subtranslucent.

**Comp.**—Perhaps $Al_2O_3.2SO_3$ = Sulphur trioxide 61·1, alumina 38·9= 100. According to Utendörffer's determinations (l. c.), contains 37–38 p. c. of alumina, with sulphuric acid, and no water.

**Pyr., etc.**—B.B. unaltered; only hygroscopic water given off, but at a high temperature sulphuric acid, which may be detected by litmus paper. With cobalt solution a fine blue.

**Obs.**—From mines in the Sierra Almagrera, southern Spain. What appears to be the same mineral was earlier mentioned by Goebel as an efflorescence on the north-east side of Mt. Ararat. He found: $SO_3$ 58·58, $Al_2O_3$ 38·75, $FeSO_4$ 2·78 = 100·11, Schw. J., **60**, 401, 1830.

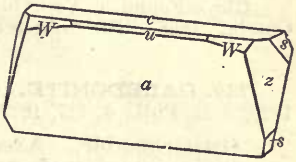
**737. LANARKITE.** Sulphato-carbonate of Lead *Brooke*, Ed. Phil. J., **3**, 117, 1820. Lanarkite *Beud.*, Tr., **2**, 366, 1832. Dioxylith *Breith.*, Char., 1832. Kohlenvitriolbleispath, Halbvitriolblei, *Germ.*

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c}$ = 0·86811 : 1 : 1·38363; $\beta$ = 88° 11′ = 001 ∧ 100 Schrauf[1].

100 ∧ 110 = 40° 56⅚′, 001 ∧ 101 = 56° 35⅚′, 001 ∧ 011 = 54° 7¾′.

**Forms**[1]: *a* (100, *i*-$\bar{i}$), *c* (001, *O*); *u* (103, – ⅓-$\bar{i}$), $\sigma$ ($\bar{3}$02, $\frac{3}{2}$-$\bar{i}$), *z* (131, –3-$\grave{3}$), *s* (1·10·5, – 2-$\overset{\frown}{10}$.) Also less certain *v* (10·1·29), *W* (13·4·37), *τ* ($\bar{2}\bar{3}$·1·15).

Angles: *cu* = 27° 34½′, *ca* = 88° 11′, *cσ* = 68° 51′, *cz* = 76° 42′, *cs* = 70° 3½′, *zz′* = 130° 36′, *az* = 69° 9′.



Leadhills, Schrauf.

Cleavage: *c* perfect; *a*, *u* (103) in traces. Laminæ flexible. H. = 2–2·5. G. = 6·3–6·4 Thomson; 6·8 Pisani. Luster of the cleavage-face pearly; elsewhere adamantine, inclining to resinous. Streak white. Color greenish white, pale yellow or gray. Transparent to translucent.

Optically –. Double refraction strong. Ax. pl. ‖ *b*.

$2H_r = 65° 3'$ $2H_{gr} = 63° 55'$ Pisani

**Comp.**—Basic lead sulphate, $Pb_2SO_5$ or $PbSO_4.PbO$ = Sulphur trioxide 15·2, lead protoxide 84·8=100; or, Lead sulphate 57·6, lead protoxide 42·4 = 100.

**Anal.**—1, Pisani, C. R., **76**, 114, 1873. 2, Flight, J. Ch. Soc., **27**, 103, 1874. 3–4, Collie, ib., **55**, 92, 1889. All from Leadhills.

| | | $SO_3$ | PbO | ign. | | |
|---|---|---|---|---|---|---|
| 1. | G. = 6·8 | 15·10 | 82·73 | 0·83 | = | 98·66 |
| | | $PbSO_4$ | PbO | ign. | | |
| 2. | | 57·70 | 42·89 | — | = | 100·89 |
| 3. | | 57·2 | 40·6 | 0·8 | = | 98·6 |
| 4. | | 57·7 | 42·9 | — | = | 100·6 |
| 5. | | $\frac{2}{2}$ 57·65 | 41·6 | 0·5 | = | 99·6 |

**Pyr., etc.**—B.B. on charcoal easily reduced. Partially dissolved in nitric acid, leaving a residue of lead sulphate.

**Obs.**—At Leadhills, Lanarkshire, Scotland, with caledonite and susannite; of very rare occurrence. Massive at Siberia, and at Tanne, in the Harz; at Biberweier, Tyrol.

**Ref.**—[1] Zs. Kr., **1**, 31, 1877.

**738. DOLEROPHANITE.** Dolerofano *A. Scacchi*, Note Min., **1**, p. 22, Napoli, 1873. Extract from Atti Accad. Sc. Napoli, **5** (read March 12, 1870). Dolerophan.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 1{\cdot}4813 : 1 : 1{\cdot}4761$; $\beta =$ *66° 8′ = 001 ∧ 100 Scacchi.

100 ∧ 110 = 53° 33⅚′, 001 ∧ 101 = 33° 0′, 001 ∧ 011 = 53° 28⅙′.

**Forms:**
*a* (100, *i*-ī)
*b* (010, *i*-ì)
*c* (001, *O*)

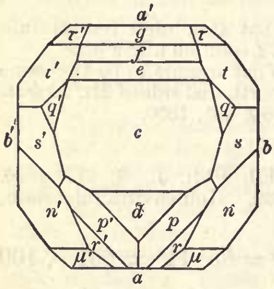
*d* (103, $-\frac{1}{3}$-ī)
*e* ($\bar{1}$03, $\frac{1}{3}$-ī)
*f* ($\bar{2}$03, $\frac{2}{3}$-ī)
*g* ($\bar{1}$01, 1-ī)

*h* ($\bar{3}$02, $\frac{3}{2}$-ī)
*n* (331, − 3)
*t* ($\bar{1}$11, 1)

*p* (739, $-\frac{7}{9}$-$\frac{7}{3}$)
*r* (533, $-\frac{5}{3}$-$\frac{5}{3}$)
*μ* (531, − 5-$\frac{5}{3}$)

*τ* ($\grave{3}$22, $\frac{3}{2}$-$\frac{3}{2}$)
*s* (133, − 1-3̀)
*q* ($\bar{1}$39, $\frac{1}{3}$-3̀)

The composition of dolerophanite seems to correspond to that of lanarkite, but the relation in form is not clear.



After Scacchi.

*cd* = 14° 59½′
*ce* = 19° 20′
*cf* = 39° 43′
*cg* = 56° 47′
*ch* = 73° 52½′
*cn* = *65° 40′

*ct* = 69° 52½′
*cr* = 50° 33′
*cs* = 50° 39′
*an* = *50° 44′
*aμ* = 37° 37′
*ar* = 38° 17′

*as* = 65° 41′
*nn′* = 98° 5′
*tt′* = 102° 12′
*ss′* = 97° 57′
*rr′* = 61° 43½′
*μμ′* = 73° 5′

Crystals small, rarely having a diameter of more than two millimeters. Faces brilliant.

Color brown. Powder brownish yellow. Opaque.

**Comp.**—A basic cupric sulphate, probably corresponding to lanarkite, $Cu_2SO_5$ or $2CuO.SO_3$ = Sulphur trioxide 33·6, cupric oxide 66·4 = 100.

| | $SO_3$ | CuO | insol. | | |
|---|---|---|---|---|---|
| 1. | 36·07 | 62·27 | 1·22 | = | 99·56 |
| 2. | 33·49 | 65·20 | [1·31] | = | 100 |

**Pyr., etc.**—Kept for some time in water, the crystals dissolve in part, giving a blue solution; they preserve their form, however, though the color changes from brown to bluish. Dissolves easily in nitric acid. B.B. fuses, leaving a black scoriaceous residue. Unaltered at a temperature of 260°. With the fluxes gives reaction for copper.

**Obs.**—Found at Vesuvius, having been produced by sublimation during the eruption of October, 1868. The name is derived from δολερός, *fallacious*, φαίνεσθαι, *to appear*.

**739. CALEDONITE.** Cupreous Sulphato-carbonate of Lead *Brooke*, Ed. Phil. J., **3**, 117, 1820, Ann. Phil., **4**, 117, 1822. Calédonite *Beud.*, Tr., **2**, 367, 1832.

Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c} = 0{\cdot}9163 : 1 : 1{\cdot}4032$ Brooke-Miller[1].

100 ∧ 110 = *42° 30′, 001 ∧ 101 = 56° 51⅓′, 001 ∧ 011 = *54° 31½′.

**Forms**[2]**:**
*b* (010, *i*-ĭ)
*c* (001, *O*)
*m* (110, *I*)

*x* (201, 2-ī)
*H* (0·1·24, $\frac{1}{24}$-ĭ)
*χ* (0·1·20, $\frac{1}{20}$-ĭ)
*h* (0·1·16, $\frac{1}{16}$-ĭ)
*γ* (0·1·10, $\frac{1}{10}$-ĭ)

*g* (018, $\frac{1}{8}$-ĭ)
*k* (016, $\frac{1}{6}$-ĭ)
*ψ* (013, $\frac{1}{3}$-ĭ)
*f* (012, $\frac{1}{2}$-ĭ)

*e* (011, 1-ĭ)
*δ* (021, 2-ĭ)
*Σ* (335, $\frac{3}{5}$)
*s* (223, $\frac{2}{3}$)

*r* (111, 1)
*v* (774, $\frac{7}{4}$)
*t* (221, 2)
*w* (20·20·1, 20)?

*mm‴* = 85° 0′
*xx′* = 143° 50′
*ff′* = 70° 6½′
*ee′* = 109° 3′

*cs* = 54° 10′
*cr* = 64° 17½′
*ct* = 76° 28′

*ss′* = 73° 25′
*rr′* = 83° 15½′
*tt′* = 91° 35′

*ss‴* = 66° 25′
*rr‴* = 74° 59½′
*tt‴* = 82° 7′

Crystals prismatic in the direction of the brachydiagonal axis; usually minute; occasionally in divergent groups.

Cleavage: *c* perfect; *a* less so. Fracture uneven. Rather brittle. H.=2·5–3. G. = 6·4. Luster resinous. Color deep verdigris-green or bluish green; inclining to mountain-green if the crystals are delicate. Pleochroic. Streak greenish white. Translucent.

Optically —. Ax. pl. ∥ $a$. Bx ⊥ 010. Axial angles, Dx.[3]

$2H_{a.r} = 112° \; 27'$ $2H_{a.bl} = 113° \; 27\frac{1}{2}'$ $2H_{o.r} = 142° \; 5\frac{1}{2}'$ $2H_{o.bl} = 141° \; 32'$

$\therefore 2V_r = 82° \; 37'$ $2V_{bl} = 83° \; 3'$ $\beta_r = 1·846$ $\beta_{bl} = 1·864$

**Comp.**—A basic sulphate of lead and copper. Perhaps $(Pb,Cu)SO_4.(Pb,Cu)(OH)_2$ or $2(Pb,Cu)O.SO_3.H_2O$. If Pb : Cu = 2 : 1 the percentage composition is: Sulphur trioxide 17·9, lead protoxide 66·3, cupric oxide 11·8, water 4·0 = 100.

**Anal.**—1, W. Flight, J. Ch. Soc., **27**, 101, 1874. 2, Collie, ib., **55**, 92, 1889.

| | $SO_3$ | PbO | CuO | $H_2O$ | |
|---|---|---|---|---|---|
| 1. Leadhills | 17·30 | 68·42 | 10·17 | 4·05 | = 99·94 |
| 2. " | 15·6[a] | 67·7[a] | 10·7 | 3·5 | $CO_2$ 1·9 = 99·4 |

[a] Given as $PbSO_4$ 59.1, PbO 24·2.

The analysis of Brooke gave $CO_2$, which according to N. Story-Maskelyne and Flight belongs with the admixed cerussite.

**Pyr., etc.**—B.B. on charcoal easily reduced. Partially soluble, with a slight effervescence when impure with lead carbonate, in nitric acid, leaving a residue of lead sulphate.

**Obs.**—Occurs at Leadhills, Scotland, accompanying other ores of lead, in crystals with linarite; at Red Gill in Cumberland; also at Rezbánya in Hungary; Tanne in the Harz; Mala-Calzetta mine near Iglesias, Sardinia, with leadhillite in a quartzose gangue (Rath). In the Ural at the Preobrayensk mine near Berezov, in gold quartz with cerussite, anglesite, bismite.

Said to occur at Mine la Motte, Missouri, but needs confirmation. In California at the argentiferous galena mines of Cerro Gordo, with anglesite, mimetite, smithsonite, etc.

**Ref.**—[1] The early, though not very satisfactory, measurements of Brooke are accepted here, as is done by Koksharov (Min. Russl., **9**, 40, 1884). Schrauf refers crystals from Rezbánya to the monoclinic system, the macrodiagonal axis of Miller becoming the clinodiagonal axis; the crystals are regarded as twins with numerous tw. lamellæ; thus $e$ (011) becomes $e$ (101) and $\eta$ ($\bar{1}$01), etc. The same conclusion is reached by Eremeyev after the study of Uralian crystals. The axial ratios deduced by these authors are:

$\grave{a} : \bar{b} : \acute{c} = 1·09134 : 1 : 1·57860$ $\beta = 89° \; 18'$ Schrauf

$1·08956 : 1 : 1·57725$ $88° \; 22'$ Erem.

The question cannot be regarded as definitely settled, until the complex structure assumed is confirmed by optical examination. On the crystallization of the species, see: Brooke, Ann. Phil., **4**, 117, 1822; Greg and Lettsom, Min., 403, 1858; Mlr., Min., 561, 1852; Peters, Ber. Ak. Wien, **44** (1), 170, 1861; Hbg., Min. Not., **9**, 48, 1870; Schrauf, Rezbánya, Ber. Ak. Wien, **64** (1), 179, 1871, Atlas XL, 1873; Erem., Mem. Acad. St. Pet., **31**, No. 16, 1883; Rath, Ber. nied. Ges., Feb. 8, 1886.

[2] Cf. Mlr., Schrauf, Erem., l. c. [3] Dx., N. R., 205, 1867, he finds no proof of the twinning assumed, cf. remarks quoted by Kk.

**740. BROCHANTITE.** Brochantite (Ural) *Lévy*, Ann. Phil., **8**, 241, 1824. Königine (fr. Russia) *Lévy*, ib., **11**, 194, 1826. Brongnartine (fr. Mexico) *Huot*, Min., **1**, 331, 1841. Krisuvigit (fr. Iceland) *Forchhammer*, Skand. Nat. Stockh., 1842, Arsb., 192, 1843. Waringtonite (fr. Cornwall) *Maskelyne*, Ch. News, **10**, 263, 1864, Phil. Mag., **29**, 475, 1865. Warringtonite, *wrong orthogr.*

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·7739 : 1 : 0·4871$ Koksharov[1].
$100 \wedge 110 = 37° \; 44\frac{1}{6}'$, $001 \wedge 101 = 32° \; 11\frac{1}{6}'$, $001 \wedge 011 = 25° \; 58\frac{1}{4}'$.

**Forms:** $a$ (100, $i$-$\bar{\imath}$) $b$ (010, $i$-$\breve{\imath}$), $c$ (001, $O$); $m$ (110, $I$), $r$ (120, $i$-$\breve{2}$); $v$ (101, 1-$\bar{\imath}$), $x$ (201, 2-$\bar{\imath}$); $e$ (012, $\frac{1}{2}$-$\breve{\imath}$).

Schrauf[1], who makes the species monoclinic-triclinic, adds: $\lambda$ (610), $\mu$ (730), $n$ (340), $i$ (011), $o$ (112), $k$ (12·1·4), $f$ (616), $g$ (313), $p$ (212), $t$ (532), $s$ (136).

Angles: $mm''' = 75° \; 28'$, $rr' = 65° \; 46'$, $vv' = 64° \; 22'$, $xx' = 103° \; 4'$, $ee' = 27° \; 22\frac{1}{2}'$, $mx = 51° \; 44'$, $kk' = 123° \; 50'$, $kk''' = 6° \; 31\frac{1}{2}'$.

Crystals commonly prismatic ∥ $\acute{c}$, with faces $m$, $r$, $b$ vertically striated; also elongated ∥ $b$ with curving faces. In groups of acicular crystals and drusy crusts. Massive with reniform structure.

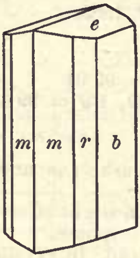
Cleavage: $b$ very perfect; $m$ in traces. Fracture uneven. H. = 3·5–4. G. = 3·907 Rose. Luster vitreous; a little pearly on the cleavage-face $b$. Color emerald-green, blackish green. Streak paler green. Transparent to translucent.

Optically −. Ax. pl. ∥ *a*. Bx ⊥ *b*. Axial angles:

$2H_a = 95° 6'$ Chili, $= 98°$ Nizhni Tagilsk, Btd. Also $2H_{gr} = 96° 10'$ Dx., Chili.

**Comp.**—A basic sulphate of copper, $CuSO_4.3Cu(OH)_2$ or $4CuO.SO_3.3H_2O$ = Sulphur trioxide 17·7, cupric oxide 70·3, water 12·0 = 100.

1.



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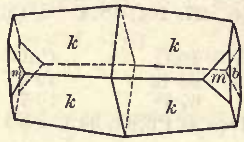

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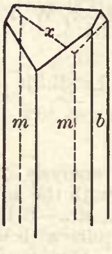


3.

Figs. 1, Ural, Rose. 2–4, Utah, Washington[2].

**Anal.**—1, Ludwig, Min. Mitth., 38, 1873; earlier Magnus. 2, Forchhammer, J. pr. Ch., **30**, 396, 1843. 3, Risse, Pogg., **105**, 614, 1858. 4. Tschermak, Ber. Ak. Wien, **51** (1), 131, 1865. 5, Chester, Am. J. Sc., 33, 287, 1887. 6, Church, J. Ch. Soc., **18**, 85, 1865. 7, Maskelyne, Phil. Mag., **29**, 475, 1865. 8, Pearce, Proc. Col. Soc., **1**, 119, 1884.

| | | $SO_3$ | CuO | $H_2O$ | |
|---|---|---|---|---|---|
| 1. Rezbánya | | 17·38 | 70·64 | 11·97 | = 99·99 |
| 2. Krisuvig | | 18·88 | 67·75 | 12·81 | = 99·44 |
| 3. Nassau | | 19·0 | 67·8 | 13·2 | Cl *tr.* = 100 |
| 4. N. S. Wales | G. = 3·89 | 19·4 | 69·1 | 11·5 | = 100 |
| 5. Chili | | 18·21 | 71·73 | 10·06 | = 100 |
| 6. Cornwall, *Waringtonite* | | 18·93 | 68·27 | 12·22 | insol. 0·58 = 100 |
| 7. " " | G. = 3·43 | 16·73 | 68·24 | 14·64 | = 99·61 |
| 8. Colorado | | 18·65 | 68·70 | [12·65] | = 100 |

Ludwig found that the water went off above 300°; Church gives $H_2O$ 1·04, below 260°.

**Var.**—1. *Ordinary Brochantite.* The analyses vary considerably, as shown below. The crystals are vertically striated.

2. *Waringtonite.* Essentially brochantite in composition, but occurring in non-striated crystals in form like a doubly curving wedge, of paler green color than ordinary brochantite, with G. = 3·39–3·47, and H. = 3–3·5.

**Pyr., etc.**—Yields water, and at a higher temperature sulphuric acid, in the closed tube, and becomes black. B.B. fuses, and on charcoal affords metallic copper. With soda gives the reaction for sulphuric acid.

**Obs.**—Occurs in small but well-defined crystals, with malachite and native copper, at Gumeshevsk and Nizhni Tagilsk in the Ural; the königine (or *königite*) was from Gumeshevsk; in small brilliant crystals with malachite in a quartzose rock near Roughten Gill, in Cumberland; in Cornwall (in part *waringtonite*), and sometimes with crystals of brochantite on the so-called waringtonite; at Rezbánya; in Nassau, with chalcopyrite; in small beds at Krisuvig in Iceland (*krisuvigite*); in Mexico (*brongnartine*); in Chili, at Andacollo, Atacama with atacamite, with which it can easily be confounded; in Australia (brought from Sydney, N. S. W.); Balade mine, New Caledonia.

In the U. States, found at Monarch mine, Chaffee Co., Colorado; Bill Williams Fork, Arizona. In Utah, Tintic district, at the Mammoth mine; also, near Frisco.

Named after Brochant de Villiers. Waringtonite is for Warington W. Smyth (1817–1890).

**Artif.**—Formed in a bright green powder by Field (Phil. Mag., **24**, 123, 1862) by adding to a strong solution of sulphate of copper a small quantity of caustic potash, boiling, filtering, and washing till all the sulphate of copper is removed; analysis after drying at 100° C. afforded $SO_3$ 16·98, CuO 67·51, $H_2O$ [15·51] = 100. See further under LANGITE.

Also by Meunier as the result of the action of concentrated sulphate of copper upon galena for 11 months, C. R., **86**, 686, 1878. Atanasesco heated copper sulphate in a closed tube at 200° with (A) oxide of copper and (B) with water. The brochantite obtained had the following composition:

| | $SO_3$ | CuO | $H_2O$ | |
|---|---|---|---|---|
| A | 23·00 | 67·46 | 10·36 | = 100·82 |
| B | 22·51 | 67·20 | 10·47 | = 100·18 |

These correspond to $3CuO.SO_3.2H_2O$. Bull. Soc. Ch., **44**, 14, 1885.

**Ref.**—[1] Min. Russl., 3, 260. Compare also Rose, Reis., Ural, 1, 267, 1837; Lévy, Heul. Min., 3, 98, 1837; Schrauf, Ber. Ak. Wien, **67** (1), 275, 1873. Schrauf gives an exhaustive monograph of the species; he makes it isomorphous with malachite, and in crystalline form approximately monoclinic. He distinguishes four types. I. Brochantite from Rezbánya (in two varieties), Redruth, Cornwall, etc., triclinic. II. Waringtonite from Cornwall, and a variety from Rezbánya, monoclinic (?). III. From Nizhni Tagilsk, monoclinic-triclinic. IV. Königine from Russia, also a variety from Rezbánya, monoclinic or orthorhombic.

Cf. also Groth, Min.-Samml., Strassb., 155, 1878. [2] Washington, Utah, Am. J. Sc., **35**, 306, 1888; Dx., Btd., Bull. Soc. Min., 3, 56, 1880.

**741. LINARITE.** Cupreous Sulphate of Lead *Brooke*, Ann. Phil., 4, 117, 1822. Cupreous Anglesite. Linarite *Alger-Phillips*, Min., 552, 1844. Bleilasur, Kupferbleispath, Kupferbleivitriol, *Germ.*

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 1{\cdot}71613 : 1 : 0{\cdot}82962$; $\beta = {*}77° 22' 40'' = 001 \wedge 100$ Koksharov[1].

$100 \wedge 110 = 59° 9' 25''$, $001 \wedge 101 = 23° 6' 23''$, $001 \wedge 011 = 38° 59' 33''$.

**Forms**[2]:
*a* (100, $i$-$\bar{i}$)
*b* (010, $i$-$\grave{i}$)
*c* (001, *O*)
*l* (210, $i$-$\bar{2}$)
*m* (110, *I*)

*y* (101, − 1-$\bar{i}$)
*η* (501, − 5-$\bar{i}$)
*d* ($\bar{1}08$, $\frac{1}{8}$-$\bar{i}$)
*o* ($\bar{2}03$, $\frac{2}{3}$-$\bar{i}$)
*t* (506, $\frac{5}{6}$-$\bar{i}$)
*s* ($\bar{1}01$, 1-$\bar{i}$)

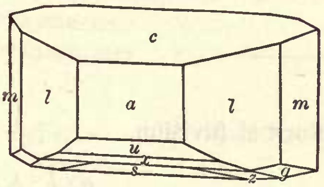
*x* ($\bar{3}02$, $\frac{3}{2}$-$\bar{i}$)
*ρ* ($\bar{3}\bar{9}{\cdot}0{\cdot}20$, $\frac{39}{20}$-$\bar{i}$)
*u* ($\bar{2}01$, 2-$\bar{i}$)
*π* ($\bar{7}03$, $\frac{7}{3}$-$\bar{i}$)
*β* ($\bar{1}\bar{2}{\cdot}0{\cdot}5$, $\frac{12}{5}$-$\bar{i}$)
*p* ($\bar{7}01$, 7-$\bar{i}$)

*w* (012, $\frac{1}{2}$-$\grave{i}$)
*r* (011, 1-$\grave{i}$)
*q* ($\bar{1}12$, $\frac{1}{2}$)
*e* ($\bar{1}11$, 1)
*n* ($\bar{2}21$, 2)
*v* ($\bar{2}\bar{2}{\cdot}1{\cdot}14$, $\frac{11}{7}$-$\bar{2}\bar{2}$)

*α* ($\bar{1}\bar{3}{\cdot}1{\cdot}13$, 1-$\bar{1}\bar{3}$)
*γ* ($\bar{1}\bar{1}{\cdot}1{\cdot}10$, $\frac{11}{10}$-$\bar{1}\bar{1}$)
*θ* ($\bar{9}19$, 1-$\bar{9}$)
*z* ($\bar{8}17$, $\frac{8}{7}$-$\bar{8}$)
*g* ($\bar{2}11$, 2-$\bar{2}$)
*σ* ($\bar{1}21$, 2-$\grave{2}$)

Also doubtful *k* ($\bar{2}\bar{8}{\cdot}5{\cdot}27$), *λ* ($\bar{2}\bar{4}{\cdot}5.21$), *h* ($\bar{2}\bar{8}{\cdot}5{\cdot}30$).

1.



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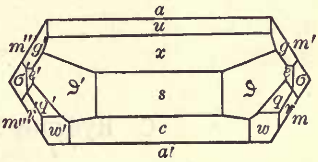

Figs. 1, 2, After Koksharov.

*ll'''* = 79° 53'
*mm'''* = *118° 18' 50"
*co* = 18° 41½'
*ct* = 23° 19'
*cs* = 27° 49'
*cx* = 40° 3½'
*cu* = 50° 6'

*a'u* = *52° 31'
*ww'* = 44° 4½'
*rr'* = 77° 59'
*cq* = 26° 19'
*ce* = 46° 20'
*cn* = 67° 10½'
*cm'* = 96° 26'

*m'e* = 50° 6'
*cg* = 57° 36½'
*cl'* = 99° 39'
*l'g* = 42° 2'
*a'e* = 78° 12'
*a'r* = 99° 47'

*a'g* = 59° 27'
*θθ'* = 10° 10'
*ee'* = 77° 22'
*σσ'* = 116° 2'
*gg'* = 66° 43'
*nn'* = 105° 34'

Twins[3]: tw. pl. *a*. Crystals elongated ∥ $\bar{b}$, and often tabular ∥ *c*; also ∥ *s* ($\bar{1}01$). Cleavage: *a* very perfect; *c* less so. Fracture conchoidal. Brittle. H. = 2·5. G. = 5·3–5·45. Luster vitreous or adamantine. Color deep azure-blue. Streak pale blue. Translucent.

**Comp.**—A basic sulphate of lead and copper, $(Pb,Cu)SO_4.(Pb,Cu)(OH)_2$ or $PbO.CuO.SO_3.H_2O$ = Sulphur trioxide 20·0, lead oxide 55·7, cupric oxide 19·8, water 4·5 = 100.

**Anal.**—1, Kobell, J. pr. Ch., **83**, 454, 1861. 2, Collie, J. Ch. Soc., **55**, 93, 1889. 3, Petersen, Sandb. Erzg., 125, 1882. 4, Frenzel, Jb. Min., 675, 1875.

| | | $PbSO_4$ | CuO | $H_2O$ | |
|---|---|---|---|---|---|
| 1. Nerchinsk | | 76·41 | 17·43 | 6·16 | Cl *tr.* = 100 |
| 2. Leadhills | | 75·3 | 19·6 | 5·2 | = 100 |
| 3. Schapbach | G. = 5·47 | 74·88[a] | 19·06 | 4·75 | = 98·69 |
| 4. Argentine R. | G. = 5·06 | 74·42 | 20·22 | 4·69 | = 99·33 |

[a] $SO_3$ 20·08, PbO 54·80.

**Pyr., etc.**—In the closed tube yields water and loses its blue color. B.B. on charcoal fuses easily to a pearl, and in R.F. is reduced to a metallic globule which by continued treatment coats the coal with oxide of lead, and if fused boric acid is added yields a pure globule of copper. With soda gives the reaction for sulphuric acid. Decomposed by nitric acid, leaving a white residue of lead sulphate.

**Obs.**—Formerly found at Leadhills. Occurs at Roughten Gill, Red Gill, and near Keswick, in Cumberland, in crystals sometimes an inch long; near Schneeberg, rare; in Dillenburg, at the mines Aurora and Thomas; Nassau on the Lahn; at Schapbach, in Baden (Sandberger, l. c.), and from Badenweiler (Liweh, Zs. Kr., **9**, 522, 1884); at Rezbánya; at the Kadainski mine, Nerchinsk, in E. Siberia; in the vicinity of Berezov in the Ural; supposed formerly to be found at Linares in Spain, whence the name.

From the Ortiz mine in the Sierra Capillitas, Argentine Republic; from Chili (Stelzner, Min. Mitth., 249, 1873; Frenzel, l. c.). Also from the state of Jalisco, Mexico.

In the United States, in fine specimens at the Cerro Gordo mines in Inyo Co., California.

**Alt.**—Linarite occurs altered to cerussite, a change like that of anglesite to cerussite.

**Ref.**—[1] Cumberland, Bull. Ac. St. Pet., **13**, 472. 1869, Min. Russl., **5**, 206. Cf. Erem., Ural and Altai, Vh. Min. Ges., **19**, 15, 1884.

[2] Mlr., Min., 554, 1852; Greg and Lettsom, Min., 395, 1858; Hbg., Min. Not., **6**, 31, 1864; Kk., l. c.; Schrauf, Ber. Ak. Wien, **64** (1), 172, 1871, **65** (1), 241, 1872; Zeph., Erzberg, Lotos, Dec. 1874. [3] Rath, Ber. nied. Ges., 79, 1878, or Zs. Kr., **4**, 426, 1880.

ANTLERITE *W. F. Hillebrand*, U. S. G. Surv., Bull. **55**, 54, 1889.

Massive; in soft lumps of a light green color. G. = 3·93 corrected. Composition, perhaps $3CuSO_4.7Cu(OH)_2$ or $10CuO.3SO_3.7H_2O$ = Sulphur trioxide 20·7, cupric oxide 68·4, water 10·9 = 100. Anal.—Hillebrand, l. c., after deducting 8 and 6 p. c. gangue.

| | $SO_3$ | CuO | ZnO | CaO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|
| 1. | 20·46 | 68·19 | 0·29 | 0·05 | 11·11 | = | 100·10 |
| 2. | 21·49 | 67·64 | 0·04 | 0·04 | 10·76 | = | 99·97 |

From the Antler mine, Yucca Station (Atlantic & Pacific R.R.), Mohave Co., Arizona.

## C. Hydrous Sulphates.—Normal Division.

| | | | | | |
|---|---|---|---|---|---|
| | | | | $\breve{a} : \bar{b} : \acute{c}$ | |
| **742. Lecontite** | $(Na,NH_4,K)_2SO_4 + 2H_2O$ | Orthorhombic | | 0·7848 : 1 : 1·5312 | |
| | | | | $\grave{a} : \overset{\shortmid}{b} : \acute{c}$ | $\beta$ |
| **743. Mirabilite** | $Na_2SO_4 + 10H_2O$ | Monoclinic | | 1·1158 : 1 : 1·2372 | 72° 15′ |
| **744. Kieserite** | $MgSO_4 + H_2O$ | " | | 0·9147 : 1 : 1·7571 | 89° 6′ |
| **745. Szmikite** | $MnSO_4 + H_2O$ | | | | |
| **746. Gypsum** | $CaSO_4 + 2H_2O$ | Monoclinic | | 0·6899 : 1 : 0·4124 | 80° 42′ |
| **747. Ilesite** | $(Mn,Zn,Fe)SO_4 + 4H_2O$ | Monoclinic? | | | |

### **Epsomite Group.** $RSO_4 + 7H_2O$. Orthorhombic.

| | | |
|---|---|---|
| | | $\breve{a} : \bar{b} : \acute{c}$ |
| **748. Epsomite** | $MgSO_4 + 7H_2O$<br>$(Fe,Mg)SO_4 + 7H_2O$ | 0·9902 : 1 : 0·5709 |
| Tauriscite | $FeSO_4 + 7H_2O$? | |
| **749. Goslarite** | $ZnSO_4 + 7H_2O$ | 0·9807 : 1 : 0·5631 |
| Ferro-goslarite | $(Zn,Fe)SO_4 + 7H_2O$ | |
| **750. Morenosite** | $NiSO_4 + 7H_2O$ | 0·9816 : 1 : 0·5655 |

**Melanterite Group.** $RSO_4 + 7H_2O$. Monoclinic.

| | | | $\grave{a} : \bar{b} : \acute{c}$ | $\beta$ |
|---|---|---|---|---|
| 751. | **Melanterite** | $FeSO_4 + 7H_2O$ | 1·1828 : 1 : 1·5427 | 75° 44′ |
| | Luckite | $(Fe,Mn)SO_4 + 7H_2O$ | | |
| 752. | **Mallardite** | $MnSO_4 + 7H_2O$ | | |
| 753. | **Pisanite** | $(Fe,Cu)SO_4 + 7H_2O$ | 1·1609 : 1 : 1·5110 | 74° 38′ |
| 754. | **Bieberite** | $CoSO_4 + 7H_2O$ | 1·1815 . 1 : 1·5325 | 75° 20′ |
| | Cupromagnesite | $(Cu,Mg)SO_4 + 7H_2O$ | | |

755. **Chalcanthite** $CuSO_4 + 5H_2O$ Triclinic

$\breve{a} : \bar{b} : \acute{c} = 0·5656 : 1 : 0·5507$; $\alpha = 82° 21'$, $\beta = 73° 11'$, $\gamma = 77° 37'$

| | | | | $\grave{a} : \bar{b} : \acute{c}$ | $\beta$ |
|---|---|---|---|---|---|
| 756. | **Syngenite** | $K_2Ca(SO_4)_2 + H_2O$ | Monoclinic | 1·3699 : 1 : 0·8738 | 76° 0′ |
| 757. | **Löweite** | $Na_2Mg(SO_4)_2 + 2\frac{1}{2}H_2O$ | Tetragonal | | |
| 758. | **Blödite** | $Na_2Mg(SO_4)_2 + 4H_2O$ | Monoclinic | 1·3494 : 1 : 0·6705 | 79° 22′ |

| | | | | $\grave{a} : \bar{b} : \acute{c}$ | $\beta$ |
|---|---|---|---|---|---|
| 759. | **Boussingaultite** | $(NH_4)_2Mg(SO_4)_2+6H_2O$ | Monoclinic | 0·7438 : 1 : 0·4862 | 71° 50′ |
| 760. | **Picromerite** | $K_2Mg(SO_4)_2 + 6H_2O$ | “ | 0·7265 : 1 : 0·4900 | 75° 12′ |
| 761. | **Cyanochroite** | $K_2Cu(SO_4)_2 + 6H_2O$ | “ | 0·7477 : 1 : 0·5052 | 75° 30′ |

| | | | |
|---|---|---|---|
| 762. | **Polyhalite** | $K_2MgCa_2(SO_4)_4+2H_2O$ | Monoclinic? |
| | Krugite | | |
| 763. | **Wattevillite** | $Na_2Ca(SO_4)_2 + 4H_2O$? | |

**Alum Group.** Isometric.

$\overset{\text{I}}{R}Al(SO_4)_2 + 12H_2O$ or $\overset{\text{I}}{R}_2SO_4.Al_2(SO_4)_3 + 24H_2O$

| | | |
|---|---|---|
| 764. | **Kalinite** | $KAl(SO_4)_2 + 12H_2O$ |
| 765. | **Tschermigite** | $(NH_4)Al(SO_4)_2 + 12H_2O$ |
| 766. | **Mendozite** | $NaAl(SO_4)_2 + 12H_2O$ |

767. **Tamarugite** $NaAl(SO_4)_2 + 6H_2O$

**Halotrichite Group.** Monoclinic.

$RAl_2(SO_4)_4 + 22H_2O$ (or $24H_2O$)

| | | |
|---|---|---|
| 768. | **Pickeringite** | $MgAl_2(SO_4)_4 + 22H_2O$ |
| | Stüvenite | $(Na_2,Mg)Al_2(SO_4)_4 + 24H_2O$ |
| 769. | **Halotrichite** | $FeAl_2(SO_4)_4 + 24H_2O$, or perhaps $22H_2O$ |

| | |
|---|---|
| **770. Apjohnite** | $MnAl_2(SO_4)_4 + 24H_2O$ |
| Bushmanite | $(Mn,Mg)Al_2(SO_4)_4 + 24H_2O$ |
| **771. Dietrichite** | $(Zn,Fe,Mn)Al_2(SO_4)_4 + 22H_2O$ |

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| | | | | |
|---|---|---|---|---|
| **772. Coquimbite** | $Fe_2(SO_4)_3 + 9H_2O$ | Rhombohedral | $\acute{c}$ = 1·5613 | |
| | | | $\grave{a} : \bar{b} : \acute{c}$ | $\beta$ |
| **773. Quenstedtite** | $Fe_2(SO_4)_3 + 10H_2O$ | Monoclinic | 0·3940 : 1 : 0·4058 | 78° 7½′ |
| **774. Ihleite** | $Fe_2(SO_4)_3 + 12H_2O$ | | | |
| **775. Alunogen** | $Al_2(SO_4)_3 + 18H_2O$ | Monoclinic | | |

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| | | | |
|---|---|---|---|
| **776. Kröhnkite** | $Na_2Cu(SO_4)_2 + 2H_2O$ | Monoclinic | |
| **777. Ferronatrite** | $Na_3Fe(SO_4)_3 + 3H_2O$ | Rhombohedral | $\acute{c}$ = 0·5528 |
| **778. Roemerite** | $\overset{II}{Fe}\overset{III}{Fe}_2(SO_4)_4 + 12H_2O$ | Triclinic | |

$\breve{a} : \bar{b} : \acute{c}$ = 0·9684 : 1 : 2·6425; $\alpha$ = 116° 3′, $\beta$ = 94° 41′, $\gamma$ = 80° 7′

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**742. LECONTITE.** *W. J. Taylor*, Am. J. Sc., **26**, 273, 1858.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c}$ = 0·7848 : 1 : 1·5312 J. D. Dana[1].
100 ∧ 110 = 38° 7½′, 001 ∧ 101 = 62° 51¾′, 001 ∧ 011 = 56° 51′.

**Forms:** *m* (110, *I*), *g* (120, *i*-$\breve{2}$); *d* (104, ¼-$\bar{i}$).

Angles: *mm‴* = 76° 15′, *gg′* = *65° 0′, *dd′* = *52° 0′.

In prismatic crystals, long or short.

H. = 2–2·5. Luster vitreous. Colorless, when pure, and transparent. Taste saline and rather bitter. Permanent in the air.

**Comp.**—Hydrous sulphate of sodium, ammonium, and potassium, $(Na,NH_4,K)_2SO_4 + 2H_2O$.

**Anal.**—Taylor, l. c.

| $SO_3$ | $Na_2O$ | $(NH_4)_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|
| 44·97 | 17·56 | 12·94 | 2·67 | 19·45 | residue 2·41, $P_2O_5$ *tr.* = 100 |

**Pyr., etc.**—Only partially sublimed in the closed tube, but otherwise reacts like mascagnite.

**Obs.**—From the cave of Las Piedras, near Comayagua, Central America, embedded in a black mass made up of the excrement of bats. The crystals often have a coating of organic matter. The cave is worked for the niter, which the earth of the floor near its mouth affords by lixiviation.

Named after Dr. John L. Le Conte.

GUANOVULITE *Wibel*, Ber. Ch. Ges., **7**, 392, 1874.

Found in crystalline deposits filling the eggs of birds in Peruvian guano. H. = 2. G. = 2·33–2·65. Color yellowish white. Luster silky. A sulphate of potassium and ammonium. Calculated formula, $7K_2O.2(NH_4)_2O.12SO_3.11H_2O$. Analysis, after deducting impurities:

$SO_3$ 49·60 $K_2O$ 35·49 $(NH_4)_2O$ 5·09 $H_2O$ 9·82 = 100

In water dissolves, leaving a very small residue, and giving a light yellowish solution, which has a salty taste. Insoluble in ether or alcohol. Heated in a glass tube it first loses water and ammonia, then becomes black, and on stronger heating melts and gives off much sulphuric acid.

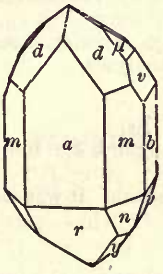
**743. MIRABILITE.** Glauber Salt. Sal mirabile *Glauber* (the artificial salt at the time of its first formation). Natürliches Wundersalz, Glaubersalz, *Germ.* Glauber Salt. Sulphate of Soda. Soude sulfatée, Sel de Glauber, *Fr.* Mirabilite *Haid.*, Handb., 488, 1845. Gediegen Glaubersalz (fr. Saidschitz and Sedlitz) *Reuss*, Crell's Ann., **2**, 18, 1791; = Natürliches Bittersalz pt. *Lenz*, Min., **1**, 489, 1794; = Reussin *Karst.*, Tab., 40, 1800.

Monoclinic. Axes $\grave{a} : \bar{b} : \dot{c} = 1·11584 : 1 : 1·23719$; $\beta = {}^*72° 15' = 001 \wedge 100$ Haidinger.

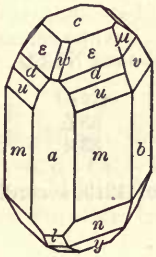
$100 \wedge 110 = 46° 44\frac{1}{2}'$, $001 \wedge \bar{1}01 = 57° 55'$, $001 \wedge 011 = 49° 40\frac{3}{4}'$.

| **Forms**[2]: | *c* (001, *O*) | *l* ($\bar{1}$02, ½-$\bar{i}$) | *v* (021, 2-$\grave{i}$) | *u* (221, − 2)[3] |
|---|---|---|---|---|
| *a* (100, *i*-$\bar{i}$) | *m* (110, *I*) | *r* ($\bar{1}$01, 1-$\bar{i}$) | $\epsilon$ (112, − ½)[3] | *y* ($\bar{1}$12, ½) |
| *b* (010, *i*-$\grave{i}$) | *w* (102, − ½-$\bar{i}$) | $\mu$ (011, 1-$\grave{i}$) | *d* (111, − 1) | *n* ($\bar{1}$11, 1) |

1.



2.



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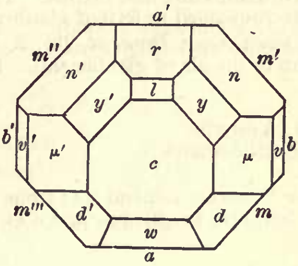


Figs. 1, 2, Aussee, Zepharovich.

$mm''' = {}^*93° 29'$
$cw = 24° 18'$
$cl = 32° 26'$
$cr = 57° 55'$
$a'r = {}^*49° 50'$
$\mu\mu' = 99° 21\frac{1}{2}'$
$vv' = 134° 1'$
$c\epsilon = 34° 5'$
$cd = 49° 47'$
$cu = 62° 5\frac{1}{2}'$
$cm = 77° 56\frac{1}{2}'$
$cy = 43° 35\frac{1}{2}'$
$cn = 67° 18'$
$ad = 46° 59'$
$a\mu = 78° 37'$
$a'n = 62° 3'$
$\epsilon\epsilon' = 49° 20'$
$dd' = 69° 19'$
$yy' = 61° 47\frac{1}{2}'$
$nn' = 86° 47'$

Twins: tw. pl. *a*, rare. Crystals like pyroxene (also borax) in habit as well as angles. Usually in efflorescent crusts.

Cleavage: *a* perfect; *c*, *b*, in traces. H. = 1·5–2. G. = 1·481 Haid. Luster vitreous. Color white. Transparent to opaque. Taste cool, then feebly saline and bitter.

Optically −. Ax. pl. and $Bx_a \perp b$. $Bx_{o.r} \wedge \dot{c} = +30° 56'$. $Bx_{o.bl} \wedge \dot{c} = 26° 31'$. Ax. angles, Dx.[4]

$2H_{a.r} = 73° 35' \quad \therefore 2E_r = 122° 48' \qquad 2H_{a.bl} = 72° 51' \quad \therefore 2E_{bl} = 122° 42'$

Artif. cryst. yellowish with a trace of vanadium were positive, with the bisectrix in plane ∥ *b* and nearly normal to *c*; $B_{a.r} \wedge \dot{c} = 20° 15'$, $Bx_{a.bl} \wedge \dot{c} = 18° 26'$. Also $2H_y = 58° 0'$ and $2E_y = 90° 45'$.

**Comp.**—Hydrous sodium sulphate, $Na_2SO_4 + 10H_2O$ = Sulphur trioxide 24·8, soda 19·3, water 55·9 = 100.

Analyses, 5th Ed., p. 636; also Sicily, Zs. Kr., **4**, 639, 1880; Peru, Raimondi, Min. Pérou, 288, 1878.

**Pyr., etc.**—In the closed tube much water; gives an intense yellow to the flame. Very soluble in water. Loses its water on exposure to dry air and falls to powder.

**Obs.**—Occurs at Ischl, Hallstadt, and Aussee in Upper Austria; also in Hungary, Switzerland, Italy; at Guipuzcoa in Spain, etc.; abundantly at the hot springs at Carlsbad; in considerable beds near Bompensieri Montedoro, Sicily. In beds in the province of Tarapacá, Chili; at Kailua, on Hawaii, Sandwich Islands, abundant in a cavern, and forming from the action of volcanic heat and gases on salt water.

Effloresces with other salts on the limestone below the Genesee Falls, Rochester, N. Y.; at Windsor, Nova Scotia; also near the Sweetwater River, Rocky Mountains. Large quantities of this sodium sulphate are obtained from the Great Salt Lake, Utah. It is present in solution in the waters of the lakes, and in winter when a temperature falls to a certain point the precipitation begins and the salt accumulates so that it can be gathered from the bottom and is thrown upon the shores by the waves. "Under favorable circumstances the shores become covered to a depth of several feet with crystallized mirabilite. . . . Speaking only of the amount thrown upon the shores and of most ready access, the source is practically inexhaustible. The substance must be gathered, if at all, soon after the deposit first appears; as, if the water once rises above the critical temperature, the whole deposit is taken again into solution. This change is very rapid, a single day being often sufficient to effect the entire disappearance of all the deposits within reach of the waves."—J. E. Talmage, Science, **14**, 446, Dec. 27, 1889.

The artificial salt was discovered by Glauber, a German chemist, about the middle of the seventeenth century, while he was operating with sulphuric acid and common salt; and the name *sal mirabile* was his own expression of surprise at its formation.

**Ref.**—[1] Min. Mohs, **2**, 31, 1825. [2] See Haid.; also Miller, Min., p. 545, 1852; with him, *a* is the base and *c* the orthopinacoid. Cf. also Rg., Kr. Ch., 395, 1881. [3] Aussec, Zeph., Lotos, 1877. [4] Propr. Opt., **1**, 73, 1857. N. R., 175, 1867.

The so-called *Reussin* is impure glauber salt, as pronounced by Reuss in 1791, after his early study of it. It occurred as a deposit of crystals and efflorescent crusts in or about the mineral springs of Saidschitz and Sedlitz. The crystals had the form of glauber salt. The analysis by Reuss corresponded to 68·0 of glauber salt, 31·7 of epsomite, and 0·3 of gypsum = 100.

EXANTHALOSE *Beudant*, Tr., **2**, 475, 1832. A white efflorescence, such as results from the exposure to the air of glauber salt. Beudant obtained $Na_2SO_4 + 2H_2O$; analyses:

| | $SO_3$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|
| 1. Vesuvius | 44·8 | 35·0 | 20·2 | = 100 |
| 2. Hildesheim | 42·5 | 33·4 | 18·8 | gangue 5·3 = 100 |

The Vesuvian mineral was from the lavas of 1813, according to Beudant. It was named from ἐξανθεῖν, *to effloresce*, and ἅλς, *salt.*

**744. KIESERITE.** Kieserit *Reichardt*, Salzbergwerk Stassfurt, 1860; B. H. Ztg., **20**, 39, 1861. Martinsite *Kenngott*, Ueb., 22, 1856–57; *Rammelsberg*, Pogg., **98**, 262, 1856 (not Martinsite *Karsten*, 1845).

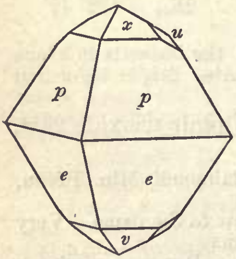
Monoclinic. Axes $\grave{a} : \overset{|}{b} : \acute{c} = 0·91470 : 1 : 1·75713$; $\beta = 89° 5\frac{2}{3}' = 001 \wedge 100$ Tschermak[1].

$100 \wedge 110 = 42° 26\frac{3}{4}'$, $001 \dot{\wedge} \bar{1}01 = 63° 12\frac{5}{6}'$, $001 \wedge 011 = 60° 21\frac{1}{6}'$.

**Forms**: *t* (101, – 1-ī) cleavage; *u* (012, ½-ī); *x* (113, – ⅓), *p* (111, – 1); *h* ($\bar{2}$29, $\frac{2}{9}$), *v* ($\bar{1}$13, ⅓), *e* ($\bar{1}$11, 1).

$uu' = 82° 36'$ $cp = 68° 24'$ $ve = {*}28° 20'$ $vv' = {*}52° 50'$
$ct = 61° 47'$ $cv = 41° 14'$ $xx' = 52° 11'$ $ee' = {*}78° 28'$
$cx = 40° 40'$ $ce = 69° 34'$ $pp' = 77° 44\frac{1}{2}'$ $pe''' = 42° 2'$

Rarely in crystals. Habit pyramidal, resembling lazulite in form and angle. Faces *e*, *v*, brilliant and smooth, *p* less so; *x*, *u* rounded. Twinning lamellæ of undetermined position observed in grains. Usually massive, coarse to fine granular, or compact.



Hallstadt, Tschermak.

Cleavage: *e*, *v* perfect; *p*, *t*, *u* less so. Friable to firm. H. = 3–3·5. G. = 2·569 Tsch.; 2·517 Bischof. Luster vitreous. Color white, grayish white, to yellowish. Translucent to opaque. Little soluble.

Optically +. Ax. pl. ∥ *b*. $Bx_a \wedge \acute{c} = 76° 25'$. Dispersion inclined distinct (30′), $\rho > v$ also distinct.

$2E_r = 90° 42'$ $2E_y = 90°$ Na $2E_{gr} = 89° 38'$ $2E_{bl} = 89° 16'$

**Comp.**—Hydrous magnesium sulphate, $MgSO_4 + H_2O$ = Sulphur trioxide 58·0, magnesia 29·0, water 13·0 = 100.

The water goes off above 200° (Tschermak), whence the formula $H(MgOH)SO_4$.

Analyses agree with formula closely; see 5th Ed., p. 641; also Wieser, Vh. G. Reichs., 130, 1871, and Tschermak, l. c., both of Hallstadt. Also Precht and Wittjen, Ber. Ch. Ges., **14**, 2131, 1881, who show that the massive and crystallized varieties have the same composition.

**Pyr., etc.**—In the closed tube yields water. B.B. fuses easily, and with soda on charcoal gives the sulphuric acid reaction. But little altered at 100° C. Dissolves in nitric acid, leaving a small residue of impurities. Soluble slowly, but completely, in water, 100 of water taking up 40·9 parts; a residue is deposited of microscopic crystals of anhydrite, or of stassfurtite.

**Obs.**—From the salt mine of Stassfurt, often mixed with carnallite ~~and gypsum~~. F. Bischof divides the Stassfurt salt beds vertically (Ann. Ch. Phys., **5**, 305, 1865, and B. H. Ztg., **24**, 1865) into four regions, corresponding, he observes, to the natural order of origin from an evaporating saline: 1, or lower, the *anhydrite* region; 2, the *polyhalite;* 3, the *kieserite;* and 4, the *carnallite.* The kieserite is in beds, 9 to 12 in. thick, alternating with common salt. The whole deposit is about 190 feet thick, and has the following as its mean percentage composition: Common salt 65, kieserite 17, carnallite 13, magnesium chloride (hydrated) 3, anhydrite 2 = 100. At Neu-Stassfurt it forms a mass with halite on the border of the white carnallite; the solution of the halite leaves the kieserite in crystals resembling anhydrite.

Occurs also at the Hallstadt salt beds with blödite, halite, anhydrite, glauberite; at Kalusz in Galicia. In the Mayo salt mines, Punjab, India.

Named after Mr. Kieser, President of the Academy of Jena. For the *martinsite* of Karsten, see under HALITE, p. 156.

**Ref.**—[1] Ber. Ak. Wien, 63 (1), 317, 1871.

ABRAUM SALTS. Abraumsalze *Germ.* (From the German Abraum, abräumen, *i.e.*, to be removed). The mixed salts overlying the rock-salt deposits at Stassfurt, Prussia; they consist chiefly of carnallite, sylvite, and kieserite.

**745. SZMIKITE.** *J. von Schröckinger*, Vh. G. Reichs., 115, 1877.

Amorphous, stalactitic, with botryoidal surface. H. = 1·5. G. = 3·15. Color whitish, on the fracture reddish white to rose-red.

**Comp.**—$MnSO_4 + H_2O$ = Sulphur trioxide 47·4, manganese protoxide 41·9, water 10·7 = 100.

**Anal.**—1, Schrauf; 2, Dietrich, both l. c.

|  | $SO_2$ | MnO | $H_2O$ |  |  |
|---|---|---|---|---|---|
| 1. | 47·43 | 41·78 | 10·92 | = | 100·13 |
| 2. | 47·11 | 41·61 | 11·19 | = | 99·91 |

Exposed to damp air in small fragments becomes deeper red, and increases slightly in weight.

**Obs.**—From Felsöbánya, Hungary. Named after Bergrath Szmik.

**746. GYPSUM.** *Γύψος* [= mostly *burnt Gypsum*] *Herodotus, Plato, Theophrastus.* *Σεληνίτης, Ἀφροσέληνον, Dioscorides*, **5**, 152, 159. Lapis specularis (principal part), Gypsum (= burnt gypsum only), *Plin.* Lapis specularis, Gypsum, *σεληνίτης*, *Germ.* Gips *and* Fraueneis, *Ital.* Lumen de Scaiola [Scagliola], *Agricola*, Foss., 251, Interpr., 465, 1546. Glacies Mariæ, Marienglas [= Selenite], Gips, Gypsum, Alabastrum (fine-grained G.), Selenites (cryst. G.), *Wall*, Min., 50, 1747. Marmor fugax *Linn.*, Syst., 1736. Gypsum, Terra calcarea acido vitrioli saturata, Alabaster, Selenites, *Cronst.*, Min., 18, 1758. Montmartrite *Delameth.*, Leçons, **2**, 380, 1812. Gips, Gyps, Fraueneis, *Wern.* Gesso *Ital.* Yeso *Span.* Sulphate of Lime, Alabaster, Plaster Stone. Chaux sulfatée, Albâtre, *Fr.* Satin Spar.

Perhaps in part *Ἀλαβαστρίτης, Theophr., Plin.*

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c} = 0·68994 : 1 : 0·41241$; $\beta = 80° \, 42\frac{1}{6}' = 001 \wedge 100$ Des Cloizeaux[1].

$100 \wedge 110 = 34° \, 15'$, $001 \wedge 101 = 28° \, 16\frac{2}{3}'$, $001 \wedge 011 = 22° \, 8\frac{3}{4}'$.

**Forms**[2]:
a (100, $i\text{-}\bar{i}$)
b (010, $i\text{-}\grave{i}$)
c (001, $O$)
z (310, $i\text{-}\bar{3}$)[6]
α (210, $i\text{-}\bar{2}$)
ψ (320, $i\text{-}\bar{\tfrac{3}{2}}$)[6]

m (110, $I$)
g (230, $i\text{-}\grave{\tfrac{3}{2}}$)
η (470, $i\text{-}\grave{\tfrac{7}{4}}$)
h (120, $i\text{-}\grave{2}$)
ϵ (490, $i\text{-}\grave{\tfrac{9}{4}}$)
$i_1$ (250, $i\text{-}\grave{\tfrac{5}{2}}$)
k (130, $i\text{-}\grave{3}$)
q (270, $i\text{-}\grave{\tfrac{7}{2}}$)

r (140, $i\text{-}\grave{4}$)
ϕ (290, $i\text{-}\grave{\tfrac{9}{2}}$)
λ (103, $-\tfrac{1}{3}\text{-}\bar{i}$)[4,5]
d (101, $-1\text{-}\bar{i}$)
ϑ (302, $-\tfrac{3}{2}\text{-}\bar{i}$)[7]
e ($\bar{1}03$, $\tfrac{1}{3}\text{-}\bar{i}$)
β ($\bar{5}09$, $\tfrac{5}{9}\text{-}\bar{i}$)[3]

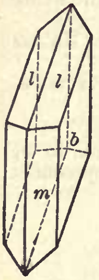
t ($\bar{1}01$, $1\text{-}\bar{i}$)
γ (023, $\tfrac{2}{3}\text{-}\grave{i}$)[4]
v (011, $1\text{-}\grave{i}$)
l (111, $-1$)
μ (995, $-\tfrac{9}{5}$)[5]
w ($\bar{1}13$, $\tfrac{1}{3}$)
n ($\bar{1}11$, 1)

ζ (733, $-\tfrac{7}{3}\text{-}\bar{\tfrac{7}{3}}$)[8]
ξ (697, $-\tfrac{9}{7}\text{-}\grave{\tfrac{3}{2}}$)[7]
y (131, $-3\text{-}\grave{3}$)
σ ($\bar{2}34$, $\tfrac{3}{4}\text{-}\grave{\tfrac{3}{2}}$)[4]
x ($\bar{1}21$, $2\text{-}\grave{2}$)
u ($\bar{1}33$, $1\text{-}\grave{3}$)
s ($\bar{1}31$, $3\text{-}\grave{3}$)

Also doubtful (besides some included above): 11·5·0, 13·23·0, 11·25·0, 7·25·0, 5·23·0, $\bar{7}$·0·11, $\bar{2}$25 or $\bar{7}$·7·18, $\bar{2}$45 or 5·10·12, $\bar{1}\bar{1}$·21·26.

| | | | |
|---|---|---|---|
| $zz''' = 25^\circ\ 34\frac{1}{2}'$ | $c\lambda = 10^\circ\ 47'$ | $cm = 82^\circ\ 19\frac{1}{2}'$ | $ll' = 36^\circ\ 12'$ |
| $\alpha\alpha''' = 37^\circ\ 36'$ | $ad = 52^\circ\ 25\frac{1}{2}'$ | $cy = 51^\circ\ 2'$ | $yy' = 88^\circ\ 52\frac{1}{2}'$ |
| $\psi\psi''' = 48^\circ\ 50'$ | $ce = 11^\circ\ 29'$ | $cw = 13^\circ\ 52'$ | $ww' = 15^\circ\ 38\frac{1}{2}'$ |
| $mm''' = {}^*68^\circ\ 30'$ | $a'e = 87^\circ\ 49'$ | $cn = 38^\circ\ 25\frac{1}{2}'$ | $nn' = {}^*41^\circ\ 20'$ |
| $gg' = 88^\circ\ 47\frac{1}{2}'$ | $ct = 33^\circ\ 8\frac{1}{2}'$ | $nm' = {}^*59^\circ\ 15'$ | $xx' = 74^\circ\ 4'$ |
| $hh' = 72^\circ\ 35'$ | $\gamma\gamma' = 30^\circ\ 22'$ | $cx = 48^\circ\ 3'$ | $uu' = 44^\circ\ 48'$ |
| $kk' = 52^\circ\ 10'$ | $vv' = 44^\circ\ 17\frac{1}{2}'$ | $cu = 25^\circ\ 2'$ | $ss' = 97^\circ\ 4'$ |
| $rr' = 40^\circ\ 19\frac{1}{2}'$ | $cl = 33^\circ\ 10'$ | $cs = 56^\circ\ 20'$ | |

1.



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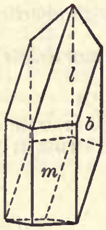

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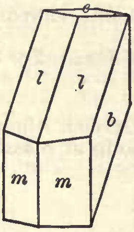

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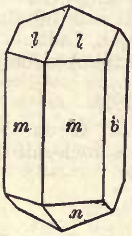

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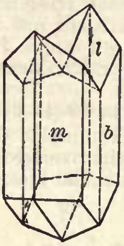

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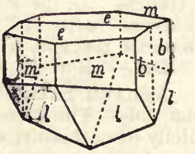

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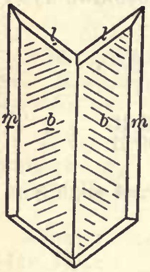

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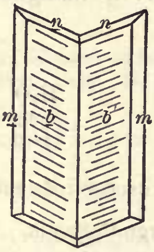

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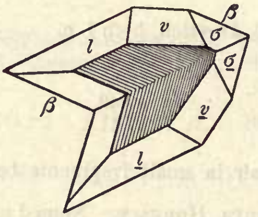

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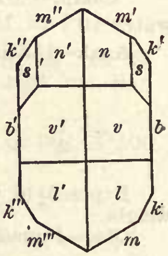
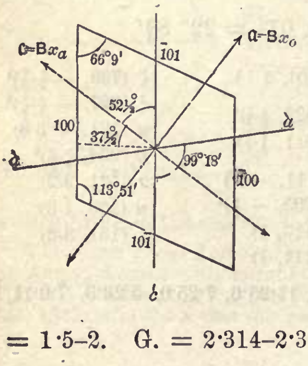


Figs. 1–5, etc., Common forms. 6, Sicily, Pirsson. 9, Wasenweiler, Kaiserstuhl, Hbg.

Twins: (1) tw. pl. *a*, and usually contact-twins, very common, often the familiar swallow-tail twins; the reëntrant angle formed by the pyramid *l*; also as cruciform penetration-twins. (2) *d* (101), contact-twins and usually bounded by *m* or *n*; again in forms represented by f. 9. Crystals usually simple in habit, common form (f. 1) flattened ‖ *b* or prismatic to acicular ‖ *ċ*; again prismatic (f. 3) by extension of *l* (111). The faces *m*, *b* often vertically striated. Also lenticular by rounding of *l* (111) and *e* ($\bar{1}03$). The form *e* ($\bar{1}03$), whose faces are usually rough and convex, is nearly at right angles to the vertical axis (edge *m*/*m‴*), hence the apparent hemimorphic character of the twin, f. 6. Simple crystals often with warped as well as curved surfaces. Also foliated massive; lamellar-stellate; often granular massive; and sometimes nearly impalpable.

11.



Cleavage: *b* eminent, yielding easily thin polished folia; *a* (100), giving a surface with conchoidal fracture; *n* ($\bar{1}11$), with a fibrous fracture ‖ *t* ($\bar{1}01$); a cleavage fragment has the rhombic form of fig. 11, with plane angles of 66° and 114°. Also cleavage ‖ *β* ($\bar{5}09$) and *e* ($\bar{1}03$) developed by pressure in thin cleavage fragments. H. = 1·5–2. G. = 2·314–2·328, when pure crystals. Luster of *b* pearly and shining, other faces subvitreous. Massive varieties often glistening, sometimes dull earthy. Color usually white; sometimes gray, flesh-red, honey-yellow, ocher-yellow, blue; impure varieties often black, brown, red, or reddish brown. Streak white. Transparent to opaque.

Optically +. Ax. pl. at ordinary temperatures ‖ *b*, and $Bx \wedge \acute{c} = +52\frac{1}{2}°$ (at 9·4° C.), cf. f. 16. Dispersion $\rho > v$, also inclined strong, $Bx_r \wedge Bx_{bl} = 0° 30'$. Axial angles, Dx.:

$$2E_r = 95° 14' \text{ at } 20°, \quad 75° 58' \text{ at } 47°, \quad 59° 19' \text{ at } 71\frac{1}{2}°, \quad 39° 1' \text{ at } 95\frac{1}{2}°, \quad 0° \text{ at } 116°.$$

With increase of temperature the axes come together, and at 116° the axial angle is 0° for red rays; at 120° the axes (red) open in a plane ⊥ *b* with small horizontal dispersion. $Bx_r$ changes its position 5° 38′ between 20° and 95°, the axial figure in the polariscope showing the more rapid motion for the blue rays than for the red.

Refractive Indices, Lang[8]:

| | $\alpha$(16·8°) | $\beta$ (17·7°) | $\gamma$ (16·8°) |
|---|---|---|---|
| For B | 1·517427 | 1·519407 | 1·527251 |
| C | 1·518325 | 1·520365 | 1·528142 |
| D | 1·520818 | 1·522870 | 1·530483 |
| E | 1·523695 | 1·525806 | 1·533552 |
| F | 1·526269 | 1·528262 | 1·535994 |
| G | 1·530875 | 1·532831 | 1·540736 |

The values corrected by Cauchy's formula agree closely, *e.g.*:

For D 1·520717 1·522772 1·530483

Also axial angles (observed):

$2V_B = 57° 18'$ $2V_C = 57° 42'$ $2V_D = 58° 8'$ $2V_E = 58° 6'$ $2V_F = 57' 28'$ $2V_G = 56° 13'$

Further at 19°, Dufet:[8]

For D $\alpha = 1·52046$ $\beta = 1·52260$ $\gamma = 1·52962$ $\therefore 2V_D = 58° 1\frac{1}{2}'$

**Var.**—1. *Crystallized*, or *Selenite;* either in distinct crystals, or in broad folia, the folia sometimes a yard across and transparent throughout. Usually flexible and yielding a fibrous fracture ‖ *t* ($\bar{1}01$), but the variety from Montmartre rather brittle.

An *arenaceous* variety occurs in Sussex, N. Brunswick, the crystals containing much sand, which is often regularly arranged within (O. C. Marsh).

2. *Fibrous;* coarse or fine. (*a*) *Satin spar*, when fine-fibrous, a variety which has the pearly opalescence of moonstone (cf. p. 266); (*b*) *plumose*, when radiately arranged.

3. *Massive; Alabaster*, a fine grained variety, either white or delicately shaded; *scaly-granular; earthy* or *rock gypsum*, a dull-colored rock, often impure with clay, calcium carbonate or silica, and sometimes with anhydrite. The *Montmartre* gypsum contains calcium carbonate, and Delametherie called it *Montmartrite*.

Also, in caves, curious curved forms, often grouped in rosettes and other shapes.

**Comp.**—Hydrous calcium sulphate, $CaSO_4 + 2H_2O$ = Sulphur trioxide 46·6, lime 32·5, water 20·9 = 100.

**Pyr., etc.**—In the closed tube gives off water and becomes opaque. Fuses at 2·5–3, coloring the flame reddish yellow. For other reactions, see ANHYDRITE, p. 911. Ignited at a temperature not exceeding 260° C., it again combines with water when moistened, and becomes firmly solid. Soluble in hydrochloric acid, and also in 400 to 500 parts of water.

Recent experiments on the solubility of gypsum and anhydrite in water have been made by McCaleb, Am. Ch. J., **11**, 30, 1889. The specimens employed were as follows: A, gypsum, pink foliated mass, Saltville, Va.; B, do., white massive, Nova Scotia; C, selenite, honey-yellow crystal, Montmartre; D, gray massive anhydrite, impure (81 p. c.) 13 p. c. sand, Salzburg; E, do., grayish massive, pure (97 p. c.), Nova Scotia; F, gypsum and anhydrite mixed, white massive, Nova Scotia. The following figures give the amount of calcium sulphate in grams dissolved from each square centimeter in one week:

| A | B | C | D | E | F |
|---|---|---|---|---|---|
| 0·2388 | 0·2219 | 0·1177 | 0·0666 | 0·0601 | 0·2184 |

The differences in A, B, C, are due to the different amount of surface presented; in C only the face *b* was exposed.

Obs.—Gypsum often forms extensive beds in connection with various stratified rocks, especially limestones, and marlytes or clay beds. It occurs occasionally in crystalline rocks. It is also a product of volcanoes, occurring about fumaroles, or where sulphur gases are escaping, being formed from the sulphuric acid generated, and the lime afforded by the decomposing lavas—lime being contained in augite and labradorite. It is also produced by the decomposition of pyrite when lime is present; and often about sulphur springs where hydrogen sulphide is emitted, this gas changing, through reaction with vegetable matter, into sulphuric acid. Gypsum is also deposited on the evaporation of sea-water and brines, in which it exists in solution. Crystals may be seen to form on evaporating a drop of sea-water in the field of a microscope.

Fine specimens are found in the salt mines of Bex in Switzerland; at Hall in Tyrol; in the sulphur mines of Sicily; in the gypsum formation near Oçana in Spain; in the clay of Shotover Hill, near Oxford; and large lenticular crystals have been met with at Montmartre, near Paris. A noted locality of alabaster occurs at Castelino, 35 m. from Leghorn, whence it is taken to Florence for the manufacture of vases, figures, etc.

This species occurs in extensive beds in several of the United States, and more particularly N. York, Ohio, Illinois, Virginia, Tennessee, and Arkansas, and is usually associated with salt springs, also with rock salt. Also on a large scale in Nova Scotia, etc.

Handsome selenite and snowy gypsum occur in *N. York*, near Lockport in limestone along with pearl spar and anhydrite; also near Camillus, Onondaga Co.; occasionally crystals are met with in the vicinity of Manlius. In *Maryland*, large grouped crystals on the St. Mary's in clay; also near the mouth of the Patuxent. In *Virginia*, large beds of gypsum with rock salt, in Washington Co, 18 m. from Abingdon; also near Lynchburg. In *Ohio*, large transparent crystals have been found at Ellsworth and Canfield, Trumbull Co. In *Tenn.*, selenite and alabaster in Davidson Co. In *Kentucky*, in Mammoth Cave, it has the forms of rosettes, or flowers, vines, and shrubbery, often called *oulopholites* (cf. Encyc. Brit., **15**, 449). Also common in isolated crystals and masses, in the cretaceous clays in the western U. S.

In *N. Scotia*, in Sussex, Kings Co., on Capt. McCready's farm, large single and grouped crystals, which mostly contain much symmetrically disseminated sand.

Named from *γύψος*, the Greek for the mineral, but more especially for the *calcined* mineral. The derivation ordinarily suggested, from *γῆ*, *earth*, and *ἕψειν*, *to cook*, corresponds with this, the most common use of the word among the Greeks. Theophrastus, after mentioning localities, speaks of the making of gypsum by burning the proper stones (among which *alabaster* is included); of making plaster or cement from it by "powdering it, pouring on water, and stirring it with wooden instruments, there being too much heat for the hand;" of the necessity of preparing it "immediately before the use of it, because it soon dries and becomes hard;" of its value for whitening the walls of houses, and of its being an excellent material for making images and ornaments.

The word *γύψος* in Plato and Herodotus has been sometimes translated *chalk*, but not so by the best authorities. The sentences in Herodotus containing it, and the verb *γυψόω* derived from it meaning *to cover or whiten with gypsum*, are most intelligible if calcined gypsum, or preparations from it, are understood.

Powdered chalk is not likely to have been used for a whitewash; and a wash is implied instead of dry chalking. Moreover, true chalk was probably unknown to the Greeks, it being a production of more western countries; and, according to Pliny, even the Romans included under their term *Creta* (Latin for *chalk*) principally clays, and prominently the "Cimolian earth" (cimolite, p. 689), true chalk being what Pliny calls "the inferior kind." Theophrastus speaks of a *Tymphæan gypsum* (so called by the people of Tymphæa) which was a fuller's earth of some kind. The word *γύψος* is, therefore, much more likely to have been applied at times to white clays than to the chalk. The ancients were acquainted with lime from the burning of limestone, and could not have called this *γύψος*. Plato's expression, *Τὴν δε οση λευκὴ γύψου ἢ χιόνος λευκότεραν*, "Whiter than gypsum or snow," is not improved by supposing it chalk; for there is nothing whiter than calcined gypsum, or the ceilings or ornaments made from it.

*Selenites* (= moonstone) of Dioscorides, which he says was also called *aphroselenon* (moon-froth), "because it was found at night while the moon was on the increase," was probably crystallized gypsum or modern selenite. His description *λευκός*, *διαυγής*, *κοῦφος* (= *white, transparent, light*), is good as far as it goes; and the uses of the stone which he mentions also agree better with this view than with that of its being either the modern *moonstone* or *cat's-eye*, to which it has been referred. The name is from *σελήνη*, *moon*, and alludes probably to the peculiar moon-like white reflections. Some aggregated crystallized masses might well have suggested the name *aphroselenon*. It is doubtful what Pliny had in view under the name *selenitis* (**37**, 67); it is probable, from his brevity on the subject, that he did not know the mineral.

*Lapis specularis* (Specular-stone) of Pliny was mostly crystallized gypsum (the rest being *mica*): he speaks of it (**36**, 59) as affording by burning the best of gypsum.

*Ἀλαβαστρίτης* (or alabaster-stone, meaning the stone out of which ointment vases of the kind called *alabastra* were made) was with Theophrastus and Pliny mainly if not wholly stalagmite, which is now often called *oriental alabaster* (see under CALCITE, p. 268); and Thebes in Egypt was a famous locality. Such vases were made of other materials, and it is possible that gypsum-alabaster was one; for when polished it often resembles some clouded stalagmites. This opinion is favored—though not placed beyond question—by the statement in Theophrastus, which Pliny reiterates,* that the gypsum-stone is "very similar to," "not unlike" (meaning in the rough state, of course) *alabastrites*, which resemblance is not obvious if stalagmite is the only alabastrites. The *alabastritis* of Pliny, from Syria, said to be white spotted with various tints, may be of this kind, as Syria was noted for its gypsum-stone, according to Theophrastus and Pliny.

*'Αλάβαστρον* (alabastron) occurs as the name of alabaster-stone in the writings of the historian Herodianus about two centuries after Christ, but without description. The *alabastrum* of Pliny, something white and froth-like, called also, as he says, *stimmi*, *stibi*, and *larbasis*, and coming from silver mines, cannot be alabaster. There is here probably some mistake on the part of Pliny.

Burnt gypsum is called *Plaster-of-Paris*, because the Montmartre gypsum quarries, near Paris, are, and have long been, famous for affording it.

**Alt.**—Gypsum occurs altered to calcite, malachite, quartz; also to anhydrite; cf. Hammerschmidt, Min. Mitth., **5**, 245, 1882.

**Ref.**—[1] Bull. Soc. Min., **9**, 175, 1886; cf. also Ann. Ch. Phys., **10**, 53, 1844. Trustworthy angles are difficult to obtain; the dimensions change sensibly, with change of temperature; cf. Beckenkamp, Zs. Kr., **6**, 450, 1882. Beckenkamp deduces the following :

| | $a : b : c$ | $\beta'(= 180° - \beta)$ |
|---|---|---|
| At 0° | 0·689724 : 1 : 0·413411 | 98° 56′ 17·7″ |
| 25° | 0·689515 : 1 : 0·413251 | 98° 58′ 6·4″ |
| 50° | 0·689301 : 1 : 0·413072 | 98° 59′ 59·0″ |
| 75° | 0·688998 : 1 : 0·412916 | 99° 1′ 32·8″ |
| 100° | 0·688596 : 1 : 0·412661 | 99° 3′ 25·6″ |
| 120° | 0·688395 : 1 : 0·412517 | 99° 5′ 29·6″ |

See earlier, Neumann, Pogg., **27**, 240, 1833. With Dx., *m* is also the unit prism but *n* = 011, *t* = 001, etc.; in the 5th Ed. *n* was the unit prism, *t* = 100, etc.

[2] See Hbg., Min. Not., **4**, 1, 1861, and Brezina, Min. Mitth., 17, 1872, for lists of planes and early authorities; also Dx., l. c., Gdt. Index, **2**, 121, 1888. [3] Hbg., Girgenti, l. c [4] Hbg., Wasenweiler,, ib., **10**, 30, 1871. [5] Schrauf, Harz, Ber. Ak. Wien, **63** (1), 157, 1871. [6] Brezina, Kalinka l. c . [7] Lasp., Eisleben, Min. Mitth., 113, 1875, who gives the axes :

$$a : b : c = 0·6895 : 1 : 0·4133 \qquad \beta = 81° \ 2'.$$

On experiments on *hardness*, see Exner, Unt. Härte, 71, 1873; on artificial twinning, Lcx., Bull. Soc. Min., **12**, 515, 1889. *Elasticity*, Reusch, Pogg., **136**, 135, 1869, Min. Mitth., 67, 1876, Ber. Ak. Berlin, 259, 1883; Laspeyres, l. c; Coromilas (abstr. in Zs. Kr., 1, 408), Inaug. Diss., Tübingen, 1877. Gliding planes, Mügge, Jb. Min., **2**, 13, 1883; percussion-figure, id., ibid., **1**, 51, 1884. *Etching-figures*, Baumhauer, Ber. Ak. München, 1875. *Thermo-electricity*, Hankel, Wied., **1**, 277, 1877. *Thermal expansion*, Beckenkamp, l. c., and Neumann (1833), l. c. [8] Optic axes of elasticity and effect of heat, Lang., Wien, **76** (2), 793, 1877; also Dufet, Bull., **4**, 113, 191, 1881, **11**, 123, 1888, **14**, 144, 1891, and J. Phys., **8**, 292, 1888.

CALCIUM CHROMATE. An artificial calcium chromate, isomorphous with gypsum, has been described by Foullon. Cf. p. 916.

### 747. ILESITE. *A. F. Wuensch*, Mining Index, Leadville, Colorado, Nov. 5, 1881. *M. W. Iles*, Am. Ch. J., 3, 420, 1881.

Monoclinic?, in artificial crystals Hillebrand[1].

In loosely adherent crystalline aggregates, prismatic. Color clear green, becoming white on exposure in consequence of loss of water. Taste bitter, astringent. Friable. Soluble in water.

**Comp.**—$RSO_4 + 4H_2O$ with R = Mn : Zn : Fe = 5 : 1 : 1. This requires: Sulphur trioxide 35·6, manganese protoxide 22·5, zinc protoxide 5·2, iron protoxide 4·6, water 32·1 = 100.

**Anal.**—M. W. Iles, mean of several partial analyses, deducting residue (0·63 $SiO_2$).

| $SO_3$ | MnO | ZnO | FeO | $H_2O$ | | |
|---|---|---|---|---|---|---|
| 36·07 | 22·31 | 5·97 | 4·18 | 31·60 | = | 100·13 |

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* It is not clear that Pliny is here independent authority. He appears to be citing from Theophrastus in the most of what he says about gypsum; and in one or two cases he cites blunderingly. He says, for instance, that plaster after hardening may by pounding be powdered [for use again]; whereas Theophrastus states more correctly that "*by burning* it may again and again be made fit for use."

The amount of water is in doubt, and in the unaltered mineral is probably larger than in the material analyzed (Hillebrand).

**Obs.**—Occurs in a siliceous gangue with the sulphides of iron and zinc (from which it has been formed), in veins 2 to 8 inches wide; found in several mines at the head of Hall Valley, Park Co., Colorado. Named after Dr. M. W. Iles of Denver.

**Ref.**—[1] Proc. Col. Soc., **1**, 140, 1884.

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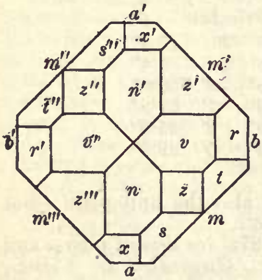
**748. EPSOMITE.** Epsom Salt. Sal nativum catharticum *A. Hermann*, De Sale nativo cathartico in fodinis Hungariæ recens invento, Posonii, 1721. Sal neutrum acidulare, Sal Anglicanum, *Wall.*, Min., 184, 1747. Id., Sel d'Epsom *Fr. Trl.* Wall., **1**, 339, 1753. Halotrichum *Scopoli*, De Hydrarg. Idriense Tent., Venet., 1761 (Klapr. Beitr., **3**, 104), Princip. Min., 1772. Magnesia vitriolata (Sal Anglicus, Epsomensis, Seidlizensis, Seydschütensis, amarus, etc.) *Bergm.*, Sciagr., 1782. Bittersalz *Wern.* Gletschersalz. Haarsalz pt. Epsomite *Beud.*, Tr., 445, 1824. Reichardtit *Krause* [Arch. Pharm., **5**, 423, **6**, 41], Zs. Nat. Halle, **44**, 554, 1874.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}9902 : 1 : 0{\cdot}5709$ Miller[1].
$100 \wedge 110 = 44^\circ\ 43'$, $001 \wedge 101 = 29^\circ\ 58'$, $001 \wedge 011 = 29^\circ\ 43\tfrac{1}{3}'$.



After Miller.

**Forms:** $m$ (110, $I$) $x$ (201, 2-$\bar{i}$) $z$ (111, 1)
$a$ (100, $i$-$\bar{i}$) $f$ (120, $i$-$\check{2}$) $v$ (011, 1-$\breve{i}$) $s$ (211, 2-$\bar{2}$)
$b$ (010, $i$-$\breve{i}$) $n$ (101, 1-$\bar{i}$) $r$ (021, 2-$\breve{i}$) $t$ (121, 2-$\check{2}$)

$mm''' = {*}89^\circ\ 26'$ $rr' = 97^\circ\ 34\tfrac{1}{2}'$ $ss'' = 104^\circ\ 17\tfrac{1}{2}'$
$ff' = 53^\circ\ 35'$ $zz' = 53^\circ\ 12'$ $ss''' = 41^\circ\ 1'$
$nn' = 59^\circ\ 56'$ $zz'' = 78^\circ\ 7'$ $tt' = 41^\circ\ 36'$
$xx' = 98^\circ\ 8'$ $zz''' = {*}52^\circ\ 38'$ $tt'' = 103^\circ\ 58'$
$vv' = 59^\circ\ 27'$ $ss' = 90^\circ\ 5'$ $tt''' = 89^\circ\ 22\tfrac{1}{2}'$

Crystals prismatic in habit; often hemihedral in the pyramidal planes. Also in botryoidal masses and delicately fibrous crusts.

Cleavage: $b$ very perfect; $v$ (011) less perfect; $m$ in traces. Fracture conchoidal. H. = 2·0–2·5. G. = 1·751; 1·685, artif., Schiff. Luster vitreous to earthy. Streak and color white. Transparent to translucent. Taste bitter and saline.

Optically −. Ax. pl. ∥ $c$. Bx ⊥ $b$. Axial angles:

$2E_r = 77^\circ\ 59'$, $78^\circ\ 5'$, $78^\circ\ 11'$ in three sections, Dx.[2]
$2E_y = 77^\circ\ 43'$, $77^\circ\ 44'$, $78^\circ\ 3'$ " " " "

Refractive indices for D line, Topsoe and Christiansen[2]:

$\alpha = 1{\cdot}4325$ $\beta = 1{\cdot}4554$ $\gamma = 1{\cdot}4608$ $\therefore$ $2E = 78^\circ\ 18'$ $2V = 51^\circ\ 25'$

**Comp.**—Hydrous magnesium sulphate, $MgSO_4 + 7H_2O$ = Sulphur trioxide 32·5, magnesia 16·3, water 51·2 = 100.

**Pyr., etc.**—Liquefies in its water of crystallization. Gives much water in the closed tube at a high temperature; the water is acid. B.B. on charcoal fuses at first, and finally yields an infusible alkaline mass, which, with cobalt solution, gives a pink color on ignition. Very soluble in water, and has a very bitter taste.

**Obs.**—Common in mineral waters, and as a delicate fibrous or capillary efflorescence on rocks, in the galleries of mines and elsewhere. In the former state it exists at Epsom, England, and at Sedlitz and Saidschitz (or Saidschütz) in Bohemia At Idria in Carniola it occurs in silky fibers, and is hence called *hairsalt* by the workmen. Also obtained at the gypsum quarries of Montmartre, near Paris; in Fitou, Dept. of the Aude, France; at the anthracite mine of Peychagnard, Isère, in large crystals; in Aragon and Catalonia in Spain; in the Cordillera of St. Juan in Chili; and in a grotto in Southern Africa, where it forms a layer 1½ in. thick. Also found at Vesuvius, at the eruptions of 1850 and 1855. A massive variety (*reichardtite*) occurs in thin layers with carnallite at Leopoldshall, Stassfurt.

The floors of the limestone caves of Kentucky, Tennessee, and Indiana, are in many instances covered with epsomite, in minute crystals, mingled with the earth. In the Mammoth Cave, Ky., it adheres to the roof in loose masses like snowballs. At the Alum Cave, in Sevier, Tenn., on the headwaters of the West Fork of Little Pigeon River, masses of nearly pure epsomite, almost a cubic foot in volume, have been obtained (Safford's Rep.. 119). It effloresces from the calcareous sandstone, 10 m. from Coeymans, on the east face of the Helderberg, N. Y. Said to occur also over the California plains, east of San Diego (Am. J. Sc., **6**, 389, 1848). Also effloresces from a pyritiferous serpentine in Marmora, Ontario; and on dolomites of the Clinton formation (Silurian) in sheltered places between Niagara Falls and Lake Huron as at Dundas, where layers occur 1 in. thick.

**Ref.**—[1] Min., 546, 1852; earlier, Brooke, Ann. Phil., **6**, 40, 1823; see also Mitsch., ib., **11** 327, 1827, and Rg., Pogg., **91**, 324, 1854.

[2] Propt. Opt., **2**, 39, 1859. Topsoe and Christiansen, Pogg., Erg., **6**, 545, 1874.

On the wide variation in form, for different isomorphous compounds of $MgSO_4 + 7H_2O$ and $ZnSO_4 + 7H_2O$, see Dufet, Bull. Soc. Min., **12**, 22, 1889; cf. also Rg., l. c.

TAURISCITE. Tauriszit *G. H. O. Volger*, Jb. Min., 152, 1855.

Orthorhombic. Planes and angles those of epsomite. In acicular crystals. Luster and other physical characters those of copperas (melanterite), p. 941. Composition stated to be that of copperas, $FeSO_4 + 7H_2O$, but needs confirmation.

From Windgälle in the Canton Uri (Pagus Tauriscorum of the Romans), Switzerland, associated with copperas and alum. The crystal is stated to be a rhombic prism with pyramidal terminations.

**749. GOSLARITE.** Atramentum sutorium, candidum, potissimum reperitur Goselariæ, translucidum, crystalli instar, *Agric.*, Foss., 213, 1546. A. album fossile durum Goslarianum *Gesner*, Foss., 13, 1565. Vitriolum Zinci album nativum, Galizensten, Hvit Viktril, *Wall.*, 157, 1747. Zinc Vitriol, White Vitriol, White Copperas, Sulphate of Zinc. Zinc sulfatée, Couperose blanche, *Fr.* Gallizinite *Beud.*, Tr., 446, 1824. Galiznite. Goslarit *Haid.*, Handb., 490, 1847. Ferro-Goslarite *H. A. Wheeler*, Am. J. Sc., **41**, 212, 1891.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}9807 : 1 : 0{\cdot}5631$ Brooke[1].

$100 \wedge 110 = 44° 26\frac{1}{2}'$, $001 \wedge 101 = 29° 51\frac{5}{6}'$, $001 \wedge 011 = 29° 23'$.

**Forms:**
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)
*m* (110, *I*)
*f* (120, *i*-2̆)
*n* (101, 1-ī)
*x* (201, 2-ī)
*v* (011, 1-ĭ)
*r* (021, 2-ĭ)
*z* (111, 1)
*s* (211, 2-2)?
*t* (121, 2-2̆)

$mm''' = {}^*88° 53'$
$ff' = 54° 2'$
$nn' = 59° 44'$
$xx' = 97° 54'$
$vv' = 58° 46'$
$bv = {}^*60° 37'$
$rr' = 96° 47\frac{1}{2}'$
$zz' = 53° 9\frac{1}{2}'$
$zz'' = 77° 37'$
$zz''' = 52° 3'$
$ss' = 90° 2'$
$tt' = 41° 44'$
$tt''' = 88° 39'$

In long acicular crystals; commonly massive or stalactitic.

Cleavage: *b* perfect. Brittle. H. = 2–2·5. G. = 1·9–2·1; 2·036; 1·953, artif. cryst., Schiff. Luster vitreous. Color white, reddish, yellowish, bluish. Transparent to translucent. Taste astringent, metallic, and nauseous.

Optically –. Ax. pl. ‖ *c*. Bx ⊥ *b*. Dispersion $\rho < v$ small, Dx.

$$2E_r = 70° 23' \qquad 2E_v = 70° 6', \text{ Dx.}$$

Refractive indices for D line, Topsoe and Christiansen[2]:

$$\alpha = 1{\cdot}4568 \quad \beta = 1{\cdot}4801 \quad \gamma = 1{\cdot}4836 \quad \therefore 2E_y = 71° 3' \quad 2V_y = 46° 14'$$

**Comp.**—Hydrous zinc sulphate, $ZnSO_4 + 7H_2O$ = Sulphur trioxide 27·9, zinc oxide 28·2, water 43·9 = 100. Iron may be present replacing the zinc.

**Anal.**—1, Frenzel, Jb. Min., 675, 1875. 2, Hillebrand, quoted by Pearce, Proc. Col. Soc., 2, 12, 1885.

| | $SO_3$ | ZnO | CuO | (Mn,Fe)O | MgO | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. Freiberg | 29·52 | 21·58 | — | — | 6·18 | [42·72] = 100 |
| 2. Butte | 28·09 | [27·56] | 0·12 | 0·30 | — | 43·93 = 100 |

In 2, six molecules of water escape at 100°.

Wheeler found 4·9 p. c. $FeSO_4$ in the *ferro-goslarite*.

**Pyr., etc.**—Yields water. On charcoal with soda gives a zinc coating, and a sulphide which tarnishes silver. Easily soluble in water.

**Obs.**—This salt is formed by the decomposition of sphalerite, and is found in the passages of mines. It occurs at the Rammelsberg mine near Goslar, in the Harz; at Schemnitz in Hungary; at Falun in Sweden; and at Holywell in Wales; Elba at Capanne Vecchie. It is not of common occurrence.

In Montana at the Gagnon mine, Butte, derived from the alteration of a cupriferous zinc sulphide. *Ferro-goslarite* occurs associated with sphalerite at Webb City, Jasper Co., Missouri; it is in mammillary or stalactitic incrustations of a light yellow to brown color. Goslarite is common in the drainage of the mines of the region.

**Ref.**—[1] Ann. Phil., **6**, 437, 1823; Mlr., Min., 547, 1852. Cf. also Schrauf, Jb. Min., 675, 1875. [2] Ibid., (epsomite), p. 548.

**750. MORENOSITE.** Nickel-Viktril, Vitriolum ferrum et nicolum continens ("of a deep green color, with Kupfernickel, in Cobalt mines") *Cronst.* (the discov. of the metal Nickel), Min., 114, 1758. Niccolum vitriolatum (interdum e mineris sulphuratis fatiscentibus genitum) *Bergm.*, Sciagr., 50, 1782. Sulfato de niquel (fr. Galicia) *D. A. Casares*, 1849, A. M. Alcibar, in Revista Minera, Madrid, 305, 1850. Sulfato de nickel, Morenosita, *Casares*, ib., 176, March, 1851. Nickel Vitriol *T. S. Hunt.* Dana Min., 679, 1850, Logan's G. Rep. Can., 1863. Pyromelin *Kbl.*, Gel. Anz. Münch., **35**, 215, 1852, J. pr. Ch., **58**, 44.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}9816 : 1 : 0{\cdot}5655$ Marignac[1].
$100 \wedge 110 = 44° 28'$, $001 \wedge 101 = 29° 56\frac{3}{4}'$, $001 \wedge 011 = 29° 29\frac{1}{4}'$.

**Forms:** *f* (120, *i*-2̆) *x* (201, 2-ī) *r* (021, 2-ĭ) *s* (211, 2-2̄)
*b* (010, *i*-ĭ) *n* (101, 1-ī) *v* (011, 1-ĭ) *z* (111, 1) *t* (121, 2-2̆)
*m* (110, *I*)

$mm''' = {*}88° 56'$ $xx' = 98° 5'$ $zz'' = 77° 50'$ $ss' = 90° 10'$
$ff' = 53° 59'$ $vv' = 58° 58\frac{1}{2}'$ $zz''' = 52° 13'$ $ss''' = 40° 40\frac{1}{2}'$
$nn' = 59° 53\frac{1}{2}'$ $zz' = {*}53° 16'$

In acicular crystals and thin prisms. Also fibrous; and as an efflorescence.

Cleavage: *b*. H. = 2–2·25. G. = 2·004, Fulda. Luster vitreous. Color apple-green to greenish white. Streak white, faintly greenish. Soluble; taste metallic astringent.

Optically −. Ax. pl. ∥ *c*. Bx ⊥ *b*. Dispersion $\rho > v$ large.

$$2E_r = 64° 24' \qquad 2E_v = 63° 45' \text{ Dx.}$$

Refractive indices for D line, Topsoe and Christiansen[2]:

$$\alpha = 1{\cdot}4669 \quad \beta = 1{\cdot}4888 \quad \gamma = 1{\cdot}4921 \quad \therefore \quad 2E_y = 64° 22' \quad 2V_y = 41° 56'$$

**Comp.**—Hydrous nickel sulphate, $NiSO_4 + 7H_2O$ = Sulphur trioxide 28·5, nickel protoxide 26·6, water 44·9 = 100.

**Pyr., etc.**—B.B. in tube gives water, strongly acid, swells up, and hardens, becoming yellow and opaque. On charcoal glows strongly and evolves sulphurous acid. With borax and phosphorus salt gives a distinct nickel reaction. The Riechelsdorf mineral colors the outer flame blue, from the presence of arsenic.

**Obs.**—A result of the alteration of nickel ores. Occurs near Cape Hortegal, in Galicia, Spain, on magnetite, with which some millerite is mixed; at Riechelsdorf, in Hesse; as an earthy crust, mountain-green in color, with native bismuth and arsenical nickel, at the Friedens mine near Lichtenberg in Bayreuth (pyromeline). Also in acicular crystals and crusts at Wallace mine, Lake Huron, upon a sulphide of nickel and iron; at the Gap nickel mine, Lancaster Co., Pennsylvania.

Named by Casares after Sr. Moreno, of Spain. A. M. Alcibar states that Prof. Casares sent a communication on this mineral to the Société de Pharmacie of Paris in 1849, which was not published.

**Ref.**—[1] Mem Soc. Genève, **14**, 242, 1858. There has also been believed to be a tetragonal form, [3] cf. Haid., Pogg., **6**, 196, 1826; Mitsch., ib., **12**, 144, 1828, but according to Marignac this contains only $6H_2O$.

[2] Ibid. (epsomite), p. 549. [3] Lang, Ber. Ak. Wien, **31**, 99, 1858.

TECTICITE *Breith.* Graulit *Glocker*, Syn., 1847. A clove-brown mineral, easily soluble in water and attracting moisture readily, occurring in small pyramidal and acicular crystals supposed to be orthorhombic, and also massive. Probably a hydrous sulphate of ferric iron; but composition not ascertained. H. = 1·5–2.

From Graul, near Schwarzenberg, in Saxony, and Bräunsdorf in the Erzgebirge. Named from τηκτικός, in allusion to the deliquescence; but changed to *graulite* by Glocker, because the Greek signifies liquefying *actively*, and not *passively* as in deliquescence.

FAUSERITE. Fauserit *Breith.*, B. H. Ztg., **24**, 301, 1865.

Orthorhombic. Prismatic angle 88° 42'. Cleavage: brachypinacoidal, distinct; prismatic, in traces or none; basal, rather distinct. Crystals grouped in stalactitic forms. H. = 2–2·5. G. = 1·888. Luster vitreous. Color reddish and yellowish white to colorless. Translucent to transparent. Taste astringent, bitter.

**Comp.**—Perhaps $(Mn,Mg)SO_4 + 6H_2O$, with Mn : Mg = 2 : 1, requiring: Sulphur trioxide 32·2, manganese protoxide 19·0, magnesia 5·4, water 43·4 = 100. Some authors give $7H_2O$.

**Anal.**—1, 2, Mollnár, quoted by Breithaupt.

| | $SO_3$ | MnO | MgO | $H_2O$ | |
|---|---|---|---|---|---|
| 1. | 34·49 | 19·61 | 5·15 | 42·66 | $Al_2O_3$,$Fe_2O_3$ *trace* |
| 2. | 33·78 | 20·05 | 5·63 | 40·54 | |

**Obs.**—Stated to be from Herrengrund in Hungary. Named after Mr. Fauser.

A mineral called fauserite by Loczka, from Hodrusbánya, Hungary, was epsomite, $MgSO_4 + 7H_2O$, with only small quantities of zinc (0·54 ZnO), manganese (0·54 MnO), cobalt (0.08 CoO), iron (0·04 FeO). Ber. aus Ungarn, **8**, 108, 1890. This throws doubt over Breithaupt's mineral.

## **Melanterite or Copperas Group.** Monoclinic.

The species here included are the ordinary vitriols. They are identical in general formula with the species of the Epsomite group, and are regarded as the same compound essentially under oblique crystallization. The copper sulphate diverges from the others in crystallization, and contains but 5 of water.

SYNONYMY BEFORE 1750. *Χαλκανθον*, *Χαλκῖτης*, *Μελαντηρία*, *Σῶρυ*, *Μίσυ*, *Dioscor.*, **5**, 114-118. [*Chalcanthum* (from *χαλκός*, *brass*, and *ἄνθος*, *flower*) is vitriol of any kind; Spain is given as a locality; *Chalcitis*, a disintegrating pyrites, iron or copper, impregnated with the same, as a result of its alteration; *Melanteria* (fr. *μέλαν*, *ink*), a salt-like chalcanthus, or earth containing it; *Soru*, a black earth or stone impregnated with some vitriol; *Misu*, a yellowish vitriolic stone, perhaps partly copiapite, and partly yellow ocher impregnated with vitriol of some kind.]

Atramentum sutorium = Chalcanthum, Chalcites, Sory, Misy, *Plin.*, **34**, 29-32; evidently in part from Dioscorides. [The description of *Chalcanthum* gives prominence to *blue* vitriol, while its use as shoemaker's ink (which Atr. sutorium signifies) implies the presence of *green* (or iron) vitriol, the material still used for blackening leather; *Chalcites* and *sory* are the same as above; *Misy* is yellow and pulverulent, like the mineral now called copiapite.]

Atramentum sutorium = Melanteria = Chalcanthum, Chalcites, Sory, Misy, *Agric.*, Foss., 212-214, 1546; Kupferwasser *id.*, Interpr., 463, 1546. [The first three of these names are synonyms for any vitriol or all; and include (as partly also in Dioscorides) capillary or wool-like, plumose, stalactitic, and salt-like kinds, besides *Lapis atramenti;* Agricola mentions the varieties *Atramentum sutorium candidum* (= *λευκόιον Gr.*), which is white or zinc vitriol; *A. s. viride*, which is green vitriol; *A. s. cæruleum*, which is blue vitriol; *Sory*, a gray or blackish stone, often nodular (glebæ rotundæ), impregnated with any vitriol; *Misy*, a yellow efflorescent or mealy vitriol. Goslar in the Harz is the principal locality cited by Agricola. *Chalcites* is said to be between sory and misy in texture, and *rubra et æris colore;* perhaps a red ocher (a frequent result of the alteration of pyrites) containing copperas and some unaltered pyrites.

Atramentum viride, a quibusdam *Vitreolum* vocatur, *Albertus Magnus*, De Min., Libr. **5**, c. 3, 1270. Vitriolum *Agric.*, ib., 213. [So named from *vitrium*, *glass*, in allusion to the glassy appearance of the crystals of vitriols; Agricola speaks, in connection with his explanation of the word, of "A. candidum translucidum instar Crystalli."]

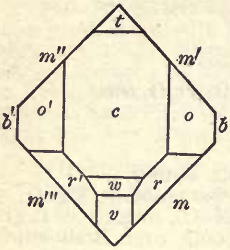
Atramentum *Gesner*, Foss., 13, 1565; divided into A. album durum Goslarianum [or Zinc vitriol], A. viride [or Iron vitriol], A. cœruleum Cyprium pulcherrimum [or Blue vitriol], etc. Melanteria, Sory, Misy, *Gesner*, ib., 15, 16.

Vitriolum *Wallerius*, Min., 155, 1747, and *Cronstedt*, Min., 113, 1758; a genus including the species V. Cupri (= V. Cypri, V. Veneris); 2, V. viride (= V. ferri, V. martis); 3, V. album, vel zinci (from Goslar); besides 4, V. mixtum (a mere mixture); 5, 6, Terra vitriolica and Lapis atramentarius (earth or stone impregnated with vitriol of some kind), and including Lapis atramentarius flavus, or *Misy*.

**751. MELANTERITE.** *Μελαντηρία*, *Χάλκανθον*, etc., *Dioscor.* Chalcanthum, Atramentum sutorium, etc., *Plin.* Melanteria, Atramentum sutorium viride, *Agric.* Vitriolum pt. *Albertus Magnus.* Atramentum viride *Gesner.* Vitriolum viride, V. ferri, V. martis, *Wallerius.* Green Vitriol. Copperas. Sulphate of Iron. Fer sulfaté *Fr.* Mélantérie *Beud.*, Tr., **2**, 482, 1832. Luckite *Carnot*, Bull. Soc. Min., **2**, 168, 1879. Alcaparrosa verde *S. Amer.*, Raimondi, Min. Pérou, 212, 1878. Vitrolo verde *Span.*

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 1{\cdot}1828 : 1 : 1{\cdot}5427$; $\beta = 75^\circ\ 44\frac{1}{2}' = 001 \wedge 100$ Zepharovich[1].

$100 \wedge 110 = 48^\circ\ 54'$, $001 \wedge 101 = 43^\circ\ 44'$, $001 \wedge 011 = {}^*56^\circ\ 13\frac{1}{2}'$.



**Forms**[2]:
a (100, i-ī)
b (010, i-ĭ)
c (001, O)
m (110, I)
w (103, − ⅓-ī)
v (101, − 1-ī)
u (301, − 3-ī)
s ($\bar{1}$05, ⅕-ī)
t ($\bar{1}$01, 1-ī)
e (013, ⅓-ĭ)
o (011, 1-ĭ)
p (112, − ½)
r (111, − 1)
n (211, − 2-2̄)
β (121, − 2-2̆)
σ ($\bar{1}$21, 2-2̆)

mm''' = *97° 48′
cw = 20° 50′
av = 32° 0½′
ct = 61° 46′
ee′ = 52° 59′
oo′ = 112° 27′
cp = 40° 9′
cr = 55° 59′
cm = *80° 41′
cn = 60° 47′
cs = 67° 51′
cσ = 78° 11½′
rr′ = 78° 33′
nn′ = 52° 45′
ββ′ = 117° 6½′
σσ′ = 128° 44′

Crystals (artif.) short prismatic in habit; usually in capillary, fibrous, stalactitic, and concretionary forms; also massive and pulverulent.

Cleavage: c perfect; m less so. Fracture conchoidal. Brittle. H. = 2. G. = 1·89 –1·90; 1·79 Idria. Luster vitreous. Color, various shades of green, passing into white; becoming yellowish on exposure. Streak uncolored. Subtransparent to translucent. Taste sweetish, astringent, and metallic.

Optically +. Ax. pl. ∥ b. $Bx_{a.r} \wedge \grave{c} = -61°$. Dispersion $\rho > v$, inclined weak. Axial angles, Dx.[3]

$2H_{a.r} = 86° 54'$ $2H_{o.r} = 94° 13'$ $\beta_r = 1·469$ ∴ $2V_{a.r} = 86° 21\frac{1}{2}'$ (mean)
$2H_{a.y} = 86° 49'$ $2H_{o.y} = 94° 24'$ $\beta_y = 1·470$ ∴ $2V_{a.y} = 86° 13'$ "
$2H_{a.bl} = 86° 33'$ $2H_{o.bl} = 94° 46'$ $\beta_{bl} = 1·478$ ∴ $2V_{a.bl} = 85° 53\frac{1}{2}'$ "

**Comp.**—Hydrous ferrous sulphate, $FeSO_4 + 7H_2O$ = Sulphur trioxide 28·8, iron protoxide 25·9, water 45·3 = 100. Manganese and magnesium sometimes replace part of the iron, the former in the variety *luckite*.

**Anal.**—1, Janovsky, Ber. Ak. Wien, **79** (1), 187, 1879. 2, Carnot, l. c.

An impure iron-magnesium sulphate from Falun, sold as "botryogen," belongs here, see analyses by Blaas, Ber. Ak. Wien, **88** (1), 1135, 1884; Hockauf, Zs. Kr., **12**, 253, 1886.

| | | $SO_3$ | FeO | MnO | MgO | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. Idria | G. = 1·79 | ⅜ 29·80 | 20·37 | — | 4·60 | 45·07 = 99·84 |
| 2. Utah, *Luckite* | | 26·3 | 21·7 | 1·9 | 0·2 | [42·2] CaO 0·5, insol. 7·2 = 100 |

**Pyr., etc.**—In the closed tube yields water, and after a time sulphurous and sulphuric acids. On charcoal turns at first brown, then red, and finally black, becoming magnetic. With the fluxes reacts for iron. Soluble in twice its weight of water, and the solution is blackened by a tincture of nutgalls. Exposed to the air becomes covered with a yellow powder, which is the ferric sulphate.

**Obs.**—This salt usually proceeds from the decomposition of pyrite or marcasite, which readily afford it, if occasionally moistened while exposed to the atmosphere. Occurs near Goslar in the Harz; Bodenmais in Bavaria; Falun, Sweden; at Hurlet, near Paisley; and in many mines in Europe and elsewhere. Usually accompanies pyrite in the U. States, occurring as an efflorescence; at Copperas Mt., a few miles E. of Bainbridge, Ohio, it is associated with alum and pyrite.

*Luckite* is from the "Lucky Boy" mine, Butterfield Cañon, Utah.

**Ref.**—[1] Ber. Ak. Wien, **79** (1), 183, 1879, measurements of the pure iron sulphate; the presence of magnesium in varying amounts makes a sensible change in angle, cf. Zeph., l. c., and Rg., Pogg., **91**, 325, 1854; Schrauf, Jb. Min., **1**, 236, 1886. Cf. epsomite, p. 938.

[2] Cf. Brooke, Ann. Phil., **6**, 120, 1823; Mlr.. Min., 550, 1852.

Rammelsberg shows that there is a close relation in form between the monoclinic melanterite and orthorhombic epsomite, Kr. Ch., 425, 1881. See also Schrauf, Ber. Ak. Wien, **39**, 894, 1860; Zeph., l. c. [3] Dx., N. R.. 173, 1867.

BOURBOLITE. Lefort, C. R., **55**, 919, 1862. An impure sulphate of iron, apparently a mixture of melanterite and a ferric sulphate; from Bourboule, in the Dept. of Puy-de-Dôme, France. Derived apparently from the alteration of marcasite. Lefort's analyses obtained:

| $SO_3$ | $Fe_2O_3$ | FeO | $H_2O$ |
|---|---|---|---|
| 38·04 | 5·08 | 16·08 | 40·80 = 100 |
| 37·55 | 8·71 | 13·83 | 39·91 = 100 |
| 35·22 | 8·25 | 12·99 | 43·54 = 100 |

It is a friable greenish substance, partly soluble in water and partly in acids.

**752. MALLARDITE.** *Carnot,* Bull. Soc. Min., **2**, 117, 1879.

Monoclinic, Mld. In crystalline masses with fibrous structure. Colorless.

**Comp.**—Hydrous manganese sulphate, $MnSO_4 + 7H_2O$ = Sulphur trioxide 28·9, manganese protoxide 25·6, water 45·5 = 100.

Analyses by Carnot and Rioult agree closely, l. c. and App. III, p. 72.

**Pyr., etc.**—Easily soluble in water. Changes rapidly on exposure; effloresces, becomes opaque, and finally pulverulent. Is decomposed by strong heating, losing the sulphuric acid and water, and leaving a reddish brown residue. Carnot obtained from a solution of manganese sulphate at 15° C. the salt $MnSO_4 + 5H_2O$ in triclinic crystals; but at a temperature of 6° C. he obtained monoclinic crystals with the composition $MnSO_4 + 7H_2O$.

**Obs.**—Occurs in a gray clay-like gangue, with quartz sand and barite. From the silver mine "Lucky Boy," south of Salt Lake, near Butterfield Cañon, Utah.

**753. PISANITE.** *F. Pisani,* C. R., 48, 807, 1859. Pisanit *Kenng.*, Ueb. 1859, 10, 1860. Cyanoferrite *Adam,* Tabl. Min., 66, 1865. Cuproferrite *Des Cloizeaux,* N. R., 157, 1867. Kupfereisenvitriol *Germ.*

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c} = 1·1609 : 1 : 1·5110$; $\beta = 74° \, 38\frac{1}{6}' = 001 \wedge 100$ Des Cloizeaux[1].

$100 \wedge 110 = 48° \, 13\frac{1}{2}'$, $001 \wedge \bar{1}01 = 62° \, 26\frac{1}{6}'$, $001 \wedge 011 = 55° \, 32\frac{1}{6}'$.

**Forms:** *b* (010, *i*-*ì*), *c* (001, *O*); *m* (110, *I*); *w* (103, $-\frac{1}{3}$-*ī*), *t* ($\bar{1}01$, 1-*ī*); *o* (011, 1-*ì*); *β* ($\bar{5}·5·22$, $\frac{5}{22}$), *π* ($\bar{1}12$, $\frac{1}{2}$), *γ* ($\bar{8}89$, $\frac{8}{9}$).

Angles *mm‴* = *96° 27′, *cw* = *20° 34′, *oo′* = 111° 4′, *cπ* = 49° 17′, *ππ′* = 70° 6′, *cm* = *79° 50′.

In concretionary and stalactitic forms, occasionally showing distinct crystals.

Cleavage: *c* easy. Luster vitreous. Color bright blue. Becomes ocherous externally. Optically +. Ax. pl. ‖ *b*. $Bx_a$ nearly ‖ axis *à*. Axial angles, Hintze[2].

$2H_{a.r} = 86° \, 8'$

$2H_{o.r} = 94° \, 25'$

$2H_{a.y} = 85° \, 52'$

$2H_{o.y} = 94° \, 59'$

$2H_{a.gr} = 85° \, 3'$

$2H_{o.gr} = 95° \, 31'$

**Comp.**—An iron vitriol (melanterite) with the iron in part replaced by copper, $(Fe,Cu)SO_4 + 7H_2O$.

**Anal.**—Pisani, l. c. 2, C. Hintze, Zs. Kr., **2**, 309, 1878.

| | $SO_3$ | FeO | CuO | $H_2O$ |
|---|---|---|---|---|
| 1. Turkey | 29·90 | 10·98 | 15·56 | 43·56 = 100 |
| 2. Tuscany | 28·84 | *und.* | 10·07 | *und.* |

**Pyr., etc.**—B.B. gives with the fluxes reactions for copper. Otherwise like melanterite.

**Obs.**—Occurs with chalcopyrite at a copper mine in the interior of Turkey. The interior of the mineral has sometimes druses of minute crystals. Also as a recent formation at the mines of chalcopyrite and pyrite near Massa Marittima, Tuscany.

**Ref.**—[1] N. R., 157, 1867. [2] Zs. Kr., 2, 309, 1878.

**754. BIEBERITE.** Cobalt Vitriol *Sage,* J. Phys., **39**, 53, 1791. Kobaltvitriol *Kopp,* Gehlen's J., **6**, 157, 1808. Red Vitriol. Sulphate of Cobalt. Rhodhalose *Beud.*, Tr., **2**, 481, 1832. Bieberit *Haid.*, Handb., 489, 1845.

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c} = 1·1815 : 1 : 1·5325$; $\beta = 75° \, 19\frac{3}{4}' = 001 \wedge 100$ Marignac[1].

$100 \wedge 110 = 48° \, 49'$, $001 \wedge 101 = 43° \, 22'$, $001 \wedge 011 = 56° \, 0'$.

**Forms:**
*b* (010, *i*-*ì*)
*c* (001, *O*)
*m* (110, *I*)
*f* (103, $-\frac{1}{3}$-*ī*)
*v* (101, − 1-*ī*)
*t* ($\bar{1}01$, 1-*ī*)
*e* (013, $\frac{1}{3}$-*ì*)
*o* (011, 1-*ì*)
*r* (111, − 1)
*n* (121, − 2-*2̀*)
*ν* ($\bar{1}21$, 2-*2̀*)

*mm‴* = *97° 38′
*cf* = 20° 39′
*cv* = 43° 22′
*ct* = 61° 51′
*ee′* = 52° 36′
*oo′* = 112° 0′
*co* = *56° 0′
*cr* = 55° 38′
*cm* = 80° 24′
*cn* = 67° 35′
*cν* = 78° 13′
*rr′* = 78° 6′
*nn′* = 116° 42½′

Usually in stalactites and crusts, investing other minerals.

G. = 1·924, artificial crystals, Schiff. Luster vitreous. Color flesh- and rose-red. Subtransparent to translucent. Friable. Taste astringent.

**Comp.**—Hydrous cobalt sulphate, $CoSO_4 + 7H_2O$ = Sulphur trioxide 28·5, cobalt oxide 26·6, water 44·9 = 100.

**Pyr., etc.**—In a matrass yields water, and when strongly heated, sulphur dioxide. Gives a blue bead with borax.

**Obs.**—In the rubbish of old mines at Bieber, in Hesse; at Leogang in Salzburg; at Tres Puntas, near Copiapo, Chili.

Beudant's name *Rhodhalose* is not an admissible derivative from ροδόεις, *rose-colored*, and ἅλς, *salt*, and is unmineralogical in its termination; it should have been *Rhodohalite*. Instead of making it right (in which case it would be no longer Beudant's name), it appears better to adopt the name applied by Haidinger, derived from the longest known locality.

**Ref.**—[1] Mem. Soc. Phys. Genève, **14**, 245, 1855. See also Rg., Kr. Ch., **1**, 419, 1881.

Cupromagnesite. *Scacchi*, Rend. R. Accad. Sc. Napoli, Oct., 1872; Zs. G. Ges., **24**, 506. Found at Vesuvius as a product of the eruption of April, 1872, in bluish green crusts, consisting of copper vitriol and sulphate of magnesium. From the solution crystals are obtained having the composition $(Cu,Mg)SO_4 + 7H_2O$, and isomorphous with iron vitriol.

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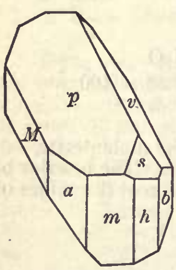
**755. CHALCANTHITE.** Χάλκανθον, Chalcanthum pt., *Dioscor.*, *Plin.*, Atramentum cœruleum, *Agric.*, *Gesner.* Vitriolum Cupri = V. Cypri = V. Veneris, *Wall.*, *Cronst.* Sulphate of Copper, Blue Vitriol, Copper Vitriol. Kupfervitriol *Germ.* Couperose bleue, Cuivre sulfaté, *Fr.* Vitriolo di Rame *Ital.* Cyanose *Beud.*, Tr., **2**, 486, 1832. Chalkanthit *v. Kobell*, Tafeln, 31, 1853. Vitriolo azul *Span.*

Triclinic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·56562 : 1 : 0·55067$; $\alpha = 82° 21\frac{1}{4}'$, $\beta = 73° 10\frac{5}{6}'$ $\gamma = 77° 37\frac{1}{4}'$ Kupffer[1].

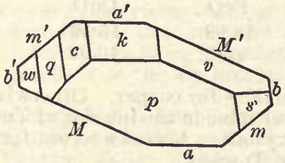
100 ∧ 010 = *100° 41′, 100 ∧ 001 = 105° 37⅚′, 010 ∧ 001 = 94° 21⅓′.

**Forms**[2]:
*a* (100, *i*-*ī*, n Mlr.)
*b* (010, *i*-*ĭ*, r Mlr.)
*c* (001, *O*, o Mlr)
*d* (210, *i*-2̄′)
*m* (110, *I*′, t Mlr.)
*h* (120, *i*-2̆′)
*α* (130, *i*-3̆′)
*f* (31̄0, ′*i*-3̆)
*r* (21̄0, ′*i*-2̄)
*M* (11̄0, ′*I*, m Mlr.)
*k* (011, 1-*ĭ*′)
*v* (021, 2-*ĭ*′)
*q* (01̄1, ′1-*ĭ*)
*w* (02̄1, ′2-*ĭ*)
*p* (111, 1′)
*s* (121, 2-2̆′)
*x* (131, 3-3̆′)
*z* (12̄1, ′2-2̆)

1.



2.



*ad* = 15° 47′
*am* = 30° 51′
*ah* = 53° 24′
*bm* = *69° 50′
*aM* = 25° 59′
*mM* = 56° 50′
*ck* = 29° 18′
*cv* = 49° 32′
*cq* = 27° 20′
*cw* = 44° 51′
*cp* = 54° 57′
*cm* = 107° 17′
*mp* = *52° 20′
*cs* = 62° 55′
*ap* = 59° 10′
*ak* = *109° 38′
*kp* = 50° 28′
*as* = 68° 46′
*bp* = *76° 33′
*bs* = 55° 2½′
*bx* = 40° 47′
*b′z* = 41° 14′
*Mp* = 71° 39′
*M′v* = 54° 2½′

Crystals commonly flattened ∥ *p*. Occurs also massive, stalactitic, reniform, sometimes with fibrous structure.

Cleavage: *M*, *m*, *p* imperfect. Fracture conchoidal. Brittle. H. = 2·5. G. = 2·12–2·30. Luster vitreous. Color Berlin-blue to sky-blue, of different shades; sometimes a little greenish. Streak uncolored. Subtransparent to translucent. Taste metallic and nauseous.

Optically —. Acute bisectrix in the right quadrant behind; a plane, *S*, normal to it makes the following angles, Pape[3] (see Introduction, p. xxiii):

*mS* = 81° 31′  *MS′* = 43° 41′  *pS* = 72° 52½′

Dispersion $\rho < v$. Axial angle, 2V = 56° 2′. Refractive indices for the D line, Pape[3]:

$\alpha = 1·5156$  $\beta = 1·5394$  $\gamma = 1·5464$

Also $\alpha = 1·5140$  $\beta = 1·5368$  $\gamma = 1·5433$  2E = 93° 1′ K.[4]

**Comp.**—Hydrous cupric sulphate, $CuSO_4 + 5H_2O$ = Sulphur trioxide 32·1, cupric oxide 31·8, water 36·1 = 100.

**Pyr., etc.**—In the closed tube yields water, and at a higher temperature sulphur trioxide. B.B. with soda on charcoal yields metallic copper. With the fluxes reacts for copper. Soluble in water; a drop of the solution placed on a surface of iron coats it with metallic copper.

**Obs.**—Found in waters issuing from mines and in connection with rocks containing chalcopyrite, by the alteration of which it is formed. Some of its foreign localities are the Rammelsberg mine near Goslar in the Harz; Falun in Sweden; at Parys mine, Anglesea; at various mines in Co. of Wicklow; formerly in crystals an inch long at Ting Tang mine in Gwennap; also Rio Tinto mine, Spain. The waters of the Rio Tinto mine have yielded annually 1,800 cwt. of copper, consuming 2,408 cwt. of iron. At Wicklow about 500 tons of iron were laid in the pits at one time, and in about 12 months the bars were dissolved, and each ton of iron yielded 1⅓ to 2 tons of a reddish mud which was *cement* copper (Cementkupfer *Germ.*) containing for every ton 16 cwt. of pure copper. It has been observed at Vesuvius among the products of the eruption of 1855; at Copiapo, Chili, with stypticite.

Found at the Hiwassee copper mine, also in large quantities at the Isabella and other mines, in Polk Co., Tennessee, 30 m. from Cleveland; at the Canton mine, Georgia. In Arizona, at the Yavapai mine near Clifton, Graham Co., and at Jerome, Yavapai Co.

On the ancient *chalcanthum*, see p. 645. Beudant's name *cyanose* (with *cyanosite* derived from it, from κύανος) is rejected like other names in which the terminal *s* of the Greek is retained. Moreover, *chalcanthite*, meaning *flowers of copper*, is old and good.

**Ref.**—[1] Pogg., 8, 218, 1826. [2] Mlr., Min., 556, 1852. Gdt., Index, 2, 277, 1888. [3] Pape, Pogg., Erg., **6**, 35, 1873; cf. also ib., **138**, 364, 1868 (corrosion ellipsoid, etc.). [4] Kohlrausch, Zs. Kr., **2**, 102, 1877.

**756. SYNGENITE.** *v. Zepharovich*, Lotos, 137, 213, June, 1872; Ber. Ak. Wien, **67** (1), 128, 1873. Kaluszite *Rumpf*, Min. Mitth., 117, 1872. Kalk-Kali-Sulfat *Germ.*

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 1{\cdot}3699 : 1 : 0{\cdot}8738$; $\beta = {}^*76^\circ\ 0' = 001 \wedge 100$ Zepharovich[1].

$100 \wedge 110 = 53^\circ\ 2\frac{3}{4}'$, $001 \wedge 101 = 28^\circ\ 12'$, $001 \wedge 011 = 40^\circ\ 17\frac{1}{2}'$.

**Forms**[1]:
a (100, $i\text{-}\bar{i}$)
b (010, $i\text{-}\grave{i}$)
c (001, *O*)
h (810, $i\text{-}\bar{8}$)

k (610, $i\text{-}\bar{6}$)
l (410, $i\text{-}\bar{4}$)
ϑ (310, $i\text{-}\bar{3}$)
λ (210, $i\text{-}\bar{2}$)
ϵ (650, $i\text{-}\frac{\bar{6}}{5}$)

m (110, *I*)
g (120, $i\text{-}\grave{2}$)
ρ (203, $-\frac{2}{3}\text{-}\bar{i}$)
r (101, $-1\text{-}\bar{i}$)

u ($\bar{1}01$, $1\text{-}\bar{i}$)
v ($\bar{2}01$, $2\text{-}\bar{i}$)
q (011, $1\text{-}\grave{i}$)
o (111, $-1$)

ω ($\bar{1}11$, 1)
π ($\bar{2}21$, 2)
i (411, $-4\text{-}\bar{4}$)
e ($\bar{2}11$, $2\text{-}\bar{2}$)

$a\vartheta = {}^*23^\circ\ 53\frac{5}{6}'$
$\vartheta\vartheta''' = 47^\circ\ 48'$
$\lambda\lambda''' = 67^\circ\ 13'$
$mm''' = 106^\circ\ 5'$
$gg' = 41^\circ\ 14'$
$ar = 47^\circ\ 48'$
$a'u = 67^\circ\ 48'$
$a'v = 43^\circ\ 11'$
$qq' = 80^\circ\ 35'$

$co = 42^\circ\ 17'$
$cm = 81^\circ\ 38'$
$c\omega = 51^\circ\ 9'$
$c\pi = 71^\circ\ 46'$
$ao = 55^\circ\ 40\frac{1}{2}'$
$aq = {}^*79^\circ\ 22'$
$a'\omega = 72^\circ\ 55'$
$oo' = 65^\circ\ 50'$
$\omega\omega' = 77^\circ\ 57'$

1. 2.

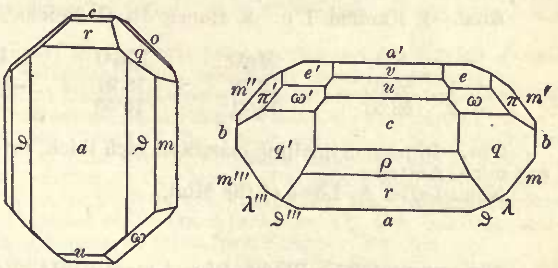


Fig. 1, 2, After Rumpf.

Twins: tw. pl. *a*, observed in the lamellar aggregates; also on artif. cryst.[2] Crystals prismatic and flattened ∥ *a*; faces *a* vertically striated, also ϑ, λ.

Cleavage: *m* perfect; *a* also perfect. Fracture conchoidal. Brittle. H. = 2·5. G. = 2·603. Luster vitreous. Colorless or milky-white. Transparent to translucent.

Optically −. Ax. pl. ⊥ *b*. $Bx \wedge \grave{c} = +87^\circ\ 14'$, hence nearly ⊥ *a*.

$2E_r = 41^\circ\ 36'$ $2E_y = 44^\circ\ 23'$ $2E_{bl} = 49^\circ\ 45'$ Tsch.[3]

$2E_r = 41^\circ\ 35'$ $2E_{bl} = 46^\circ\ 22'$ $\beta = 1{\cdot}55$ $\therefore$ $2V_r = 26^\circ\ 31'$ $2V_{bl} = 29^\circ\ 24'$ Vrba.[4]

**Comp.**—$CaSO_4.K_2SO_4 + H_2O$ = Sulphur trioxide 48·8, lime 17·1, potash 28·6, water 5·5 = 100; or, Calcium sulphate 41·5, potassium sulphate 53·0, water 5·5 = 100.

**Anal.**—1, Ullik, Min. Mitth., 120, 1872. 2, Völker, Ber. Ak. Wien, **66** (1), 197, 1872.

| | | $SO_3$ | CaO | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|
| 1. | ¼ | 48·44 | 16·88 | 28·55 | 5·47[a] | = 99·34 |
| 2. | | 49·04 | 16·97 | 28·03 | 5·85 (also 0·46 MgO) | = 99·89 |

[a] Also in one anal., 1·42 Na,Cl.

**Pyr., etc.**—In the flame of a Bunsen gas-burner becomes milky, colors the flame violet, and melts easily to a colorless (on cooling white) bead, with a crystalline granular texture. In closed tube gives off water, decrepitating violently. Easily attacked by water, dissolving in part with the separation of calcium sulphate. Vrba found that one part of syngenite dissolved in 400 pts. of water, like gypsum.

**Obs.**—Found in cavities in halite at Kalusz, East Galicia; it occurs below the level of the "Abraum Salts" (p. 933), and in gypsum-anhydrite-bearing rock salt. Name derived from συγγενής (related), alluding to its close relation to polyhalite.

**Artif.**—The artificial salt is well known; it was described by Miller[5] and Lang[6] as orthorhombic, which has led to the supposition of dimorphism[7]. It is shown, however, by Zepharovich that the natural and artificial salts are identical and both monoclinic, but the latter often twins.

**Ref.**—[1] Ber. Ak. Wien, **67** (1), 128, 1873. [2] Brz., Min. Mitth., 47, 1873, also Zeph., l. c. [3] Min. Mitth., 198, 1872. [4] Lotos, 212, 1872, quoted by Zeph.; cf. also Murmann & Rotter, Ber. Ak. Wien, **34**, 135, 1859. [5] J. Ch. Soc., 3, 348, 1850; Min. Mitth., 47, 1873. [6] Lang, Ber. Ak. Wien, **61** (1), 194, 1870. [7] Rumpf, p. 123; Rg., Kr. Ch., 446, 1881.

**757. LÖWEITE.** Löweit *Haid.*, Abh. Ges. Wiss. Prag, 4, 1846; *Haid.*, Ber. Fr. Nat. **2**, 266, 1847. Loeweite.

Tetragonal. Cleavage octahedrons yield the angles 68° 16′ and 74° 58′. Massive, cleavable.

Cleavage: basal, distinct; prismatic, imperfect; octahedral in traces. Fracture conchoidal. H. = 2·5–3·0. G. = 2·376. Luster vitreous. Color yellowish-white to honey-yellow, also reddish. Taste weak.

Optically uniaxial, positive. Double refraction strong; $\omega = 1·491$, $\epsilon = 1·494$, Haid.

**Comp.**—Hydrous sulphate of magnesium and sodium, $MgSO_4.Na_2SO_4 + 2\frac{1}{2}H_2O$ = Sulphur trioxide 52·1, magnesia 13·0, soda 20·2, water 14·7 = 100; or, Magnesium sulphate 39·1, sodium sulphate 46·3, water 14·7 = 100.

**Anal.**—1, Karafiat, l. c. 2, Hauer, Jb. G. Reichs., 605, 1856.

| | $SO_3$ | MgO | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|
| 1. | 52·35 | 12·78 | 18·97 | 14·45 $Fe_2O_3$,$Al_2O_3$ 0·66 = 99·21 |
| 2. | 52·53 | 14·31 | 18·58 | 14·80 $Fe_2O_3$,NaCl *tr.* = 100·22 |

**Obs.**—In pure crystalline masses an inch thick, involved with foliated anhydrite, at the Ischl salt mine, Austria.

Named after A. Löwe of the Mint.

**758. BLÖDITE.** Blödit *John*, Unters., 1811. Astrakanit *G. Rose*, Reis. Ural, **2**, 270, 271, 1842. Simonyit *Tschermak*, Ber. Ak. Wien, **60** (1), 718, 1869. Warthite. Bloedite.

Monoclinic. Axes $\breve{a} : \bar{b} : \dot{c} = 1·34940 : 1 : 0·67048$; $\beta = 79° 21\frac{3}{4}' = 001 \wedge 100$ Groth and Hintze[1].

$100 \wedge 110 = 52° 59'$, $001 \wedge 101 = 24° 6'$, $001 \wedge 011 = {}^*33° 23'$.

**Forms**[2]:
*a* (100, *i*-ī)
*b* (010, *i*-ĭ)
*c* (001, *O*)
*λ* (310, *i*-3̄)
*n* (210, *i*-2̄)
*l* (320, *i*-3̄/2)
*m* (110, *I*)
*ν* (120, *i*-2̀)
*μ* (130, *i*-3̀)[3]
*r* (1̄01, 1-ī)[4]
*q* (2̄01, 2-ī)
*d* (011, 1-ì)
*e* (021, 2-ì)
*p* (111, – 1)
*w* (1̄12, ½)
*u* (1̄11, 1)
*y* (2̄21, 2)
*t* (3̄11, 3-3̄)
*s* (2̄11, 2-2̄)
*v* (2̄12, 1-2̄)
*o* (121, –2-2̀)
*z* (131, –3-3̀)
*x* (1̄21, 2-2̀)
*f* (1̄44, 1-4̀)[3]

1. 2.

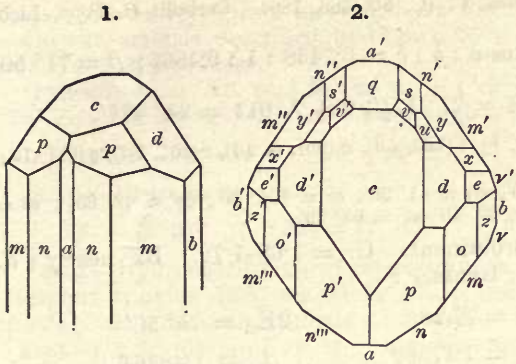


Fig. 1, 2, Stassfurt, after Groth.

| | | | |
|---|---|---|---|
| $\lambda\lambda'''$ | = 47° 42′ | $co$ | = 52° 10′ |
| $nn'''$ | = 67° 6′ | $cz$ | = 61° 48′ |
| $ll'''$ | = 82° 58′ | $cv$ | = 32° 58′ |
| $mm'''$ | = 105° 58′ | $cs$ | = 55° 16½′ |
| $\nu\nu'$ | = 41° 19′ | $ap$ | = 60° 4′ |
| $\mu\mu'$ | = 28° 13′ | $ad$ | = 81° 8′ |
| $cr$ | = 28° 16′ | $a'u$ | = 75° 13′ |
| $cq$ | = 50° 6′ | $pp'$ | = *57° 42½′ |
| $dd'$ | = 66° 46′ | $uu'$ | = 65° 9½′ |
| $ee'$ | = 105° 37′ | $yy'$ | = 91° 59′ |
| $cp$ | = *36° 55′ | $oo'$ | = 95° 33′ |
| $cm$ | = 83° 37′ | $zz'$ | = 117° 39′ |
| $cw$ | = 23° 15½′ | $ss'$ | = 54° 44′ |
| $cu$ | = 42° 5′ | $vv'$ | = 35° 26′ |
| $cy$ | = 63° 32′ | | |

In short prismatic crystals often highly modified. Also massive granular or compact, also somewhat fibrous.

Cleavage not observed. H. = 2·5. G. = 2·22–2·28. Luster vitreous. Colorless and transparent to bluish green, reddish yellow and translucent; also flesh-red to brick-red. Taste faint, saline and bitter.

Optically—. Ax. pl. ∥ $\bar{b}$. $Bx_r \wedge \dot{c} = -44° 48'$, $Bx_{bl} \wedge \dot{c} = -43° 21'$. Axial angles[1]:

$2H_{a.r} = 71° 17'$ $2H_{o.r} = 112° 23'$ ∴ $2V_r = 70° 5'$ $\beta_r = 1·500$

$2H_{a.bl} = 73° 22'$ $2H_{o.bl} = 108° 55'$ ∴ $2V_{bl} = 72° 34'$

**Var.**—The original *blödite* from Ischl, analyzed by John, was massive, somewhat fibrous, flesh-red to brick-red in color, and splintery in fracture. The *astrakanite*, from near Astrakhan, was in whitish crystals. Simonyite from Hallstadt was supposed to differ from blödite in not efflorescing in the air, which, however, has been shown not to be true of the characteristic mineral.

**Comp.**—Hydrous sulphate of magnesium and sodium, $MgSO_4.Na_2SO_4 + 4H_2O$ = Sulphur trioxide 47·9, magnesia 12·0, soda 18·6, water 21·6 = 100; or, Magnesium sulphate 36·4, sodium sulphate 42·0, water 21·6 = 100.

Analyses agree closely with the formula; one by Paul, Stassfurt, gave: $SO_3$ 48·14, MgO 11·97, $Na_2O$ 18·55, $H_2O$ 21·60 = 100·26, Zs. G. Ges., **23**, 671, 1871; see also 5th Ed., p. 659; Tschermak, l. c. (simonyite); Zimmermann, Stassfurt, quoted by Luedecke, l. c. *et al.* Foullon obtained a somewhat abnormal composition (12·6 MgO, 24 $H_2O$, etc.) for blödite from Hall in Tyrol (Jb. G. Reichs., **38**, 1, 1888).

**Pyr., etc.**—Heated loses water rapidly; at a red heat fuses quietly to a transparent globule, which is white on cooling. Somewhat deliquescent in a moderately moist atmosphere.

**Obs.**—From the salt mines of Ischl; at Hallstadt (*simonyite*) in thin layers between rock salt; at Stassfurt in crystals, sometimes an inch across, on the massive mineral or on carnallite. Also from salt lakes near Astrakhan, east of the mouth of the Volga; the soil of the country near Mendoza, between San Luis de la Punta and the foot of the Andes, especially east of San Juan, occurring in imperfect crystals at the junction of two layers of common salt, one to two feet below the surface. Also common in northern Chili in the Pampa del Toro, Atacama (Dietze, Zs. Kr., **19**, 446, 1891), and at Cerros Pintados, in Tarapacá (Schulze, Vh. Ver. Santiago, **2**, 54, 1889). In India, in rock salt at the Varcha mine, 30 miles from Shahpur, Punjab.

Named after the chemist and mineralogist Blöde. Simonyite from F. Simony, who discovered the Hallstadt locality.

**Ref.**—[1] Stassfurt, Zs. G. Ges., **23**, 670, 1871; also Rath. Pogg., **144**, 586, 1871. [2] See Groth, and Hintze, l. c., and vom Rath. l. c. Brezina noted on simonyite *c*, *n*, *m*, *d*, *p*, Ber. Ak. Wien, **60** (1), 718, 1869, Min. Mitth., 20, 1872.

[3] Schimper, Punjab, Zs. Kr., **1**, 71, 1877.

[4] Luedecke, Zs. Nat. Halle, **59**, 157, 1886. Cf. also Bücking, Douglashall, Westeregeln, Zs. Kr., **15**, 568, 1889.

A sulphate of magnesium and sodium having the formula $Na_2SO_4.4MgSO_4 + 7H_2O$ is mentioned by Domeyko as occurring at Canota, 55 miles from Mendoza, Argentine Republic. An analysis gave:

$SO_3$ 33·45 MgO 14·00 $Na_2O$ 4·60 $H_2O$ 47·95 = 100

It is fibrous in structure, white, translucent.

**759. BOUSSINGAULTITE.** *E. Bechi*, C. R., **58**, 583, 1864. Cerbolit *O. Popp*, Lieb. Ann., Suppl. Bd. 8, 1, 1872.

Monoclinic. For artif. cryst., axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}7438 : 1 : 0{\cdot}4862$; $\beta = 71° 50' = 001 \wedge 100$ Brooke[1].

$100 \wedge 110 = 35° 15'$, $001 \wedge 101 = 27° 17\frac{1}{2}'$, $001 \wedge 011 = 24° 47\frac{3}{4}'$.

**Forms:** *b* (010, *i-ì*), *c* (001, *O*); *m* (110, *I*), *l* (130, *i-3̀*), *n* (201, – 2-*ī*), *r* (2̄01, 2-*ī*), *q* (011, 1-*ì*), *o* (111, – 1), *s* (1̄11, 1).

Angles: $mm''' = {}^*70° 30'$, $ll' = 50° 30'$, $cn = 41° 26'$, $cr = {}^*64° 30'$, $qq' = 49° 35\frac{1}{2}'$, $co = 32° 44\frac{1}{2}'$, $cm = {}^*75° 15'$, $cs = 44° 11\frac{1}{2}'$, $oo' = 37° 40'$, $ss' = 65° 29'$.

Crystals prismatic (*m*) with *c* prominent. G. = 1·68–1·72. Bx nearly ‖ $\grave{a}$. Ax. pl. ‖ *b*. Axial angles and indices, Heusser[2]:

$2E_r = 77° 26'$ $2E_y = 77{\cdot}28$ $2E_{bl} = 75° 50'$

$\beta_r = 1{\cdot}46772$ $\beta_y = 1{\cdot}47369$ $\beta_{bl} = 1{\cdot}48461$

**Comp.**—A hydrous sulphate of ammonium and magnesium $(NH_4)_2SO_4.MgSO_4 + 6H_2O = SO_3$ 44·4, MgO 11·1, $(NH_4)_2O$ 14·4, $H_2O$ 30·0 = 100; or, Ammonium sulphate 36·7, magnesium sulphate 33·3, water 30·0 = 100.

**Anal.**—1, 2, O. Popp, l. c.: 1 of crystals obtained by recrystallization; 2, crystallized product from evaporation of lagoon waters.

| | $SO_3$ | MgO | $(NH_4)_2O$ | $H_2O$ |
|---|---|---|---|---|
| 1. | $\frac{2}{2}$ 44·39 | 11·05 | 9·38 | 35·16 = 99·98 |
| 2. | $\frac{2}{2}$ 44·30 | 10·27 | 9·32 | 34·67 FeO 0·38, MnO 0·73, CaO 0·34 = 100·01 |

**Obs.**—Occurs in the water of the boric acid lagoons, Tuscany, especially at the fumaroles of Monte Cerboli; the amount increases as the quantity of boron diminishes.

**Ref.**—[1] Ann. Phil., **7**, 117, 1824. Cf. Rg., Kr. Ch., 447, 1881. [2] Heusser, Pogg., **91**, 506, 1854.

A soft white mineral occurring in irregular granular masses in Sonoma, California, gave Goldsmith: $SO_3$ 38·86, MgO 15·56, $(NH_4)_2O$ 5·03, $H_2O$ 40·55 = 100. G. = 1·67. Proc. Acad. Philad., 264, 1876.

**760. PICROMERITE.** Picromeride *Scacchi*, Mem. Incend. Vesuv., 191, 1855. Pikromerit Rg., Min. Ch., 281, 1860. Schoenite *E. Reichardt*, Jb. Min., 602, 1865, 340, 1866.

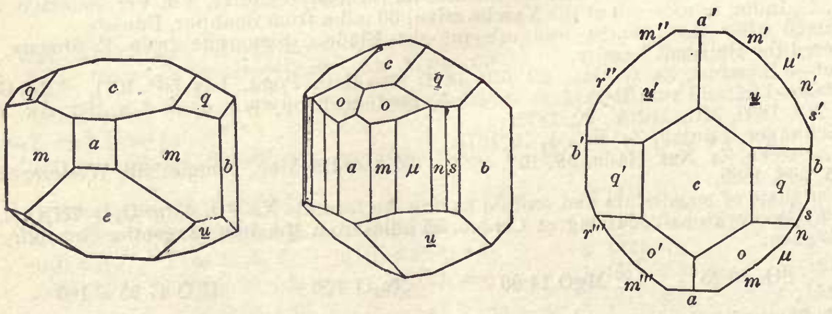
Monoclinic. Axes $\grave{a} : \bar{b} : \dot{c} = 0{\cdot}7265 : 1 : 0{\cdot}4900$; $\beta = {}^*75° 12' = 001 \wedge 100$ Scacchi[1].

$100 \wedge 110 = {}^*35° 5'$, $001 \wedge 101 = 29° 5\frac{1}{6}'$, $001 \wedge 011 = {}^*25° 21'$.

| **Forms**[1]: | *c* (001, *O*) | *n* (120, *i-2̀*)[2] | *q* (011, 1-*ì*) |
|---|---|---|---|
| *a* (100, *i-ī*) | *m* (110, *I*) | *s* (130, *i-3̀*)[2] | *o* (111, – 1)[2] |
| *b* (010, *i-ī*) | *μ* (230, *i*-$\frac{3}{2}$)[2] | *e* (2̄01, 2-*ī*) | *u* (1̄11, 1) |

| | | | |
|---|---|---|---|
| $mm''' = 70° 10'$ | $ce = 63° 19'$ | $cm = 77° 56'$ | $uu' = 48° 25'$ |
| $\mu\mu' = 87° 1'$ | $qq' = 50° 42'$ | $cu = 44° 14'$ | $ao = 49° 11'$ |
| $nn' = 70° 53'$ | $co = 34° 31'$ | $oo' = 38° 54'$ | $a'u = 68° 44'$ |
| $ss' = 50° 46\frac{1}{2}'$ | | | |

1. 2. 3.



Figs. 1–3, Aschersleben, Luedecke.

As a white crystalline incrustation; the solution of this (Vesuvius) yielded Scacchi the crystals described by him. G. = 2·10–2·20. Also rarely in natural crystals, f. 1–3, Luedecke.

Optically +. Ax. pl. ∥ *b*. $\mathfrak{a}\mathfrak{c} = -1° 0'$ or $\mathfrak{c}a = 13° 48'$, hence $Bx_a \wedge \acute{c} = -76° 12'$. Dispersion $\rho > v$. Axial angles, M. & R.[3]

$2H = 48° 22'$ $2E = 74° 2'$ $2V = 48° 21'$ $\beta_r = 1·468$ $\beta_y = 1·470$ $\beta_{bl} = 1·476$

Also, Des Cloizeaux[4]:

$2E_r = 72° 20'$ $2E_v = 71° 16'$ $2V_r = 47° 37'$ $\beta_r = 1·462$

**Comp.**—Hydrous sulphate of magnesium and potassium, $MgSO_4.K_2SO_4 + 6H_2O$ = Sulphur trioxide 39·8, magnesia 9·9, potash 23·4, water 26·9; or, Magnesium sulphate 29·9, potassium sulphate 32·2, water 26·9 = 100.

**Anal.**—1, 2, H. Reichardt, Jb. Min., 602, 1865; 340, 1866. 3, Staute, Zs. Nat. Halle, **58**, 653, 1885. 4, Rosenthal, ibid. 5, Niedzwiedzki, Vh. G. Reichs., 149, 1890.

| | | $SO_3$ | MgO | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|
| 1. Leopoldshall | | 39·74 | 10·40 | 23·28 | 26·87 | Cl 0·28 = 100·57 |
| 2. " | | 38·52 | 11·56 | 22·82 | [26·29] | Cl 0·81 = 100 |
| 3. Aschersleben | | 38·85 | 9·64 | 23·01 | 28·49 | = 99·99 |
| 4. " | | 39·49 | 10·40 | 23·99 | 26·54 | Cl 0·99 = 101·41 |
| 5. Galusz | G. = 2·10 | 39·78 | 10·01 | 22·35 | 26·71 | $Na_2O$ 1·54, Cl 0·48 = 100·87 |

**Pyr., etc.**—Loses 11 p. c. water at 100°, and all the rest by heating to 133°, Reichardt. According to Graham, the artificial salt loses its water wholly at 132°.

**Obs.**—Found at Vesuvius among the salts produced at the eruption in 1855, in crystals along with crystals of cyanochroite, an isomorphous species in which copper replaces the magnesium. Further as a thin incrustation upon the kainite of Leopoldshall, Stassfurt (*schoenite*); also at Aschersleben in the kainite region; with kainite at Galusz in East Galicia.

Named from πικρός, *bitter*, and μέρος, *part*, in allusion to the magnesium present. *Schoenite* is for the mining officer Schoene of Leopoldshall.

**Ref.**—[1] L. c. The artificial crystals have been measured by Brooke, Murmann and Rotter, and Rammelsberg with results agreeing for the most part with the above, cf. Rg., Kr. Ch., **1**, 448, 1881. [2] Luedecke, Zs. Nat. Halle, **58**, 651, 1885. [3] Murmann and Rotter, Ber. Ak. Wien, **34**, 142, 1859. [4] Dx., Propr. Opt., **2**, 51, 1859.

### 761. CYANOCHROITE. Cianocroma *Scacchi*, Mem. Vesuv., 191, 1855.

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c} = 0·7477 : 1 : 0·5052$; $\beta = {}^*75° 30' = 001 \wedge 100$ Scacchi[1].

$100 \wedge 110 = {}^*35° 54'$, $001 \wedge \bar{1}01 = 38° 13'$, $001 \wedge 011 = 26° 3\frac{5}{6}'$.

**Forms**: *a* (100, *i*-*ī*), *b* (010, *i*-*ì*), *c* (001, *O*); *m* (110, *I*); *η* ($\bar{1}01$, 1-*ī*), *e* ($\bar{2}01$, 2-*ī*); *o* (011, 1-*ì*); *n* ($\bar{1}11$, 1); *μ* ($\bar{1}21$, 2-$\grave{2}$).

Angles: $ce = 63° 10'$, $cn = 44° 31'$, $nn' = 49° 39'$, $\mu\mu' = 85° 32\frac{1}{2}'$, $em' = {}^*52° 32'$.

In crystalline crusts of a clear blue color, crystals obtained from solution. Artif. crystals of this salt have been measured by Brooke[2].

Optically +. Ax. pl. ∥ *b*. $\mathfrak{a}c = +4° 23'$ or $\mathfrak{c}a = 18° 53'$, hence $Bx_a \wedge \acute{c} = -71° 7'$. Dispersion $\rho > v$. Axial angles, Murmann and Rotter[3]:

$2H = 49° 39'$ $2E = 76° 12'$ $2V = 48° 53'$ $\beta_r = 1·489$ $\beta_y = 1·491$ $\beta_{bl} = 1·498$

**Comp.**—Hydrous sulphate of copper and potassium, $CuSO_4.K_2SO_4 + 6H_2O$ = Sulphur trioxide 36·3, cupric oxide, 17·9, potash 21·3, water 24·5 = 100; or, Cupric sulphate 36·1, potassium sulphate 39·4, water 24·5 = 100.

**Obs.**—From the saline crusts formed on the lavas during the eruption of Vesuvius in 1855.

Named in allusion to the color from κύανος, *blue*, and χρόα, *color*. Scacchi's name has been changed to the above, in order to secure the termination *ite* and avoid ambiguity (the mineral containing no chrome).

**Ref.**—[1] L. c. [2] Ann. Phil., **7**, 118, 1824. [3] Ber. Ak. Wien, **34**, 169, 1859. Cf. Rg., Kr. Ch., **1**, 462, 1881.

**762. POLYHALITE.** Polyhalites *Strom.*, Comment. Soc. R. Götting., **4**, 139. Polyhalit *Strom.*, Unters., **1**, 444, 1821.

Probably monoclinic[1]. Usually in compact fibrous or lamellar masses.

Cleavage easy in one direction. H. = 2·5–3. G. = 2·769; 2·784 Pfeiffer. Luster resinous or slightly pearly. Streak red. Color flesh- or brick-red, sometimes yellowish. Translucent to opaque. Taste bitter and astringent, but very weak.

**Comp.**—Hydrous sulphate of calcium, magnesium, and potassium, $2CaSO_4.MgSO_4.K_2SO_4 + 2H_2O$ = Sulphur trioxide 53·2, lime 18·6, magnesia 6·6, potash 15·6, water 6·0 = 100; or, Calcium sulphate 45·2, magnesium sulphate 19·9, potassium sulphate 28·9, water 6·0 = 100.

Analyses conform closely to the formula after deduction of impurities ($NaCl, Fe_2O_3$, etc.); see 5th Ed., p. 641; also Schober, Berchtesgaden. Jb. Min., 578, 1869; v. Lill, Stebnik, Galicia, Min. Mitth., 89, 1874; E. Pfeiffer, Stassfurt [Arch. Pharm., **219**, 1881], Zs. Kr., **10**, 524, 1885, *et al.*

**Pyr., etc.**—In the closed tube gives off water. B.B. fuses at 1·5, colors the flame yellow. On charcoal fuses to a reddish globule, which in R.F. becomes white, and on cooling has a saline hepatic taste; with soda like glauberite. With fluorite does not give a clear bead. Partially soluble in water, leaving a residue of calcium sulphate which dissolves in a large amount of water.

**Obs.**—Occurs at the mines of Ischl, Ebensee, Aussee, Hallstadt, and Hallein in Austria, with common salt, gypsum, and anhydrite; at Berchtesgaden in Bavaria; at Stassfurt, cf. kieserite, p. 932; at Stebnik, Galicia; at Vic in Lorraine.

The name polyhalite is derived from πολύς, *many*, and ἅλς, *salt*, in allusion to the number of salts in the constitution of the mineral.

**Ref.**—[1] Cf. Dx., N. R., 202, 1867, who finds that the Ischl variety is amorphous, inclosing a biaxial mineral whose ax. pl., about the + bisectrix, is strongly inclined to the plane of cleavage and oblique to the direction of fibers.

KRUGITE *Precht*, Ber. Ch. Ges., **14**, 2138, 1881. Near polyhalite. Massive, crystalline. H. = 3·5. G. = 2·801.

Formula, $4CaSO_4.MgSO_4.K_2SO_4 + 2H_2O$ = Calcium sulphate 62·3, magnesium sulphate 13·7, potassium sulphate 19·9, water 4·1 = 100. Anal.—Precht:

| | $CaSO_4$ | $MgSO_4$ | $K_2SO_4$ | $H_2O$ | NaCl | |
|---|---|---|---|---|---|---|
| 1. | 63·15 | 13·71 | 18·60 | 4·16 | 0·38 | = 100 |
| 2. | 63·85 | 13·34 | 17·85 | 4·20 | 0·80 | = 100·04 |

In cold water the magnesium sulphate is dissolved, and gypsum and the double salt $K_2SO_4.CaSO_4 + 2H_2O$ are left insoluble; in hot water the magnesium and potassium sulphates are dissolved out, and only the gypsum is left behind. Named for the Mining Director, D. Krug v. Nidda.

MAMANITE *A. Goebel* Bull. Ac. St. Petersb., **9**, 16, 1865. Like polyhalite in aspect and characters, but stated to have the CaO, MgO, $K_2O$ in the ratio 3 : 2 : 1. Color white; luster silky; structure foliated fibrous. In nodules as large as the fist, at the salt mine of Maman in Persia, with carnallite, and also investing or intersecting nodules of carnallite.

**763. WATTEVILLITE.** *Singer*, Inaug. Diss. Würzburg, p. 18, 1879.

In very minute acicular crystals, orthorhombic or monoclinic; in part twins; forms fine fibrous aggregates. G. = 1·81. Color snow-white. Luster silky. Taste first sweet, then astringent.

**Comp.**—Perhaps $CaSO_4.Na_2SO_4 + 4H_2O$ = Sulphur trioxide 45·7, lime 16·0, soda 20·6, water 17·7 = 100; or, Calcium sulphate 38·8, sodium sulphate 43·5, water 17·7 = 100.

The calcium is replaced in part by magnesium and about one third of the sodium by potassium. The water corresponds more closely to $4\frac{1}{2}H_2O$.

**Anal.**—Singer, l. c., after deducting 33·69 p. c. hygroscopic water.

| $SO_3$ | $Al_2O_3$ | FeO | NiO | CoO | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| 44·01 | 0·24 | 0·88 | 1·05 | 1·30 | 16·87 | 2·49 | 4·74 | 10·46 | 17·73 = 99·77 |

**Pyr., etc.**—B.B. swells up and fuses with difficulty to a white blebby enamel. Very soluble in water; from the concentrated solution, crystals of gypsum separate on standing, and still more quickly on warming.

**Obs.**—Found on lignite, associated with other related sulphates on the Bauersburg, near Bischofsheim vor dem Rhön, in Bavaria. Named after M. v. Watteville, of Paris.

## Alum and Halotrichite Groups.

The ALUMS proper are isometric in crystallization and, chemically, are hydrous sulphates of aluminium with an alkali metal and 12 (*i.e.*, if the formula is doubled, 24) molecules of water. The HALOTRICHITES are oblique in crystallization, commonly fibrous in structure, and are hydrous sulphates of aluminium with magnesium, manganese, etc.; the amount of water in some cases is given as 22 molecules, and in others 24, but it is not always easy to decide between the two.

The species here included are not easily distinguishable by the taste or external characters, and hence early authors on minerals include all under one or two names. The old synonymy and the history of the species are therefore more conveniently given here than under the several subdivisions of the group.

*Στυπτηρία Gr.* Alumen *Plin.* [embracing vitriols as well as the alums]. *Σγιστη στυπτηρία Diosc.* [embracing the fibrous or feathery kinds, *Σχιστή* being from *σχίζειν*, *I cut*, and alluding to the easy subdivision into fibers]. *Τριχίτης Dioscr.* [fr. *θρίξ*, *hair*, it embracing capillary kinds]. Alumen fossile, *Germ.* Alaun, *Gesner*, Foss., 1565 [vitriols being excl., and comprising the var. A. candidum Neapolitanum (fr. Naples), A. capillare, ib., A. Placodes (latas crustas habens), ib., etc.]. Alun, Alumen [including var. $\alpha$ solidum, $\beta$ crystallisatum, $\gamma$ plumosum, or Fjäder-Alun], *Wall.*, Min., 161, 1747. Alun, Argilla acido vitrioli imbuta, *Cronst.*, 115, 1758. Argilla vitriolata [= Sulphate of Alumina] *Bergm.*, Sciagr., 1782. Alaun, Haarsalz, Federalaun [all as one species, or if two, without right distinctions], *Wern.*, *and other Min. before* 1800. Alumine sulfatée alkaline *H.*, Tr., **2**, 278, 1801 [citing Vauquelin's anal. of potash-alum, but including all alums].

In 1795 Klaproth proved (Beitr., **1**, 311), and in 1792 Breislak (Essais Min. sur la Solfatara, etc.), that some alum (that of Miseno and the Solfatara, near Naples) was *potash-alum*. In 1802 Klaproth showed (Beitr., **3**, 102) that the *Federalaun* of Freyenwald was *iron-alum*. Beudant ascertained that there was a native alum-like mineral which had the constitution attributed in the last century to true alum—that is, was a simple *sulphate of aluminium*, without an alkali or other protoxide (Tr., 449, 1824). Grüner, in 1821 (Gilb. Ann., **69**, 218), made known a native *ammonia-alum;* Thomson, in 1828 (Ann. Lyc. N. Y., **3**, 19, 1828), a native *soda-alum;* A. A. Hayes, in 1845 (Am. J. Sc., **47**, 360), a *magnesia-alum*.

Alaun *Germ.* Alun *Fr.* Allume *Ital.* Alumbre *Span.*

**764. KALINITE.** Potash Alum. Native Alum. Kalialaun, Kalinischer Alumsulphat, *Germ.* Alumen *Weisbach*, Synops. Min., 9, 1875. Kalinite *Dana.*

Isometric. Usually fibrous or massive, or in mealy or solid crusts. Artif. cryst. commonly octahedral, also cubic and with *d* (110, *i*), *n* (211, 2-2), *p* (221, 2), and the pyritohedron *e* (210, *i*-2)[1]. Twins: tw. pl. *o*.

H. = 2–2·5. G. = 1·75. Luster vitreous. Color white. Transparent to translucent. Often exhibits anomalous double refraction[3]. Refractive index, $n = 1{\cdot}4557$ for D, Fock[2].

The anomalous double refraction was early explained by Biot[3] as due to lamellar polarization, but Reusch[3] (Pogg., **132**, 618, 1867) showed that this hypothesis would not answer, since the more transparent the crystals the more distinctly the phenomena are shown, but that they were probably to be explained by secondary internal tension. The subject has been discussed by Mallard[3], from his standpoint an octahedral crystal being regarded as made up of eight hexagonal pyramids having their bases coincident with the octahedral faces and their vertices at the center. Again by Klocke[3], who, after giving the results of detailed observations, shows that Mallard's hypothesis does not explain the facts observed, but they are rather to be referred to secondary disturbances in the normal isotropic molecular structure. The investigations of the same author have extended also to the etching-figures and related points.

**Comp.**—Hydrous sulphate of aluminium and potassium, $K_2SO_4.Al_2(SO_4)_3 + 24H_2O$ = Sulphur trioxide 33·7, alumina 10·8, potash 9·9, water 45·6 = 100; or, Potassium sulphate 18·1, aluminium sulphate 36·3, water 45·6 = 100.

The alum from Vulcano contains traces of cæsium and rubidium, Cossa.

**Pyr., etc.**—B.B. fuses in its water of crystallization, and froths, forming a spongy mass; with cobalt solution an intense blue; on charcoal gives a hepatic mass. Soluble in from 16 to 20 times its weight of cold water, and in little more than its weight of boiling water.

**Obs.**—Effloresces on argillaceous minerals, and more particularly alum slate. Whitby in Yorkshire is a noted locality, also Hurlet and Campsie near Glasgow. Also obtained at the volcanoes of the Lipari isles and Sicily. Cape Sable, Maryland, has afforded large quantities of alum. An alum, formerly described from the caves of the Unaka Mts., Eastern Tennessee, in Sevier Co., is mentioned with analysis on p. 955 (= apjohnite); masses a cubic foot in size have been obtained.

**Ref.**—[1] Cf, Weber, Pogg., **109**, 379, 1860. See also Wulff, Zs. Kr., **5**, 81, 1881. [2] Fock, Zs. Kr., **4**, 593, 1880. On the refractive indices and dispersion of various alums (Ga-Cs, Ga-Th, etc.), see Soret, Bibl. Univ., **20**, 517, 1888.

[3] Biot, C. R., **12**, 967, **13**, 155, 391, 1841. Reusch, Pogg., **132**, 618, 1867, or Ber. Ak. Berlin, 424, June, 1867. Mallard, Ann. Mines. **10**, 116, 1876. Klocke, Jb. Min., **1**, 53, 158, 1880; also on etching-figures, etc., Zs. Kr., **2**, 126, 293, 298, 552, 1878.

**765. TSCHERMIGITE.** Ammonia Alum. Ammoniakalaun, Ammonalaun, *Germ.* Ammonalun *Beud.*, **2**, 497, 1832. Tschermigit *v. Kobell*, Tafeln Bestimm., 1853.

In octahedrons and fibrous.

H. = 1–2. G. = 1·50. Luster vitreous. Color white. Transparent to translucent.

**Comp.**—Hydrous sulphate of aluminium and ammonium, $(NH_4)_2SO_4.Al_2(SO_4)_3+24H_2O$ = Sulphur trioxide 35·3, alumina 11·3, ammonium oxide 5·7, water 47·7 = 100; or, Aluminium sulphate 37·7, ammonium sulphate 14·6, water 47·7 = 100.

An analysis of ammonia alum occurring in white fibrous plates near Dux, Bohemia, gave Deichmüller (Isis, p. 33, 1885):

$SO_3$ 34·99 $Al_2O_3$ 11·40 $(NH_4)_2O$ 3·83 $H_2O$ 49·72 X[a] 0·06 = 100

[a] Alkali sulphate not volatilized.

**Pyr., etc.**—In the closed tube yields water and ammonium sulphate; B.B. sublimes; on charcoal gives a coating of ammonium sulphate, and leaves a residue which gives a fine blue with cobalt solution; with soda gives ammonia fumes, and the reaction for sulphuric acid.

**Obs.**—From Tschermig, and from the mine near Dux, in Bohemia. This salt is manufactured from the waste of gas works, and used extensively in place of potash alum.

**766. MENDOZITE.** Soda Alum. Natronalaun, Natrumalaun, *Germ.* Natronalun *Huot*, 2, 448, 1841. Solfatarite pt. *Shep.*, Min., **2**, 187, 1835 (not in Min. of 1857). Mendozite *Dana*, Min., 653, 1868.

In white fibrous masses.

H. = 3, and G. = 1·88 Thomson. Externally white or pulverulent. Some resemblance to fibrous gypsum, but harder.

**Comp.**—Hydrous sulphate of aluminium and sodium, $Na_2SO_4.Al_2(SO_4)_3+24H_2O$ = Sulphur trioxide 34·9, alumina 11·1, soda 6·8, water 47·2 = 100; or, Sodium sulphate 15·5, aluminium sulphate 37·3, water 47·2 = 100.

Some doubt exists as to the amount of water, which is sometimes taken as 22, or even 20, molecules; the theoretical amounts corresponding to these are 45·0 and 42·7 p. c. Thomson's early analysis gave 41·96 p. c. $H_2O$. The normal amount, however, can hardly differ from that of the other isometric alums. This is confirmed by an analysis by Mori (Ch. News, **44**, 218, 1881), of a soda alum from Shimané, Prov. Idzumo, Japan:

$SO_3$ 34·73 $Al_2O_3$ 11·27 $Na_2O$ 7·26 $H_2O$ 46·74 = 100

**Pyr, etc.**—Resembles ordinary alum.

**Obs.**—Occurs near Mendoza, in the Argentine Republic.

Thomson found for the composition of a soda alum from Southern Peru, which he called Subsesquisulphate of Alumina (Phil. Mag., **22**, 192, 1843): $SO_3$ 32·95, $Al_2O_3$ 22·55, $Na_2SO_4$ 6·50, $H_2O$ 39·20 = 101·20. G. = 1·584.

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**767. TAMARUGITE.** *H. Schulze*, Vh. Ver. Santiago, 2, 56, 1889.

Structure fibrous. H. = 1. G. = 2·03–2·04. Luster vitreous. Colorless. Composition like mendozite, but contains only half as much water: $Na_2SO_4.Al_2(SO_4)_3+12H_2O$ = Sulphur trioxide 45·7, alumina 14·6, soda 8·9, water 30·8 = 100. Analysis:

$SO_3$ 45·66 $Al_2O_3$ 14·48 $Na_2O$ 9·04 CaO 0·20 CoO *tr.* $H_2O$ 30·86 Cl 0·12 = 100·36

From the Cerros Pintados. Tarapacá, Chili. Named from the Pampa del Tamarugal.

An alum (*alumbre nativo*) analyzed by Domeyko (Min., 2d App. to 3d Ed., p. 30, 1883) is near the above and may be the same thing; he obtained:

$SO_3$ 41·94 $Al_2O_3$ 15·10 $Na_2O$ 10·70 CaO 0·89 $H_2O$ 31·37 = 100

**768. PICKERINGITE.** *Hayes*, Am. J. Sc., **46**, 360, 1844. Magnesia Alum *ib.* Magnesia-alaun, Talkerde-Alaun, *Germ.* Alumbre.

Monoclinic? In fine acicular crystals; in long fibrous masses; and in efflorescences.

H. = 1. Luster silky. Color white, yellowish, pale rose-red. Becomes pulverulent and white on exposure. Taste bitter to astringent.

**Comp.**—Hydrous sulphate of aluminium and magnesium, $MgSO_4.Al_2(SO_4)_3 + 22H_2O$ = Sulphur trioxide 37·3, alumina 11·9, magnesia 4·7, water 46·1 = 100; or, Aluminium sulphate 39·9, magnesium sulphate 14·0, water 46·1 = 100.

Some authors give $24H_2O$, but this is not confirmed by the analyses.

**Anal.**—1, Hayes, l. c. 2, Schulze, Vh. Ver. Santiago, **2**, 58, 1889. 3, Schickendantz, Brackebusch, Min. Argentina, 74, 1879; also other analyses giving similar results. 4, H. How, J. Ch., Soc., **16**, 200, 1863. 5, Goldsmith, Proc. Ac. Philad., 333, 1876.

| | G. | $SO_3$ | $Al_2O_3$ | FeO | MgO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. Chili | | 36·32 | 12·13 | 0·43[a] | 4·68 | 0·13 | 45·45 HCl 0·60 = 99·74 |
| 2. " | | 37·28 | 11·85 | 0·03[b] | 4·64 | 0·31 | 46·10 Cl 0·02 = 100·23 |
| 3. Argentine R. | | 37·02 | 10·90 | — | 6·75 | 1·30 | 44·95 = 100·91 |
| 4. Newport, N. S. | | 36·33 | 10·64 | 0·58[a] | 4·79 | — | 46·06 CoO 0·06, Ni 0·14, [CuO 0.02, $K_2O$ 0·23, slate 0·72 = 99·57 |
| 5. Colorado | 1·729 | 38·69 | 11·90 | — | 4·89 | 0·68 | 41·94 sand 1·90 = 100 |

[a] Incl. MnO. [b] CuO, CoO.

In two other trials How obtained: $SO_3$ 36·36, 36·59, and $H_2O$ 46·16, 46·07.

**Pyr., etc.**—In the matrass yields water, and acts like other alums. Tastes like ordinary alum.

**Obs.**—From the Cerros Pintados, northern Chili, and at other points. From various points in the Argentine Republic (Brackebusch, Min. Argent., 74, 1879). From Colorado City, Colorado (anal. 5). Also from N. Scotia, in Newport, on the bank of the Meander, as an efflorescence on the slate or shale (Silurian) of a sheltered cliff, where it results from the action on the shale of decomposing pyrite—and probably a kind containing traces of cobalt and nickel.

Named after the Hon. John Pickering of Boston (d. 1846).

STÜVENITE *L. Darapsky*, Vh. Ver. Santiago, 107, 1886.

Occurs in slender acicular crystals. Apparently intermediate between mendozite and pickeringite, but somewhat doubtful. Composition, $(Na_2.Mg)SO_4.Al_2(SO_4)_3 + 24H_2O$. Analysis:

$\frac{2}{2}$ $SO_3$ 36·1 $Al_2O_3$ 11·6 MgO 1·0 $Na_2O$ 2·7 $K_2O$ *tr.* $H_2O$ 47·6 = 99·0

Occurs with other sulphates at the old mine of Alcaparossa, near Copiapo, Chili. Named after the mining engineer Enrique Stüven.

*Sesqui-Magnesiaalaun* of Darapsky (l. c., Jb. Min., **1**, 131, 1887) is an alum near pickeringite from the Cerros Pintados, Chili, for which the formula is calculated $1\frac{1}{2}MgSO_4.Al_2(SO_4)_3+26\frac{1}{2}H_2O$. The homogeneity of the substance is well questioned by Groth. Analyses:

| | $SO_3$ | $Al_2O_3$ | MgO | $H_2O$ | $MgCl_2$ | insol. |
|---|---|---|---|---|---|---|
| 1. Compact | 37·93 | 7·75 | 8·18 | 45·22 | 0·20 | 0·73 = 100·11 |
| 2. " | 35·95 | 11·60 | 5·82 | 45·97 | 0·24 | 0·36 = 99·94 |
| 3. Fibrous | 35·17 | 10·26 | 6·90 | 48·54 | 0·14 | — = |

An analysis is also given of an altered kind.

The following are near each other, and related to pickeringite; they require further examination.

SONOMAITE *E. Goldsmith*, Proc. Ac. Philad., 263, 1876. Crystalline. G. = 1·604. Silky luster. Colorless. Composition, $3MgSO_4.Al_2(SO_4)_3 + 33H_2O$. Analysis:

$\frac{2}{3}$ $SO_3$ 38·54 $Al_2O_3$ 8·01 FeO 1·78 MgO 7·33 $H_2O$ [44·34] = 100

From the neighborhood of the Geysers, Sonoma Co., California.

PICROALLUMOGENE *G. Roster*, Boll. Com. Geol., 302, 1876. Stalactitic; in nodular and fibrous radiated masses. Color white, with a rose-red tinge. Streak nearly white. Semi-translucent. Taste acid, bitter. Composition, if homogeneous, $2MgSO_4.Al_2(SO_4)_3 + 28H_2O$. Analysis:

| $SO_3$ | $Al_2O_3$ | MgO | $H_2O$ |
|---|---|---|---|
| 36·39 | 9·16 | 8·19 | 45·69 $K_2O$ 0·37, CoO *tr.* = 99·80 |

Fuses easily in its own water of crystallization, and swells out, becoming opaque and porous. Dissolves in slightly warmed water, forming an acid solution, from which oblique prisms resembling gypsum separate on slow evaporation. Occurs with sulphur and melanterite, in the iron mine of Vigneria, Island of Elba.

DUMREICHERITE *Doelter*, Capverd Inseln, 93, 1882.

Monoclinic ?. In thin crusts consisting of aggregated columns. Taste astringent. Soluble in water. Composition, $4MgSO_4.Al_2(SO_4)_3 + 36H_2O$. Analysis, F. Kertscher:

$SO_3$ 36·65 $Al_2O_3$ 7·14 MgO 11·61 $H_2O$ 45·01 $Na_2O$,Cl *tr.* = 100·41

From crevices in the lava of the Paule valley, S. Antão, one of the Cape Verde islands. Named after A. von Dumreicher of Lisbon.

AROMITE *L. Darapsky*, Jb. Min., **1**, 49, 1890.

Crystalline. Fracture conchoidal.

Resembles epsomite, but B.B. swells up slightly, and is decomposed rapidly on exposure. Composition, $6MgSO_4.Al_2(SO_4)_3.54H_2O$. Analysis:

| | $SO_3$ | $Al_2O_3$ | MgO | $H_2O$ |
|---|---|---|---|---|
| 1. | 33·71 | 5·00 | 12·71 | 48·58 = 100 |
| 2. | 33·21 | 1·15 | 15·90 | 49·87 = 100·3 |

From the Pampa de Aroma, in the northern part of Tarapacá, Chili.

A related sulphate from the neighborhood of Copiapo is near aromite. It is in fibrous masses. Color yellowish. Luster vitreous, dull. Analysis:

| $SO_3$ | $Al_2O_3$ | FeO | MgO | $Na_2O$ | CuO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 34·59 | 4·68 | 9·45 | 2·87 | 1·03 | 2·12 | 45·36 | Cl *tr.* = 100·10 |

The copper belongs to admixed copper sulphate.

**769. HALOTRICHITE.** Federalaun vom Freyenwalde (with anal. showing it to be an iron alum) *Klapr.*, Beitr., 3, 102, 1802. Eisenalaun *Germ.* Iron Alum. Halotrichit *Glocker*, Grundr., 691, 1839. Hversalt *Forchhammer*, JB. Ch., **23**, 263, 1843. Halotrichine *Scacchi*, Mem. Geol. Camp. Nap., 84, 1849.

Monoclinic or triclinic. Silky fibrous. Yellowish white. Taste inky-astringent. Becomes dull and pulverulent on exposure.

**Comp.**—$FeSO_4.Al_2(SO_4)_3 + 24H_2O$ = Sulphur trioxide 34·5, alumina 11·0, iron protoxide 7·8, water 46·7 = 100; or, Aluminium sulphate 36·9, ferrous sulphate 16·4, water 46·7 = 100.

The early analyses gave only 22 $H_2O$; the formula then requires: Sulphur trioxide 35·9, alumina 11·5, iron protoxide 8·1, water 44·5 = 100.

**Anal.**—1, Rg., Pogg., **43**, 399, 1848. 2, Silliman, Dana Min., 226, 1850. 3, Arppe, Finsk. Min., 1857. 4, Forchhammer, l. c. 5, Scacchi, l. c. 6. Linck, Zs. Kr., **15**, 26, 1888. 7, Janovsky, quoted by Zepharovich, Ber. Ak. Wien, **79** (1), 183, 1879, after deducting impurities. 8, F. W. Clarke, Am. J. Sc., **28**, 24, 1884.

| | | $SO_3$ | $Al_2O_3$ | FeO | MgO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Mörsfeld | | 36·03 | 10·91 | 9·37 | 0·23 | — | 43·03 | $K_2O$ 0·43 = 100 |
| 2. Urumia | | 33·81 | 10·62 | 9·15 | — | — | 41·61 | $SiO_2$ 3·34, $Fe_2O_3$ 1·05 = 99·58 |
| 3. Finland | | 34·71 | 13·33 | 6·23 | — | — | 44·20 = 98·47 | |
| 4. *Hversalt* | | 35·16 | 11·22 | 4·57 | 2·19 | — | 45·63 | $Fe_2O_3$ = 100 |
| 5. *Halotrichine* | | 34·12 | 9·76 | 10·20 | — | — | 45·92 = 100 | |
| 6. Chili | G. = 1·885 | 33·98 | 10·43 | 5·55 | 0·78 | 0·69 | 46·94 | $Ti_2O_3$ 0·95 = 99·32 |
| 7. Idria | G. = 2·04 | 34·90 | 10·29 | 4·36 | 1·94 | — | 47·11 | $Fe_2O_3$ 1·40 = 100 |
| 8. Gila R., N. Mexico | G. = 1·89 | 37·19 | 7·27 | 13·59[a] | — | — | 40·62 | insol. 0·50 = 99·17 |

[a] A trace as $Fe_2O_3$.

Lippitt gives for a sulphate from Tepeji, Mexico: $SO_4$ 41·59, Al 4·92, Fe 7·81, Ca 0·52, $H_2O$ 43·60 = 98·44, Ch. News, **48**, 98, 1883.

The name *Halotrichite* is from ἅλς, *salt*, and θρίξ, *hair*.

*Berg-butter* (*Beurre de Montagne*) is an impure alum or copperas efflorescence, of a butter-like consistence, oozing from some alum slates. A yellowish kind from Wetzelstein, near

Saalfeld, afforded R. Brandes (Schw. J., **39**, 417, 1823): $SO_3$ 34·82, $Al_2O_3$ 7·00, FeO 9·97, MgO 0·80, $Na_2O$ 0·72, $(NH_4)_2O$ 1·75, $H_2O$ 43·50 = 99·00.

**Pyr., etc.**—Fuses in its own crystallization-water, cracks open, and if strongly heated gives off sulphuric oxide, leaving a brown residue; with the fluxes reacts for iron, and with soda on charcoal gives an hepatic mass.

**Obs.**—Occurs at Bodenmais, Bavaria, and at Mörsfeld in Rhenish Bavaria. Also at Urumia, Persia, where the inhabitants use it for making ink of a fine quality; at Hurlet and Campsie near Glasgow; at Björkbakkagård in Finland; at the Solfatara at Pozzuoli (*halotrichine*). At the Tierra Amarilla near Copiapo, Chili, in white silky fibrous forms with oblique extinction (triclinic?). The *Hversalt* of Forchhammer is an allied alum from Iceland.

Probably at Rossville, Richmond Co., N. Y. (Beck). The related sulphate of anal. 8 occurs in white asbestiform fibers at the headwaters of the Gila River, 40 miles north of Silver City, New Mexico; the deposit of aluminous sulphates is said to cover some two thousand acres. The salt analyzed by Lippitt was in fine flexible fibers of a greenish white color, from Tepeji, State of Mexico, Mexico.

**770. APJOHNITE.** Manganese Alum *Apjohn*, Phil. Mag., **12**, 103, 1838. Manganalaun. Apjohnit *Glocker*, Syn., 298, 1847.

Bushmanite. Manganese Alum pt., Mangano-magnesian Alum. Bosjemanite *Dana*, Min., 654, 1868. Buschmanite. Boschjesmanite.

Monoclinic? In fibrous or asbestiform masses; also as crusts and efflorescences.

H. = 1·5. G. = 1·782 (anal. 3). Luster silky. Color white or with faint tinge of rose, green, or yellow. Taste like that of ordinary alum, but less strong.

**Comp., Var.**—Hydrous sulphate of aluminium and manganese, $MnSO_4.Al_2(SO_4)_3 + 24H_2O$ = Sulphur trioxide 34·6, alumina 11·0, manganese protoxide 7·7, water 46·7 = 100; or, Manganese sulphate 16·3, aluminium sulphate 37·0, water 46·7 = 100.

*Bushmanite* is intermediate between pickeringite and apjohnite; formula, $(Mn,Mg)SO_4.Al_2(SO_4)_3+22$ (or 24) $H_2O$.

**Anal.**—1, Apjohn, l. c. 2, Ludwig [Arch. Pharm., **143**, 97], Rg., Min. Ch., 273, 1875. 3, W. G. Brown, Am. Ch. J., **6**, 97, 1884.

4, Stromeyer, Pogg., **31**, 137, 1834. 5, J. L. Smith, Am. J. Sc., **18**, 379, 1854. 6, E. Schweizer, Kenng. Ueb., 12, 1859.

*Apjohnite.*

| | $SO_3$ | $Al_2O_3$ | MnO | $H_2O$ | |
|---|---|---|---|---|---|
| 1. S. Africa | 32·79 | 10·65 | 6·60 | 48·15 | $MgSO_4$ 1·08 = 99·27 |
| 2. " | 35·90 | 10·47 | 7·44 | 46·99 | $(NH_4)_2O$ 1·54 = 102·34 [insol. 0·06 = 100·07 |
| 3. Sevier Co., Tenn. | 35·47 | 10·03 | 8·73 | 44·78 | FeO 0·39, MgO 0·30, (Co,Ni)O 0·29, CuO 0·02, |

*Bushmanite.*

| | $SO_3$ | $Al_2O_3$ | FeO | MnO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 4. S. Africa | 36·77 | 11·52 | — | 2·17 | 3·69 | 45·74 | KCl 0·20 = 100·09 |
| 5. Utah | 35·85 | 10·40 | 0·15 | 2·12 | 5·94 | 46·00 | $K_2O$ 0·20 = 100·66 |
| 6 Maderanerthal | 35·69 | 10·55 | 1·06 | 2·51 | 3·74 | 44·26 | CaO 0·27, $K_2O$ 0·58, CuO 0·22, [insol. 1·12 = 100 |

In the last there was some ammonia with the water.

Brown (l. c.) shows that anals. 1, 2, 4 agree with the general formula given above, while the others agree with $R_3Al_4(SO_4)_9 + 51H_2O$.

**Pyr.**—Nearly the same as for ordinary alum, but gives with fluxes a reaction for manganese.

**Obs.**—Apjohnite is from Lagoa Bay in South Africa.

The mineral of anal. 3 is from Alum Cave, Sevier Co., Tenn.; it had been earlier called kalinite. The cave is situated at the headwaters of the Little Pigeon, a tributary of the Tennessee river; it is properly an overhanging cliff 80 or 100 feet high and 300 feet long under which the alum has collected. It occurs in masses, showing in the cavities fine transparent needles with a silky luster; extinction oblique; color of the mass white, with faint tinge of rose, pale green or yellow: H = 1·5; G. = 1·782. Epsomite and melanterite also occur with it.

Bushmanite covers the floor of a cave near the Boschjesman (Bosjesman = Bushman) river in South Africa, to a depth of six inches; the roof is a reddish quartzose conglomerate, containing magnesia and pyrites; it rests on a bed of epsomite, 1½ inches thick. Also, a related alum is found in the Maderanerthal in Canton Uri, Switzerland (called *keramohalite* by Schweizer) and at Alum Point near Salt Lake, in Utah. This Utah mineral was made a manganesian alum by Dr. Gale, Am. J. Sc., **15**, 434, 1853.

**771. DIETRICHITE.** *Von Schröckinger*, Vh. G. Reichs., 189, 1878. *Arzruni*, Zs. Kr., **6**, 92, 1881.

Monoclinic (?), Arzruni.

In fine fibrous, tufted forms, as an efflorescence or incrusting.

H. = 2. Luster silky. Color dirty white to brownish yellow. Easily soluble in water; taste like vitriol. B.B. fusible.

**Comp.**—$(Zn,Fe,Mn)SO_4.Al_2(SO_4)_3 + 22H_2O$.

**Anal.**—Dietrich, quoted by Von Schröckinger.

| $SO_3$ | $Al_2O_3$ | ZnO | FeO | MnO | MgO | $H_2O$ |
|---|---|---|---|---|---|---|
| 35·94 | 10·92 | 3·70 | 3·11 | 1·74 | 0·33 | 44·38 = 100·12 |

A recent formation (within 14 years) in an abandoned working at Felsöbánya, Hungary.

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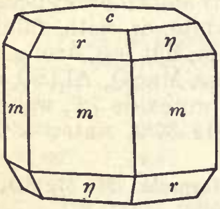
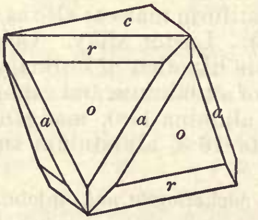
**772. COQUIMBITE.** Neutrales schwefelsaures Eisenoxyd *H. Rose*, Pogg., **27**, 310, 1833. White Copperas. Coquimbit *Breith.*, Handb., 100, 1841. Blakeite, *Dana*, Min., 447, 1850.

Rhombohedral. Axis $\dot{c} = 1·5613$; $0001 \wedge 10\bar{1}1 = 60° 59'$ Linck[1].

1.



2.



1, 2, Copiapo, Chili, Linck.

**Forms**[2]:

| | |
|---|---|
| *c* (0001, *O*) | *o* ($30\bar{3}2$, $\frac{3}{2}$) |
| *m* ($10\bar{1}0$, *I*) | *α* ($30\bar{3}1$, 3) |
| *a* ($11\bar{2}0$, *i*-2) | *n* ($03\bar{3}7$, $-\frac{3}{7}$) |
| *z* ($10\bar{1}3$, $\frac{1}{3}$) | *b* ($03\bar{3}4$, $-\frac{3}{4}$) |
| *y* ($10\bar{1}2$, $\frac{1}{2}$) | *η* ($01\bar{1}1$, $-1$) |
| *q* ($30\bar{3}5$, $\frac{3}{5}$) | *A* ($03\bar{3}1$, $-3$) |
| *r* ($10\bar{1}1$, 1) | *d* ($11\bar{2}2$, 1-2) |
| | *s* ($11\bar{2}1$, 2-2) |

*cz* = 31° 0′ *cd* = 57° 22′
*cy* = 42° 2′ *cs* = 72° 14½′
*cr* = 60° 59′ *rr′* = 98° 27½′
*m′η* = *29° 1′ *oo′* = 108° 38′
*co* = 69° 42′ *rη* = 51° 51′
*cα* = 79° 31½′ *ao* = 35° 41′

Twins: Tw. pl. *c*, the faces *a* coinciding and often showing a reversed striation ∥ edge *o*/*a*. Commonly in hexagonal prisms, f. 1, also in rhombohedral forms; again in forms simulating a regular octahedron, f. 2. Also granular massive.

Cleavage imperfect: *m*, *r*, *η*. H. = 2–2·5. G. = 2·092 Breith.; 2·105 Linck. Color white, yellowish, brownish, greenish, sometimes with a violet or amethystine tint. Taste astringent. Optically +. Refractive indices:

| | | | |
|---|---|---|---|
| $\omega_r$ = 1·5376 Li | $\epsilon_r$ = 1·5468 | $\omega_y$ = 1·5455 Na | $\epsilon_y$ = 1·5547 Arzruni |
| 1·5469 | 1·5508 | 1·5519 | 1·5575 Linck |

**Comp.**—$Fe_2(SO_4)_3 + 9H_2O$ = Sulphur trioxide = 42·7, iron sesquioxide 28·5, water 28·8 = 100. The iron may be partly replaced by aluminium.

**Anal.**—1, 2, Bamberger, Zs. Kr., **3**, 522, 1879. 3, Linck, Zs. K., **15**, 10, 1888. 4–6, J. B. Mackintosh, Am. J. Sc., **38**, 242, 1889.

| | G. | $SO_3$ | $Fe_2O_3$ | $H_2O$ | $Al_2O_3$ |
|---|---|---|---|---|---|
| 1. Chili | $\frac{2}{2}$ | 42·53 | 23.61 | 28·75 | 4·92 = 99·81 |
| 2. " | | 43·57 | 22·63 | [28·92] | 4·88 = 100 |
| 3. " | | 42·28 | 28·40 | 29·32 | *tr.* = 100 |
| 4. " | 2·07 | 43·40 | 22·17 | [29·79] | 4·39 $Na_2O$ 0·25, CaO,MgO *tr.* = 100 |
| 5. " | 2·089 | 42·90 | 26·10 | [29·08] | 1·65 $Na_2O$ 0·27, CaO,MgO *tr.* = 100 |
| 6. " | | 42·32 | 28·10 | [28·67] | 0·91[a] = 100 |

[a] Incl. $SiO_2$

From 1 and 2 some admixed epsomite and silica, and from 3, 1·3 p. c. silica, have been deducted. Water expelled at 110° in anals. 4, 5, 6 = 5, 6, 5⅓ molecules respectively. The material of anal. 4 was amethystine in color, crystalline, transparent; of 5, amethystine, massive, translucent; of 6, white, massive, opaque.

Earlier analyses by H. Rose (l. c. and 5th Ed., p. 650) established the composition.

**Pyr., etc.**—B.B. resembles melanterite. Wholly soluble in cold water; if the solution be heated, iron sesquioxide is copiously precipitated. Soluble in dilute hydrochloric acid

**Obs.**—Forms a bed in a feldspathic or trachytic rock, Tierra Amarilla near Copiapo, in the province of Atacama, Chili. The bed of salt is on the increase, and is probably derived from decomposing sulphides. Pits 20 ft. deep have been formed in it by the people of the country. Also north of Sierra Gorda near Caracoles. The mineral does not occur in Coquimbo, from which it takes its name.

A mineral referred here by Scacchi was observed by him about fumaroles after the eruption of Vesuvius in 1855, partly in a brownish friable crust, which, by solution and evaporation, afforded yellow hexagonal crystals; also as a yellowish crust, in many parts tinged green, compact in texture, with the luster of a surface of fracture very bright.

**Ref.**—[1] Zs. Kr., **15**, 5, 1888; Arzruni gave $\acute{c} = 1{\cdot}5645$, ibid., **3**, 516, 1879; Rose gave $\acute{c} = 1{\cdot}562$, Pogg., 27, 309, 1833. [2] Cf. authors quoted.

The name *blakeite* (Dana, Min., 447, 1850) was given to a mineral "from Coquimbo," analyzed by Blake and having the composition of coquimbite but supposed to occur in regular octahedrons. It is doubtless identical with coquimbite, as remarked by Linck, who notes that the combination *c*, *o* (f. 2) has nearly the form of an octahedron $co = 69° 42'$, $oo''' = 71° 22'$.

### 773. QUENSTEDTITE. *G. Linck*, Jb. Min., **1**, 213, 1888, Zs. Kr., **15**, 11, 1888.

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c} = 0{\cdot}39397 : 1 : 0{\cdot}40584$; $\beta = 78° 7\frac{1}{2}'$ Linck.[1]
$100 \wedge 110 = 21° 5'$, $001 \wedge 101 = 39° 45\frac{1}{6}'$, $001 \wedge 011 = 21° 39\frac{2}{3}'$.

**Forms:** *p* (350, $i\text{-}\frac{5}{3}$) *r* (0·11·10, $\frac{11}{10}$-ì) *t* (074, $\frac{7}{4}$-ì) *v* (094, $\frac{9}{4}$-ì)
*b* (010, *i*-ì) *q* (011, 1-ì) *s* (085, $\frac{8}{5}$-ì) *u* (0·15·8, $\frac{15}{8}$-ì) *w* (052, $\frac{5}{2}$-ì)
*m* (110, *I*)

$mm''' = 42° 10'$ $pp' = 114° 33'$ $tt' = 69° 36'$ $ww' = 89° 35\frac{1}{2}'$
$bm = {*}68° 55'$ $qq' = 43° 19'$ $bt = {*}55° 12'$ $m'q = {*}92° 37'$

Crystals tabular ‖ *b* and elongated ‖ $\grave{a}$, resembling gypsum; clinodome faces striated ‖ $\grave{a}$.

Cleavage: *b* perfect; *a* 100 (or a prism) less perfect, yielding a fibrous fracture. H. = 2·5. G. = 2·116. Luster vitreous. Color reddish violet. Transparent. Optically –. Ax. pl. ‖ *b*. Bx $\wedge \acute{c} = +21°$.

**Comp.**—$Fe_2(SO_4)_3 + 10H_2O$ or $Fe_2O_3.3SO_3.10H_2O$ = Sulphur trioxide 41·4, iron sesquioxide 27·6, water 31·0 = 100.

**Anal.**—Linck, l. c.

$\frac{4}{4}$ $SO_3$ 39·83 $Fe_2O_3$ 27·66 $H_2O$ 31·35 CaO 0·40 $Al_2O_3$,MgO *tr.* = 99·24

Also $SO_3$ 41·40, $Fe_2O_3$ 27·59. Of the water 20·84 p. c. goes off at 100°, 3·60 at 140°, 4·68 at 180°, 1·01 at 240°, 1·61 above It is readily soluble in water.

**Obs.**—Occurs with coquimbite and other sulphates of the Tierra Amarilla near Copiapo, Chili.

Named after the German mineralogist, Prof. F. A. von Quenstedt (1809–1889).

**Ref.**—[1] L. c.; Linck give as a fundamental angle $\bar{1}10 \wedge 011 = 87° 23'$; this, however, gives $\beta = 84° 14'$, while the value of $\beta$ measured on *b* was found to be 78° approx., the supplement of 87° 23' or 92° 37' gives results agreeing approximately with his (he gives $a : b : c = 0{\cdot}3942 : 1 : 0{\cdot}4060$, $\beta = 77° 58'$).

### 774. IHLËITE. *Schrauf*, Jb. Min., 252, 1877

An efflorescence on graphite, having a botryoidal or small reniform structure. G. = 1·812. Color orange-yellow, becoming pale yellow in dry air.

**Comp.**—An iron sulphate near coquimbite, probably $Fe_2(SO_4)_3 + 12H_2O$ = Sulphur trioxide 39·0, iron sesquioxide 25·9, water 35·1 = 100.

**Anal.**—Schrauf.

$SO_3$ 38·2 $Fe_2O_3(Al_2O_3)$ 24·5 FeO 2·1 $H_2O$ 35·5 = 100·3

Soluble in cold water.

Occurs at the graphite deposits at Mugrau, Bohemia, owing its origin to the decomposition of embedded crystals of pyrite. Named for Mr. Ihle, superintendent of mines in Mugrau.

KORNELITE *Krenner*, abstract in Ch. Ztg., 861, 1888, from the Hungarian Academy. Stated to be a hydrous ferric sulphate $Fe_2(SO_4)_3 + 7\frac{1}{2}H_2O$ = Sulphur trioxide 44·9, iron sesquioxide 29·9, water 25·2 = 100.

**775. ALUNOGEN.** Hydro-trisulfate d'alumine *Beud.*, Tr., 449, 1824. Davite (?) *Mill*, Quart. J., 25, 382, 1828. Alunogène *Beud.*, Tr., 2, 488, 1832. Solfatarite pt. *Shep.*, Min., 188, 1835. Keramohalit *Glocker*, Grundr., 689, 1839. Saldanite *Huot*, Min., 2, 451, 1841. Stypterit *Glocker*, Syn., 297, 1847. Halotrichit pt. *Hausm.*, Handb., 2, 1174, 1847 (not Halotrichit *Glocker*). Schwefelsaures Thonerde. Haarsalz *Rg.*

Monoclinic, Jurasky. Usually in delicate fibrous masses or crusts; also massive.

H. = 1·5–2. G. = 1·6–1·8. Luster vitreous to silky. Color white, or tinged with yellow or red. Subtranslucent to subtransparent. Taste like that of common alum.

**Comp.**—Hydrous aluminium sulphate, $Al_2(SO_4)_3 + 18H_2O$ = Sulphur trioxide 36·0, alumina 15·3, water 48·7 = 100.

Analyses agree, for the most part, closely, except for impurities; see 5th Ed., p. 649, also references as in App. III; Jb. Min., 2, 254, 1882; Clarke, Am. J. Sc., 28, 24, 1884; Hof, Teneriffe, Min. Mitth., 12, 39, 1891. Marguerite-Delacharlonny has obtained an artificial sulphate with only $16H_2O$, which requires 45·7 p.c.; an analysis of the mineral from Bolivia confirms this, giving 45·38 p.c. $H_2O$, C.-R., **111**, 229, 1890.

**Pyr., etc.**—Yields water, and at a higher temperature sulphuric acid, in the closed tube. Gives a fine blue with cobalt solution. Soluble in water.

**Obs.**—This species results both from volcanic action, and the decomposition of pyrite in coal districts and alum shales, and occurs at numerous localities; as at Kolosoruk near Bilin, Bohemia; Bodenmais; Pusterthal, Tyrol. The Pasto mineral was from the crater of a volcano. It has been observed by Scacchi at Vesuvius; at Königsberg, Hungary, it occurs in thick druses with iron vitriol. At various points in Peru and Bolivia; the Argentine Republic; Wallewarang, New South Wales; Teneriffe, Canary Islands.

It is found as an efflorescence in numerous places in the United States. A white fibrous alunogen (?) occurs abundantly at Smoky Mtn., Jackson Co., N. C., where, it is said, tons may be obtained. Extensive deposits occur on the Gila river, 40 miles north of Silver City, N. Mexico.

*Davite* was obtained from a hot spring at Chiwachi, a day's journey from Bogota. Mill obtained: $SO_3$ 28·8, $Al_2O_3$ 15·0, $H_2O$ 51·8, $Fe_2O_3$ 1·2, earthy matters 3·2 = 100.

**776. KRÖHNKITE.** Krönnkite *I. Domeyko*, 5th Appendix, Min. Chili, p. 33, 1876; also 3d Ed., Min. Chili, 250, 1879. Krönkite.

Monoclinic. Axes $\grave{a} : \bar{b} : \dot{c}$ = 0·44625 : 1 : 0·43521, $\beta$ = 72° 41′ = 001 ∧ 100 Darapsky[1].

100 ∧ 110 = 23° 4½′, 001 ∧ 101 = 35° 49⅙′, 001 ∧ 011 = 22° 34′.

**Forms:** *b* (010, *i-ì*), *m* (110, *I*), *e* (011, 1-*ì*), *p* (111, − 1).

Angles: *mm‴* = 46° 9′, *ee′* = 45° 8′, *me* = 66° 13′, *m′e* = 95° 53′.

In irregular prismatic crystalline masses with coarsely fibrous structure.

Cleavage: *m*, *b*, distinct. Fracture conchoidal. H. = 2·5. G. = 1·98. Luster vitreous. Color azure-blue, changing somewhat on exposure to the air.

**Comp.**—A hydrous sulphate of copper and sodium, $CuSO_4.Na_2SO_4 + 2H_2O$ = Sulphur trioxide 47·5, cupric oxide 23·5, soda 18·4, water 10·7 = 100; or, Cupric sulphate 47·2, sodium sulphate 42·1, water 10·7 = 100.

**Anal.**—1, 2, Darapsky, Jb. Min., 1, 192, 1889.

| | $SO_3$ | CuO | $Na_2O$ | $H_2O$ | Cl |
|---|---|---|---|---|---|
| 1. *White* | 47·02 | 22·34 | [19·24] | 11·40 | *tr.* = 100 |
| 2. *Green cryst.* | 46·64 | 21·38 | 19·52 | 12·58 | *tr.* = 100·10 |

The analysis of Kröhnke, quoted by Domeyko (who writes Krönke and Krönnke), gave

$CuSO_4$ 46·28 $Na_2SO_4$ 42·95 $H_2O$ 10·77 = 100

Another analysis by Domeyko gave:
$SO_3$ 46·56, CuO 23·20, $Na_2O$ 18·04, $H_2O$ [11·08], $Al_2O_3$ 0·22, $CuSO_4$ 0·90 = 100.

**Pyr., etc.**—B.B. decrepitates and fuses to a green mass. Easily soluble in water, giving an acid solution.

**Obs.**—Found in the copper mines near Calama, on the road from Cabija to Potosi, Atacama; from the mining district of Incahuase with sideronatrite. Named for B. Kröhnke.

An artificial salt of this composition is known.

**Ref.**—[1] L. c.; his calculations do not entirely agree with the above.

**Phillipite** *I. Domeyko*, 5th Appendix, Min. Chili, p. 38, 1876; 3d Ed., Min. Chili, p. 248, 1879.

Compact, granular, or with fibrous structure, transverse to veins in the chalcopyrite. Luster vitreous. Color azure-blue. Translucent, astringent. Composition approximately given by the formula, $CuSO_4.Fe_2(SO_4)_3 + nH_2O$. Analysis gave:

$SO_3$ 28·96, $Fe_2O_3$ 9 80 (iron subsulphate 2·28), CuO 14·39, MgO 0·85, $H_2O$ 43·72, $Al_2O_3$ *tr.* = 100. Soluble in water, but unaffected by exposure to the air. Found at the copper mines in the Cordilleras of Condes, province of Santiago, Chili. Produced from the decomposition of chalcopyrite, and found in small irregular masses and bands with it in an argillaceous ocher.

**777. FERRONATRITE.** *J. B. Mackintosh*, Am. J. Sc., **38**, 244, 1889. Gordait *Frenzel*, Min. Mitth., **11**, 218, 1890.

Rhombohedral. Axis $\dot{c}$ = 0·55278; 0001 ∧ $10\bar{1}1$ = *32° 33′ Arzruni[1].

**Forms**: *c* (0001, *O*), *m* ($10\bar{1}0$, *I*) cleavage, *a* ($11\bar{2}0$, *i*-2), *s* ($10\bar{1}2$, $\frac{1}{2}$), *r* ($10\bar{1}1$, *R*), *η* ($01\bar{1}1$, − 1).

Angles: *cs* = 17° 42′, *cr* = 32° 33′, *ss′* = 30° 32′, *rr′* = 55° 33′, *rη* = 31° 13′, *ar* = 62° 14′.

Rarely in distinct acicular crystals, combination of *a* and *r*; usually in spherical forms having a lamellar-stellate structure, often resembling wavellite.

Cleavage: *m* perfect; *a* less so. H. = 2. G. = 2·547–2·578 Genth & Penfield. Color pale greenish white, grayish white, white. Optically uniaxial, positive. Indices: $\omega_y = 1·558$, $\epsilon_y = 1·613$ Pfd.[2]

**Comp.**—$3Na_2SO_4.Fe_2(SO_4)_3 + 6H_2O$ or $3Na_2O.Fe_2O_3.6SO_3.6H_2O$ = Sulphur trioxide 51·4, iron sesquioxide 17·1, soda 19·9, water 11·6 = 100; or, Sodium sulphate 45·6, ferric sulphate 42·8, water 11·6 = 100.

**Anal.**—1, Mackintosh, l. c. 2, F. A. Genth, Am. J. Sc., **40**, 202, 1890. 3, Frenzel, Zs. Kr., **18**, 595, 1891.

| | $SO_3$ | $Fe_2O_3$ | $Al_2O_3$ | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. | 50·25 | 17·23 | 0·43 | 18·34 | 0·40 | 11·14 insol. 2·00 = 99·79 |
| 2. | ¼ 51·30 | 17·30 | — | 19·95a | | 11·89 = 100·44 |
| 3. | 50·85 | 17·69 | — | 20·22 | — | 11·90 = 100·66 |

Of the $H_2O$, 5½ molecules are lost at 110° C., the remainder is easily soluble in water. In anal. 2, the loss at 100° was 0 28 p. c. after two hours.

**Obs.**—Occurs with other sulphates at Sierra Gorda near Caracoles, Chili.

**Ref.**—[1] Zs. Kr., **18**, 595, 1891. [2] Am. J. Sc., **40**, 202, 1890.

**778. RÖMERITE.** *Grailich*, Ber. Ak. Wien, **28**, 272, 1858. Bückingit *G. Linck*, Jb. Min., **1**, 213, 1888. Roemerite.

Triclinic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·96840 : 1 : 2·64250; *α* = 116° 3½′, *β* = 94° 40½′, *γ* = 80° 7⅓′ Linck[1].

100 ∧ 010 = *98° 43′, 100 ∧ 001 = *89° 36′, 010 ∧ 001 = *64° 20′.

**Forms**:
*a* (100, *i*-$\bar{i}$)
*b* (010, *i*-$\breve{i}$)
*c* (001, *O*)
*m* (110, *I′*)
*μ* ($3\bar{2}0$, ′*i*-$\frac{3}{2}$)
*y* (508, ′$\frac{5}{8}$-$\bar{i}$′)
*x* ($\bar{1}01$, ,1-$\bar{i}$,)
*e* (011, 1-$\breve{i}$′)
*l* ($0\bar{1}4$, ′$\frac{1}{4}$-$\breve{i}$)
*t* ($0·\bar{5}·18$, ′$\frac{5}{18}$-$\breve{i}$)
*s* ($0\bar{1}3$, ′$\frac{1}{3}$-$\breve{i}$)
*n* ($0\bar{1}2$, ′$\frac{1}{2}$-$\breve{i}$)
*q* ($0\bar{1}1$, ′1-$\breve{i}$)

*am* = 51° 45′
*bm* = *46° 58′
*cy* = 56° 58½′
*cx* = *68° 27′
*ce* = 48° 10′
*cl* = 40° 19′
*cs* = 52° 38′
*cn* = 70° 46′
*cq* = 93° 46′
*cm* = 69° 33′

Crystals tabular ‖ *c*, often monoclinic in habit; faces *a*, *c* striated ‖ their intersection-edge, brachydome faces vertically striated. Also coarsely granular, crystalline.

Cleavage: *b* perfect. Fracture uneven. Brittle. H. = 3–3·5. G. = 2·174 Gl.; 2·102 Linck. Luster vitreous. Color light to dark chestnut-brown, violet-brown, rust-brown to yellow. Pleochroic. Transparent to translucent. Taste saline, astringent.

Optically −; double refraction weak. Ax. pl. on *c* bisects obtuse angle of edges *a*/*c* and *b*/*c*. Bisectrix inclined about 30° to *c*. $2H_a$ = 57° 45′.

**Comp.**—Perhaps $FeSO_4.Fe_2(SO_4)_3 + 12H_2O$ = Sulphur trioxide 41·7, iron sesquioxide 20·8, iron protoxide 9·4, water 28·1 = 100.

Some analyses give more water, $15H_2O$ call for 32·9 p. c. Mackintosh calculates 13·7 p. c.,

**Anal.**—1, L. Tschermak, Ber. Ak. Wien, **28**, 277, 1858. 2, Linck, l. c. 3, J. B. Mackintosh Am. J. Sc., **38**, 243, 1889.

| | | $SO_3$ | $Fe_2O_3$ | $Al_2O_3$ | FeO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. Goslar | | $\frac{2}{2}$ 41·54 | 20·63 | — | 6·26 | 28·00 | ZnO 1·97, CaO 0·58, insol. 0·50 |
| 2. Chili | | 38·47 | 17·62 | 1·02 | 9·06 | 34·10 | CaO *tr.* = 100·27 [= 99·48 |
| 3. " | G. = 2·15 | 40·19 | 19·40 | — | 9·52 | [30·85] | $Na_2O$ 0·14 = 100 |

Easily soluble in water, giving an acid solution; basic salts separate on heating.

**Obs.**—From the Rammelsberg mine near Goslar in the Harz, along with copiapite (cf. p. 964). Also from Persia. From Tierra Amarilla, near Copiapo, Chili, with other iron sulphates. Named for A. Römer (or Roemer), of Clausthal.

**Ref.**—[1] Chili, Zs. Kr., **15**, 22, 1888; on the form of the mineral from Persia, see Blaas, Ber. Ak. Wien, **88** (1) (1121), 1883.

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## C. Hydrous Sulphates.—Basic Division.

$\breve{a} : \bar{b} : \acute{c}$

779. **Langite** $Cu_4(OH)_6SO_4 + H_2O$ Orthorhombic 0·5347 : 1 : 0·6346

780. **Herrengrundite** $(Cu,Ca)_5(OH)_6(SO_4)_2 + 3H_2O$ Monoclinic

$\grave{a} : \overset{|}{\bar{b}} : \acute{c}$ = 1·8161 : 1 : 2·8004; $\beta$ = 88° 50′

780A. Arnimite $Cu_5(OH)_6(SO_4)_2 + 3H_2O$

781. **Cyanotrichite** $Cu_4Al_2(OH)_{12}SO_4 + 2H_2O$ Orthorhombic

782 **Serpierite** Contains $SO_3$, CuO, ZnO, $H_2O$ Orthorhombic

$\breve{a} : \bar{b} : \acute{c}$ = 0·8586 : 1 : 1·3637

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783. **Castanite** $Fe_2S_2O_9.8H_2O$ Monoclinic

$\grave{a} : \overset{|}{\bar{b}} : \acute{c}$ $\beta$

784. **Copiapite** $Fe_4S_5O_{21}.18H_2O$ Monoclinic 0·4790 : 1 : 0·9751 72° 3′

785. **Knoxvillite** Hydrous Chromium sulphate

786. **Utahite** $Fe_2SO_6.1\frac{1}{3}H_2O$ Rhombohedral $\acute{c}$ = 1·1389

787. **Amarantite** $Fe_2S_2O_9.7H_2O$ Triclinic

$\breve{a} : \bar{b} : \acute{c}$ = 0·7691 : 1 : 0·5738; $\alpha$ = 95° 38′, $\beta$ = 90° 24′, $\gamma$ = 97° 13′

788. **Fibroferrite** $Fe_2S_2O_9.10H_2O$ Monoclinic?

789. **Raimondite** $Fe_4S_3O_{15}.7H_2O$ Hexagonal or rhombohedral

790. **Carphosiderite** $Fe_6S_4O_{21}.10H_2O$ Rhombohedral?

791. **Aluminite** $Al_2SO_6.9H_2O$ Monoclinic

792. **Glockerite** $Fe_4SO_9.6H_2O$

793. **Felsöbányite** $Al_4SO_9.10H_2O$ Orthorhombic

794. **Paraluminite** $Al_4SO_9.15H_2O$

795. **Cyprusite** $Al_2Fe_{14}S_{10}O_{54}.14H_2O$ ? Hexagonal or rhombohedral

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796. **Voltaite** $(\overset{\text{II}}{Fe},Mg)_5(\overset{\text{III}}{Fe},Al)_4S_{10}O_{41}.15H_2O$ ? Tetragonal

797. **Metavoltine** $(K_2,Na_2,Fe)_5Fe_6S_{12}O_{60}.18H_2O$ Hexagonal

$\grave{a} : \overset{|}{\bar{b}} : \acute{c}$ $\beta$

798. **Botryogen** $Mg\overset{\text{II}}{Fe}\overset{\text{III}}{Fe}_2S_4O_{17}.18H_2O$ Monoclinic 0·6522 : 1 : 0·5992 62°26′

799. **Sideronatrite** $Na_4Fe_2S_4O_{17}.7H_2O$ ? Orthorhombic

| | | | | |
|---|---|---|---|---|
| 800. | **Alunite** | $KAl_3S_2O_{11}.3H_2O$ | Rhombohedral | $\dot{c} = 1{\cdot}2520$ |
| 801. | **Jarosite** | $KFe_3S_2O_{11}.3H_2O$ | " | $\dot{c} = 1{\cdot}2492$ |
| 802. | **Löwigite** | $KAl_3S_2O_{11}.4\frac{1}{2}H_2O$ | | |
| 803. | **Ettringite** | $Ca_6Al_2S_3O_{18}.33H_2O$ ? | Hexagonal | $\dot{c} = 0{\cdot}9434$ |
| 804. | **Quetenite** | $MgFe_2S_3O_{13}.13H_2O$ | Monoclinic? | |
| 805. | **Zincaluminite** | $Zn_6Al_6S_2O_{21}.18H_2O$ | Hexagonal? | |

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| | | | |
|---|---|---|---|
| 806. | **Johannite** | Hydrous copper-uranium sulphate | Monoclinic |
| 807. | **Uranopilite** | $CaU_8S_2O_{31}.25H_2O$ | " |

The simple empirical formulas are given for most of the basic hydrous sulphates above, since the data in most cases are not sufficient to determine the rational formula.

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**779. LANGITE.** A new British mineral *N. S. Maskelyne,* Phil. Mag., **27**, 316, 1864. Langite *Maskelyne,* Pisani, C. R., **59**, 633, 1864, *Maskelyne* Phil. Mag., **29**, 473, 1865. Devilline *Pisani,* C. R., **59**, 813, 1864 = Lyellite *Maskelyne,* Ch. News, **10**, 263, 1864.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}5347 : 1 : 0{\cdot}6346$ Maskelyne[1].
$100 \wedge 110 = 28° 8'$, $001 \wedge 101 = 49° 53'$, $001 \wedge 011 = 32° 24'$.

**Forms:** *a* (100, *i-ī*), *b* (010, *i-ĭ*), *c* (001, *O*); *m* (110, *I*); *f* (021, 2-*ĭ*). Angles : *mm'''* = *56° 16', *cf* = *51° 46'.

Twins: tw. pl. *m*, in forms resembling aragonite. Crystals small and short; simple forms not observed. Also in fibro-lamellar and concretionary crusts, with earthy surface.

Cleavage: *c*, *b*. H. = 2·5–3. G. = 3·48–3·50. Luster of crystals vitreous; of crusts somewhat silky. Color fine blue to greenish blue; pleochroic. Translucent. Optically –. Ax. pl. ∥ *b*. Bx ⊥ *c*.

**Comp.**—Near brochantite, but contains one molecule of water of crystallization, formula $CuSO_4.3Cu(OH)_2 + H_2O$ or $4CuO.SO_3.4H_2O$ = Sulphur trioxide 17·0, cupric oxide 67·6, water 15·3 = 100.

**Anal.**—1, Church, J. Ch. Soc., 18, 87, 1865. 2, 3, Warington, ibid. 4, Pisani, l. c. Also Tschermak, Ber. Ak. Wien, 51 (1), 127, 1865.

| | | $SO_3$ | CuO | $H_2O$ |
|---|---|---|---|---|
| 1. | Cornwall | 16·79 | 67·48 | 15·73 = 100 |
| 2. | " | 16·72 | 67·31 | 16·25 = 100·28 |
| 3. | " | 16·88 | 67·88 | 15·53 = 100·29 |
| 4. | " | 16·77 | 65·92 | 16·19 CaO 0·83, MgO 0·29 = 100 |
| 5. | *Devilline* | 23·65 | 51·01 | 16·60 CaO 7·90, FeO 2·77 = 101·93 |

Anals. 1, 2 on material dried *in vacuo;* 3, do. at 100°.

Maskelyne's early analysis (l. c.) gave 18 p. c. $H_2O$.

The *devilline* (or *lyellite*), which includes the incrusting variety, is, as Tschermak has shown, langite mixed with gypsum, which is apparent in scales. His analysis (ref. above) was made on the devilline containing 18 p. c. of gypsum; and he states that Pisani's analysis of the same (5) indicates the presence of 24 p. c. For an analysis of the *lyellite* by Church, see J. Ch. Soc., 18, 83, 1865.

**Pyr., etc.**—B.B. on charcoal yields water, acid fumes, and metallic copper. Heated it passes through (1) a bright green color, losing 1 equivalent of water, and then having the ratio of some brochantite; (2) various tints of olive-green; and (3) becomes black. It has finally a strongly acid reaction.

**Obs.**—Found in argillaceous schist (killas) in Cornwall, in minute twinned crystals; also as a blue crust, partly earthy. It is associated sometimes with connellite.

Named *langite* after Dr. Victor v. Lang, formerly of the British Museum, later Professor of Physics at Vienna.

The analyses of so-called brochantite by Berthier of a Mexican specimen, and Field of a Chilian, as well as of the artificial mineral, have the same composition assigned by Pisani and Church to the *langite;* and there is yet some uncertainty as to the true limits between the two species. The specimens had the *green* color of brochantite.

**Ref.**—[1] Phil. Mag., **29**, 473, 1865; cf. Brezina, Zs. Kr., **3**, 374, 1879.

WOODWARDITE *Church*, Ch. News, **13**, 85, 113, 1866, J. Chem. Soc., **19**, 130, 1866.

A complex sulphate of aluminium and copper, perhaps allied to cyanotrichite (lettsomite), or perhaps only an impure uncrystallized variety of langite, mixed with aluminium hydrate. Occurs in Cornwall, in minute botryoidal concretions, of a rich turquois-blue to greenish blue color, translucent to almost transparent. G. = 2·38. Anal.—1, Church, l. c. 2, 3, Warington, ibid. 4, Pisani, C. R., **65**, 1142, 1867.

| | | $SO_3$ | $Al_2O_3$ | CuO | $H_2O$ | |
|---|---|---|---|---|---|---|
| 1. | Cornwall | 13·95 | 17·97 | 48·34 | 18·48 | = 98·74 |
| 2. | " | 13·04 | 18·64 | 48·67 | [19·65] | = 100 |
| 3. | " | 12·54 | 17·93 | 46·80 | [22·73] | = 100 |
| 4. | " | 11·7 | 13·4 | 46·8 | [26·9] | $SiO_2$ 1·2 = 100 |

The material of 1, 2 was dried at 100°, of 3 *in vacuo* over $H_2SO_4$.

Church and Warington also found traces of silica, lime, magnesia, and phosphoric acid, which were undetermined. Pisani makes the mineral impure *langite*. He analyzed (l. c.) another similar material from Cornwall (received from Mr. Talling), of a clear green color, and obtained: $SO_3$ 4·7, $Al_2O_3$ 33·8, CuO 17·4, $H_2O$ 38·7, $SiO_2$ 6·7 = 100·5; showing a mixture of the copper sulphate with a hydrous silicate of aluminium as well as hydrate; and this he considers as proving that woodwardite is only a mixture. Analyses by Maskelyne & Flight (J. Ch. Soc., **24**, 1, 1871), confirm this view.

The mineral is soluble with scarcely any residue in diluted acids. Named after Dr. S. P. Woodward.

**780. HERRENGRUNDITE.** *Brezina*, Zs. Kr., **3**, 359, 1879. Urvölgyite *Szabó*, Min. Mitth., **2**, 311, 1879, and Lit. Ber. Ungarn, **3**, 510, 1879.

Monoclinic. Axes $\grave{a} : \overset{\shortmid}{\bar{b}} : \grave{c} = 1·8161 : 1 : 2·8004$; $\beta = 88° \; 50\frac{1}{6}' = 001 \wedge 100$ Brezina[1].

$100 \wedge 110 = 61° \; 9\frac{1}{3}'$, $001 \wedge 101 = 57° \; 51'$, $001 \wedge 011 = 70° \; 20\frac{2}{3}'$.

**Forms**[1]: $\gamma$ (540, $i$-$\frac{5}{4}$) $\eta$ (350, $i$-$\frac{5}{3}$) $\epsilon$ (102, $-\frac{1}{2}$-$\bar{\imath}$) $d$ ($\bar{5}$07, $\frac{5}{7}$-$\bar{\imath}$)

*c* (001, *O*) *m* (110, *I*) $\vartheta$ (120, $i$-$\grave{2}$) $\delta$ (507, $-\frac{5}{7}$-$\bar{\imath}$) $q$ ($\bar{1}$11, 1)

$\beta$ (980, $i$-$\frac{9}{8}$)? $\zeta$ (450, $i$-$\frac{5}{4}$) $\kappa$ (250, $i$-$\frac{5}{2}$)? $e$ ($\bar{1}$02, $\frac{1}{2}$-$\bar{\imath}$)

$mm''' = 122° \; 19'$ $c\delta = 47° \; 8'$ $cq = 73° \; 8'$ $qq' = 113° \; 55'$

$\vartheta\vartheta' = 30° \; 47\frac{1}{2}'$ $ce = 38° \; 3\frac{1}{2}'$ $cm' = 90° \; 34'$ $qe = 59° \; 8'$

$c\epsilon = 37° \; 12'$ $cd = 48° \; 24'$

Twins: tw. pl. *c* (001); perhaps also *n* (750). In thin six-sided tabular crystals with *c* striated ∥ *a*. Usually in spherical groups.

Cleavage: *c* perfect; $\gamma$ (or *m*) rather distinct; also *e* or $\epsilon$. Rather brittle. H. = 2·5. G. = 3·132. Luster vitreous; on *c* sometimes pearly. Color emerald-green, verdigris-green, and bluish green. Pleochroic: ∥ 𝔠 yellowish green, ∥ 𝔟 bluish green. Streak light green. Transparent.

Optically −. Ax. pl. ⊥ *b* and sensibly ∥ *a*. Bx ⊥ *c*. Axial angles, Brezina:

$2E_r = 59° \; 2'$ Li $2E_y = 65° \; 18'$ to $66° \; 53'$ Na $2E_{gr} = 68° \; 39'$ Tl

**Comp.**—$2(CuOH)_2SO_4.Cu(OH)_2 + 3H_2O$ with one-fifth of the copper replaced by calcium, or $CaO.4CuO.2SO_3.6H_2O$ = Sulphur trioxide 25·0, cupric oxide 49·4, lime 8·7, water 16·9 = 100.

**Anal.**—1, Berwerth, Zs. Kr., **3**, 373, 1879. 2, Schenek, Min. Mitth., **2**, 315, 1879. 3, Winkler, Jb. Berg-Hütt., Sachs., 1886.

| | | $SO_3$ | CuO | CaO | $H_2O$ | |
|---|---|---|---|---|---|---|
| 1. | | 24·62 | 54·16 | 2·05 | 19·61 | = 100·44 |
| 2. | | 24·62 | 49·52 | 8·59 | 16·73 | $S_2O_2$ 0·33, FeO 0·14, MnO, MgO *tr.* = 99·93 |
| 3. | G. = 2·906 | 24·59 | 49·96 | 8·17 | 17·76 | = 100·48 |

Brezina regards the CaO as present in the form of gypsum as an impurity; deducting this the result obtained is: $SO_3$ 23·04, CuO 57·52, $H_2O$ 19·44 = 100. Szabó, on the contrary, regards the CaO as essential, which is confirmed by Winkler, and also indirectly by Weisbach (cf. arnimite, following).

**Pyr., etc.**—On charcoal, loses its green color, becomes black and fuses; with soda a copper bead. Soluble in nitric acid in hydrochloric acid and in ammonia with a residue of calcium sulphate.

**Obs.**—Occurs with malachite and calcite in a quartz-conglomerate at Herrengrund in Hungary. Related to langite, brochantite, etc. Also on the Sandberg, between Altgebirg and Herrengrund. Named from the locality Herrengrund = Urvölgy in the Hungarian language.

**Ref.**—[1] L. c.; these forms are not all certain. Cf. Gdt., Index, **2**, 149, 1890.

**780A. Arnimite.** *Weisbach*, Jb. Berg-Hütt., Sachs., 1886.

Forms a bright green incrustation. consisting of short acicular or scaly crystals.

**Comp.**—$2(CuOH)_2SO_4.Cu(OH)_2 + 3H_2O$ or $5CuO.2SO_3.6H_2O$ = Sulphur trioxide 24·1, cupric oxide 59·6, water 16·3 = 100. Corresponds to the preceding species, but differs in containing no lime.

**Anal.**—1, 2, Winkler; 2 containing gypsum.

| | $SO_3$ | CuO | $Fe_2O_3,Al_2O_3$ | CaO | $H_2O$ |
|---|---|---|---|---|---|
| 1. | 24·43 | 56·81 | 0·35 | 0·56 | [17·85] = 100 |
| 2. | $\frac{2}{2}$ 28·73 | 46·38 | 0·84 | 6·89 | [17·16] = 100 |

Deducting impurities and recalculating, the result obtained is: $SO_3$ 24·07, CuO 59·69, $H_2O$ 16·24 = 100. This corresponds, as noted above, to herrengrundite.

**Obs.**—Occurs on porcelain-jasper in the coal region at Planitz near Zwickau. Named for the family von Arnim.

**781. CYANOTRICHITE** or LETTSOMITE. Kupfersammeterz, Kupfersammterz, *Wern.*, Karsten's Tab., 62, 1808. Velvet Copper Ore *Jameson*, Min., **3**, 153, 1816. Sammeterz *Breith.*, Char., 168, 1823, 320, 1832. Cuivre velouté *Fr.* Cyanotrichit *Glocker*, Grundr., 587, 1839. Lettsomite *Percy*, Phil. Mag., **36**, 100, 1850.

Orthorhombic. Occurs in velvet-like druses of short capillary crystals; sometimes in spherical globules.

Color clear smalt-blue, sometimes passing into sky-blue; strongly pleochroic. Luster pearly. Optically biaxial, negative. Ax. pl. ‖ and $Bx_a \perp$ to the direction of elongation of the crystals. Dispersion $\rho < v$ large Btd.[1]

**Comp.**—Perhaps $4CuO.Al_2O_3.SO_3.8H_2O$ (Genth) = Sulphur trioxide 12·4, alumina 15·9, cupric oxide 49·3, water 22·4 = 100.

Percy calculated $6CuO.Al_2O_3.2SO_3.12H_2O$, which requires: Sulphur trioxide 16·8, alumina 10·7, cupric oxide 49·8, water 22·7 = 100.

**Anal.**—1, 2, Percy, l. c. 3, Pisani, C. R., **86**, 1418, 1878. 4, 5, Genth, Am. J. Sc., **40**, 118, 1890.

| | | $SO_3$. | $Al_2O_3$ | $Fe_2O_3$ | CuO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. Moldawa | | 15·39 | 11·70 | | 48·16 | 23·06 | = 98·30 |
| 2. " | | 14·12 | 11·06 | 1·18 | 46·59 | 23·06 | insol. 2·35 = 98·36 |
| 3. Cap Garonne | | 12·10 | 11·21 | 1·41 | 49·00 | 22·50 | CaO 2·97 = 99·19 |
| 4. Arizona | G. = 2·737 | $\frac{3}{3}$ 12·49 | 16·47 | 1·34 | 46·71 | 21·89 | insol. 0·44 = 99·34 |
| 5. Utah | | 12·60 | 15·45 | 0·91 | 49·54 | [21·50] = 100 | |

**Obs.**—Occurs sparingly at Moldawa in the Banat, coating the cavities of an earthy hydrated iron oxide, along with a white amorphous aluminium sulphate. Also at the copper mines of Cap Garonne, Dept. du Var, France.

In Utah, at Copperopolis, formerly the American Eagle mine, Tintic district; also in Arizona, at the Copper Mountain mine near Morenci, Graham Co.

Named *Cyanotrichite* from *κύανος, blue*, and *θρίξ, hair;* and *Lettsomite* after the English mineralogist, W. G. Lettsom.

**Ref.**—[1] Bull. Soc. Min., **4**, 11, 1881.

**782. SERPIERITE.** *Des Cloizeaux*, Bull. Soc. Min., **4**, 89, 1881.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·8586 : 1 : 1·3637 Des Cloizeaux.

$100 \wedge 110 = 40° 39'$, $001 \wedge 101 = 57° 48\frac{1}{3}'$, $001 \wedge 011 = 53° 44\frac{5}{6}'$.

**Forms**: *c* (001, *O*); *m* (110, *I*); *p* (111, 1); also probable, *η* (034, $\frac{3}{4}$-ĭ), *e* (011, 1-ĭ); and uncertain, *α* (203, $\frac{2}{3}$-ī), *x* (043, $\frac{4}{3}$-ĭ), *y* (053, $\frac{5}{3}$-ĭ), *z* (081, 8-ĭ), perhaps *a* (100, *i*-ī).

Angles: $mm''' = {}^*81° 18'$, $\alpha\alpha' = 93° 16\frac{1}{2}'$, $\eta\eta' = 91° 18'$, $ee' = 107° 30'$, $xx' = 122° 23'$, $yy' = 132° 30'$, $cp = {}^*64° 28'$, $pp' = 86° 25'$, $pp''' = 72° 0'$.

Crystals minute, tabular ‖ *c*, and elongated ‖ axis $\breve{a}$; faces *c* striated ‖ $\breve{a}$; often grouped in light tufts.

Color bluish green. Transparent. Optically negative. Ax. pl. ‖ *a*. Bx ⊥ *c*. Dispersion $\rho > v$ strong. Axial angles, Dx.:

$$2H_{a.r} = 43° 40' \therefore 2E_r = 66° 5';\quad 2H_{a.r} = 44° 20' \therefore 2E_r = 67° 10';\quad 2H_{a.r} = 43° 35' \therefore 2E_r = 65° 57'$$

**Comp.**—Stated by Damour to be a basic sulphate of copper and zinc.

This may prove to belong near brochantite.

**Obs.**—Occurs on smithsonite at the zinc mines of Laurium, Greece. The probable existence of two other undetermined basic sulphates of copper at the same locality is also mentioned.

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**783. CASTANITE.** L. Darapsky, Jb. Min., 2, 267, 1890.

Monoclinic, with a prismatic angle of 82°, and terminated by one or two oblique planes. Usually in prismatic crystals, perhaps twins; they seldom show distinct faces, which are then dull and rounded. United in massive aggregates; also in minute crystals lining cavities.

H. = 3. G. = 2·118. Luster vitreous, brilliant. Color chestnut-brown. Powder orange-yellow.

**Comp.**—$Fe_2O_3.2SO_3.8H_2O$ = Sulphur trioxide 34·5, iron sesquioxide 34·5, water 31·0 = 100.

Differs from amarantite, p. 967, only in containing one molecule more of water.

**Anal.**—Darapsky, l. c.; 1*a* after deducting impurities.

| | $SO_3$ | $Fe_2O_3$ | $H_2O$ | |
|---|---|---|---|---|
| 1. | 33·80 | 33·92 | 30·76 | $Al_2O_3$ *tr*, barite 1·15 = 99·63 |
| 1*a*. | 34·32 | 34·45 | 31·23 = 100 | |

Loss of water at 50°, 1·0 p. c.; 80°, 9·5; 100°, 11·8; 145°, 15·5; 170°, 20·5.

Only very slightly soluble in water, but dissolves in warm hydrochloric acid. Remains unchanged on exposure to the air and also in the desiccator over calcium chloride.

**Obs.**—From Sierra Gorda, Chili; occurs implanted upon olive-green crystalline copiapite and associated with minute barite crystals.

Named in illusion to its chestnut-brown color.

RUBRITE *L. Darapsky*, Jb. Min., 1, 65, 1890.

In indistinct lamellar crystals of a deep red color, penetrated by white nodules and clear zones, which are present even in the purest portions and hence make the physical characters and composition of the remainder more or less doubtful. Iron sesquioxide is separated by cold water. Analyses:

$SO_3$ 41·15 $Fe_2O_3$ 18·22 $Al_2O_3$ 3·01 MgO 5·62 CaO 4·10 $H_2O$ 27·64 = 99·84

For this the formula calculated is: $2\frac{1}{2}CaO.4\frac{1}{2}MgO.Al_2O_3.4Fe_2O_3.17SO_3.51H_2O$. Deducting gypsum and epsomite, the result is: $Fe_2O_3.2SO_3.3H_2O$ = Sulphur trioxide 42·8, iron sesquioxide 42·7, water 14·5 = 100.

From the neighborhood of the Rio Loa, Chili.

**784. COPIAPITE.** *Mίσυ Diosc.* Misy (fr. Cyprus, etc.) *Plin.*, **34**, 31. Misy, *Germ.* Gelb Atrament (fr. Harz, etc.) *Agric.*, Nat. Foss., 213, 457, Interpr., 466, 1546. Misy, Gul Atrament Sten, Lapis atramentarius flavus, *Wall.*, Min., 159, 1747. Misy (fr. Harz) *Hausm.*, Handb., 1061, 1813, 1203, 1847. Gelbeisenerz *Breith.*, Char., 97, 238, 1823, 223, 1832. Yellow Copperas. Basisches schwefelsaures Eisenoxyd, *H. Rose*, Pogg., **27**, 314, 1833. Copiapite, *Haid.*, Handb., 489, 1845. Xanthosiderit pt. *Glocker*, Syn., 65, 1847.

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c} = 0·47904 : 1 : 0·97510$; $\beta = 72° 3' = 001 \wedge 100$ Linck[1].

$100 \wedge 110 = 24° 30'$, $001 \wedge 101 = 49° 57\frac{1}{2}'$, $001 \wedge 011 = 42° 51'$.

**Forms**[1]: *p* (120, *i*-$\grave{2}$) *r* (023, $\frac{2}{3}$-*ì*) *x* (427, − $\frac{4}{7}$-$\bar{2}$) *y* ($\bar{1}5 \cdot 2 \cdot 18$, $\frac{5}{6}$-$\frac{\bar{15}}{2}$)
*b* (010, *i*-*ì*) *d* ($\bar{4}09$, $\frac{4}{9}$-$\bar{i}$) *q* (011, 1-*ì*) *o* ($\bar{4}49$, $\frac{4}{9}$) *n* ($\bar{7} \cdot 4 \cdot 28$, $\frac{1}{4}$-$\frac{\bar{7}}{4}$)
*m* (110, *I*) *s* (015, $\frac{1}{5}$-*ì*)

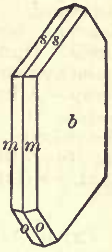
| | | | |
|---|---|---|---|
| *mm'''* = 49° 0′ | *rr'* = 63° 28′ | *oo'* = 40° 19½′ | *bs* = 79° 29′ |
| *pp'* = 95° 18′ | *qq'* = 85° 42′ | *bm* = *65° 30′ | *bq* = *47° 9′ |
| *ss'* = 21° 1′ | *m'o* = 53° 22′ | *bo* = 69° 50′ | *mq* = *60° 49′ |

Crystals tabular ∥ *b*. Usually in loose aggregations of crystalline scales, or granular massive, the scales rhombic or hexagonal tables. Incrusting.

Cleavage: *b*. H. = 2·5. G. = 2·103 Linck. Luster pearly. Color sulphur-yellow, citron-yellow. Translucent.

Optically −. Ax. pl. ⊥ *b*, and nearly coinciding with *d*. $Bx_o \perp b$. Ax. angles:

$2H_{o.r}$ = 113° 10½′ $2H_{o.y}$ = 114° 15′ Dx. $2H_{o.y}$ = 111° 36 Linck.



Chili, Linck.

**Comp.**—A basic ferric sulphate, perhaps $2Fe_2O_3.5SO_3.18H_2O$ = Sulphur trioxide 38·3, iron sesquioxide 30·6, water 31·1 = 100.

**Anal.**—1, Linck, after deducting 1·6 quartz sand, Zs. Kr., **15**, 17, 1888. 2, J. B. Mackintosh, Am. J. Sc., **38**, 242, 1889. 3, L. Darapsky, Jb. Min., **1**, 62, 1890. 4, 5, Melville & Lindgren, U. S. G. Surv., Bull. **61**, 25, 1890. Earlier anals., 5th Ed., p. 655; also Domeyko, Min. Chili, 155, 1879.

| | $SO_4$ | $Fe_2O_3$ | $Al_2O_3$ | $H_2O$ | |
|---|---|---|---|---|---|
| 1. Chili | 38·91 | 30·10 | *tr.* | 30·74 | CaO *tr.* = 99·75 |
| 2. " | 39·03 | 29·16 | — | [29·94] | FeO 1·56, $Na_2O$ 0·31 = 100 |
| 3. " | 38·47 | 28·18 | 2·95 | 29·50 | MgO 0·15, CaO *tr.* insol. 0·78 = 100·03 |
| 4. Knoxville, Cal. | 39·97 | 26·54 | — | 30·43 | FeO 0·46, MnO 0·21, MgO 3·06 = 100·67 |
| 5. Sulphur Bank, Cal. | 38·82 | 26·79 | 0·37 | [29·57] | FeO 3·28, MnO *tr.*, MgO 0·16, CaO 0·26, insol. 0·75 = 100 |

Loss of water in anal. 1. 12·73 p. c. at 110°; in 2, two-thirds (12 molecules) at 110°; in 3, 1 molecule at 75°, 2½ at 100°, 4 at 140°, 6 at 150°, 7 at 190°.

Melville calculates for anal. 4, the formula: $RO.2R_2O_3.6SO_3.20H_2O$, but in other analyses protoxides are nearly or quite wanting. Darapsky writes the formula: $Fe_2O_3.2\frac{1}{2}SO_3.8H_2O$ for the mineral analyzed by him, or intermediate between coquimbite and amarantite. He proposes, moreover, to drop the name coquimbite, and to use copiapite broadly for ferric sulphates soluble in water, which have one equivalent of iron sesquioxide to more than two of sulphur trioxide. The individual minerals he would call, *violite*, *flaveite*, *eläite*, *niveite*, etc.

*Misy* is an old term, which has been somewhat vaguely applied. It seems to belong in part here and in part also to other related species (cf. metavoltine, p. 972). The description of Dioscorides is unsatisfactory, but that of Pliny, not over 25 years later, is good, and may represent the true *μίσυ* of the Greeks; also that of Agricola, which was taken from specimens from the Rammelsberg mine near Goslar in the Harz, to which the name has been particularly applied. It is the result there of the decomposition of pyrite. Analyses by List (Lieb. Ann., **74**, 239, 1850) of this mineral gave:

| | $SO_3$ | $Fe_2O_3$ | ZnO | MgO | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. Goslar | 42·92 | 30·07 | 2·49 | 2·81 | 0·32 | 21·39 = 100 |
| 2. " | 43·21 | 30·37 | — | — | — | *undet.* |

Rammelsberg deducts magnesium sulphate 17·25, zinc sulphate 8·83, potassium sulphate 0·57, and obtains:

$SO_3$ 47·15 $Fe_2O_3$ 41·00 $H_2O$ 11·85 = 100

For this he calculates $4Fe_2O_3.9SO_3.11H_2O$; but the result is doubtful.

**Pyr., etc.**—Yields water, and at a higher temperature sulphuric acid. On charcoal becomes magnetic, and with soda affords the reaction for sulphuric acid. With the fluxes reacts for iron. Soluble in water, and decomposed by boiling water.

**Obs.**—The original copiapite described by Rose was from Copiapo. It is well represented at the Tierra Amarilla, near Copiapo, Chili, as an incrustation on coquimbite, or alone with copper and iron vitriols; also near Caracoles, in crystalline masses.

Occurs in soft masses of sulphur-yellow scales at the Redington mine, Knoxville, Cal.; the crystals are described as orthorhombic with prism of 78°, ax. pl. ∥ *b* (010), $Bx_o \perp c$. Also at Sulphur Bank, Lake Co., California, as a result of the decomposition of marcasite, on cinnabar.

A ferric sulphate, containing 38 p. c. $SO_3$ (Hillebrand) has been noted from the neighborhood of Las Vegas, N. Mexico (Pearce, Proc. Col. Soc., 3, 228, 1889).

**Ref.**—[1] Zs. Kr., **15**, 14, 1888; a number of doubtful planes are added.

**785. KNOXVILLITE.** *G. F. Becker*, U. S. G. Surv., Mon., **13**, 279, 389, 1888 (issued 1889). *W. H. Melville* and *W. Lindgren* U. S. G. Surv., Bull. **61**, 24, 1890.

Orthorhombic? In rhombic plates with angles of 78° and 102°, and inferred to be isomorphous with copiapite.

Cleavage: basal, perfect; prismatic and orthodiagonal, also good. Color greenish yellow. Pleochroic. Optically biaxial. Of the axes of elasticity in the basal plane, the greater is parallel to the brachydiagonal axis.

**Comp.**—A hydrous basic sulphate of chromium, ferric iron, and aluminium, probably related to copiapite.

The calculated ratio gives the complex formula $54RO.70R_2O_3.165SO_3.540H_2O$, which is not very far from $3RO.4R_2O_3.9SO_3.30H_2O$.

**Anal.**—Melville and Lindgren, l. c., on 0·148 grams.

| $SO_3$ | $Cr_2O_3$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | NiO | $H_2O$ above 100° | $H_2O$ (100°) | gangue |
|---|---|---|---|---|---|---|---|---|---|
| 35·90 | 7·41 | 4·84 | 15·36 | 3·81 | 3·22 | 0·83 | 17·60 | 9·30 | 1·73 = 100 |

**Obs.**—Occurs with redingtonite at the Redington mercury mine, Knoxville, California.

REDINGTONITE. *G. F. Becker*, U. S. G. Surv., Mon., **13**, 279, 1888. *W. H. Melville* and *W. Lindgren*, U. S. G. Surv., Bull. **61**, 23, 1890.

A hydrous chromium sulphate, occurring in finely fibrous masses of a pale purple color, in part white with silky luster and only purple on a surface perpendicular to the fibers. Also massive with crystalline structure. G. = 1·761. Extinction oblique (13° to 38°). Double refraction feeble. Soluble in water. When heated turns green without losing all its water.

In composition, a hydrous sulphate of chromium, aluminium, iron, etc. The calculated formula is $9RO.8R_2O_3.33SO_3.171H_2O$. The sample analyzed was moist and part of the water may hence be simply hygroscopic.

Anal.—Melville and Lindgren, l. c.

| $SO_3$ | $Cr_2O_3$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | NiO | MgO | $H_2O$ (above 100°) | $H_2O$ (100°) | gangue |
|---|---|---|---|---|---|---|---|---|---|
| 35·35 | 7·51 | 3·14 | 0·19 | 4·58 | 1·00 | 1·85 | 14·34 | 27·09 | 3·46 = 100·51 |

Occurs at the Redington mercury mine, Knoxville, California, where (Becker) it results from the action of solfataric gases on chromite.

**786. UTAHITE.** *A. Arzruni*, Zs. Kr., **9**, 558, 1884; Bull. Soc. Min., **4**, 126, 1884.

Rhombohedral. Axis $\dot{c} = 1·1389$; $0001 \wedge 10\bar{1}1 = {}^*52° \, 45'$ Arzruni. In aggregates of fine scales resolved under the microscope into tabular hexagonal crystals (*c*, *m*) with rhombohedral faces (*r*).

Color orange-yellow. Luster silky.

**Comp.**—$3Fe_2O_3.3SO_3.4H_2O$ = Sulphur trioxide 30·3, iron sesquioxide 60·6, water = 9·1 = 100.

**Anal.**—Damour, Bull. Soc. Min., **7**, 128, 1884.

| $SO_3$ | $Fe_2O_3$ | $H_2O$ | $As_2O_5$ |
|---|---|---|---|
| 28·45 | 58·82 | 9·35 | 3·19 = 99·81 |

**Pyr., etc.**—Gives off acid water in the closed tube and turns red. On charcoal becomes black and fuses with some difficulty to a black magnetic scoria.

**Obs.**—Occurs as an incrustation on quartz at the Eureka Hill mine, in the Tintic district, Utah.

Genth & Penfield mention a ferric sulphate occurring in minute brownish white, apparently hexagonal, scales at the Mimbres mine near Georgetown, N. Mexico, with vanadinite, descloizite, quartz. It seemed to contain no water, and the results of an incomplete analysis led to the ratio of $Fe_2O_3 : SO_3 = 1 : 1$, with, however, 17 or 18 p. c. unaccounted for. Am. J. Sc., 40, 203, 1890.

**787. AMARANTITE.** *Frenzel*, Min. Mitth., **9**, 398, 1887. Hohmannite *A. Frenzel*, Min. Mitth., **9**, 397, 1887.

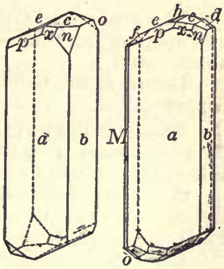
Triclinic. Axes $\breve{a} : \bar{b} : \dot{c} = 076915 : 1 : 0{\cdot}57383$; $\alpha = 95° 38' 15''$, $\beta = 90° 23' 43''$, $\gamma = 97° 13' 4''$ Penfield[1].

100 ∧ 010 = 82° 42′ 25″, 100 ∧ 001 = *88° 53′, 010 ∧ 001 = *84° 16′.

**Forms:**
*a* (100, *i-ī*)
*b* (010, *i-ĭ*)
*c* (001, *O*)
*M* (1$\bar{1}$0, ′*I*)
*x* (101, ′1-ī′)
*d* (011, 1-ĭ′)
*h* (0$\bar{1}$2, ′½-ĭ)
*e* (0$\bar{1}$1, ′1-ĭ)
*f* (0$\bar{2}$1, ′2-ĭ)
*n* (121, 2-2̆′)
*o* ($\bar{1}$11, ‚1)
*p* (1$\bar{1}$1, ′1)

*cx* = 36° 24½′
*ax* = 52° 28½′
*ce* = *31° 25′
*co* = 40° 18′
*cM′* = 92° 48′
*cp* = 42° 46′
*ae* = *92° 48′
*ap* = *57° 48′
*bn* = 42° 39½′
*b′p* = 72° 53′

1. 2.



Chili, Penfield.

Crystals slender prismatic, with the faces *a*, *b* vertically striated. Usually in columnar or bladed masses, also radiated.

Cleavage: *a*, *b* perfect. Brittle. H. = 2·5. G. = 2·11; 2·286 Pfd. Color orange-red, brownish red, amaranth-red. Streak lemon-yellow. Pleochroism not strong on *a*, stronger on *b* (brownish red and lemon-yellow).

Optically −. Ax. pl. inclined about 38° to $\dot{c}$, its trace on *a* (100) passing from right above to left below. Extinction on *b* (010) inclined 16°–17° to $\dot{c}$ in the acute angle $\beta$ above, behind. Axial angles measured on cleavage-plates ‖ *a*, and hence not strictly ⊥ Bx, gave Penfield:

$2E_r = 59° 3'$ Li $\qquad$ $2E_y = 63° 3'$ Na

**Comp.**—$Fe_2O_3.2SO_3.7H_2O$ = Sulphur trioxide 35·9, iron sesquioxide 35·8, water 28·3 = 100.

**Anal.**—1, Frenzel, l. c. 2, J. B. Mackintosh, Am. J. Sc., **38**, 243, 1889. 3, L. Darapsky, Jb. Min., **1**, 55, 1890. 4, F. A. Genth, Am. J. Sc., **40**, 201, 1890.

| | $SO_3$ | $Fe_2O_3$ | $H_2O$ | |
|---|---|---|---|---|
| 1. | 35·58 | 37·26 | 27·62 | = 100·46 |
| 2. | 36·15 | 35·69 | [27·44][a] | $Al_2O_3$ 0·21, $Na_2O$ 0·51 = 100 |
| 3. | 36·20 | 35·62 | 28·33[b] | = 100·15 |
| 4. | 35·46 | 37·46 | 28·29[c] | Alk. 0·70 = 101·91 |

[a] At 110°, 3·5 molecules. [b] At 100°, 3 molecules; at 140°, 4; at 175°, 5; at 200°, 5½; the remainder at a red heat. [c] Do. 12·17 p. c. = 3 molecules.

The fine powder is gradually decomposed by cold water, forming a basic insoluble salt.

*Hohmannite* is amarantite, in part slightly altered. The following are analyses: 1, Frenzel, l. c. 2, Id., ibid., p. 423, on fresher material. 3, Id., ibid., **11**, 215, 1890. 4, Darapsky, Jb. Min., **1**, 56, 1890.

| | | $SO_3$ | $Fe_2O_3$ | $H_2O$ | |
|---|---|---|---|---|---|
| 1. | G. = 2·24 | 30·88 | 40·05 | 29·63 | = 100·56 |
| 2. | | 33·84 | 35·58 | 30·08 | = 99·50 |
| 3. | G. = 2·17 | 35·76 | 37·03 | 27·71 | = 100·50 |
| 4. | | 36·85 | 36·86 | 26·34 | gangue 0·53 = 100·58 |

Cf. also Frenzel, l. c., and Min. Mitth., **11**, 21, 223.

**Obs.**—From a vein of argentiferous lead ores with sphalerite, chalcopyrite, atacamite, etc., near Caracoles, Chili, some leagues north of Sierra Gorda; it occurs in copiapite; also from the Sierra de la Caparrosa between Calama and Sierra Gorda.

Named *amarantite* in allusion to the red color; *hohmannite* after the discoverer, mining engineer Th. Hohmann of Valparaiso.

**Ref.**—[1] Am. J. Sc., **40**, 199, 1890. The optical determinations of Wülfing (Min. Mitth., **9**, 403, 1887) agree substantially with those of Penfield.

PAPOSITE *L. Darapsky* [Bol. Soc. Min., Santiago, 735, 1887], Jb. Min., **1**, 23 ref., 1889. In crystals and in radiate-fibrous masses. Cleavage distinct. Brittle. Color dark red.

Composition calculated by Darapsky, $2FeO_3.3SO_3.10H_2O$ = Sulphur trioxide 32·5, iron sesquioxide 43·2, water 24·3 = 100.

Anal.—1, Darapsky, l. c. 2, Gräbner, quoted by Frenzel, Min. Mitth., **11**, 223, 1890.

| | | | | |
|---|---|---|---|---|
| 1. | $SO_3$ 24·72 | $Fe_2O_3$ 30·00 | $H_2O$ 16·43 | Chalcanthite 28·85 = 100 |
| 1*a*. | 34·74 | 42·17 | 23·09 = 100 | |
| 2. | 36·18 | 35·92 | 28·13 = 100·23 | |

The analysis of Gräbner as shown by Frenzel makes paposite identical with hohmannite and amarantite; this assumes that essentially the same minerals were analyzed in the case of anals. 1 and 2.

Occurs at the Union mine, Reventon district, near Paposa in Atacama, embedded in massive copper vitriol.

**Ferric Sulphates.** Mackintosh has analyzed (Am. J. Sc., 38, 243, 245, 1889) several ferric sulphates from Chili, which cannot be classed with known species, and yet which are not sufficiently known to deserve independent position.

A. Occurs with copiapite and amarantite in pulverulent orange flakes arranged in parallel layers. It may be a result of the alteration of amarantite; the calculated formula is $Fe_2O_3.2SO_3.4H_2O$. Loss of water at 110°, 0·304 molecules; cf. also rubrite, p. 964.

B. White, pulverulent; calculated formula, $4FeO.Fe_2O_3.6SO_3.19H_2O$. Loses 9·6 molecules of water (or one half) at 110°.

C, D. Both white powders. For C, the approximate formula belongs: $12Na_2O.7FeO.6Fe_2O_3.Al_2O_3.10SO_3.10H_2O$. For D, $1\frac{1}{4}Na_2O.12FeO.8FeO.14SO_3.19H_2O$. Analyses:

| | $SO_3$ | $Fe_2O_3$ | $Al_2O_2$ | FeO | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|
| A. | 41·24 | 41·22 | — | — | — | [17·54] = 100 |
| B. | 38·00 | 12·16 | — | 22·51 | 0·58 | [26·75] = 100 |
| C. | 47·90 | 5·64 | 0·65 | 30·81 | 4·42 | [10·58] = 100 |
| D. | 45·61 | 5·14 | — | 35·05 | 0·33 | [13·87] = 100 |

**788. FIBROFERRITE.** *H. Rose*, Pogg., **27**, 316, 1833. Fibroferrite *Prideaux*, Phil. Mag., 18, 397, 1841. Stypticit *Hausm.*, Handb., **2**, 1202, 1847. Copiapite *J. L. Smith*, Am. J. Sc., 18, 375, 1854.

Monoclinic? In delicately fibrous aggregates.

H. = 2–2·5. G. = 1·84 Smith; 1·857 Linck. Luster silky, pearly. Color pale yellow, or nearly white. Translucent.

**Comp.**—$Fe_2O_3.2SO_3.10H_2O$ (Linck) = Sulphur trioxide 32·0, iron sesquioxide 32·0, water 36·0 = 100. Smith gives $10\frac{1}{2}H_2O$. Linck writes the formula $Fe_2(OH)_2(SO_4)_2 + 9H_2O$.

**Anal.**—1, Smith, Am. J. Sc., **18**, 375, 1854. 2, Tobler, Lieb. Ann., **96**, 383, 1855, 1; 3 p. c. insol. deducted. 3, Field, J. Ch. Soc., **14**, 156, 1861. 4, Brun, Zs. Kr., **5**, 103, 1880. 5. Linck, Zs. Kr., **15**, 19, 1888. 6, L. Darapsky, Jb. Min., **1**, 64, 1890. 7, Pisani, C. R., **59**, 911, 1864. 8, E. C. Woodward, priv. contr. Also 5th Ed., p. 656, and Domeyko, 4th App. Min. Chili, p. 8, 1874.

| | | $SO_3$ | $Fe_2O_3$ | $H_2O$ |
|---|---|---|---|---|
| 1. Chili | G. = 1·84 | 30·25 | 31·75 | 38·20 insol. 0·54 = 100·74 |
| 2. " | | 31·49 | 31·69 | [36·82] = 100 |
| 3. " | | 31·94 | 31·89 | 35·90 = 99·73 |
| 4. " | | 31·24 | 30·99 | 36·41 insol. 1·36 = 100 [0·63 = 100·72 |
| 5. " | G. = 1·857 | 32·94 | 32·43 | 34·32 CaO 0·40, $Al_2O_3$, MgO *tr.*, insol. |
| 6. " | | 30·60 | 32·13 | 35·74 insol. 1·41 = 99·88 |
| 7. Paillières | | 29·72 | 33·40 | [36·88] CaO *tr.* = 100 |
| 8. Colorado | | 30·7 | 30·9 | *undet.* |

Linck found the loss of $H_2O$ 21·37 p. c. at 110°; 5·52 at 155°; 4·15 at 210°; 2·59 at 260°; 1·57 above. In anal. 6, 24·96 p. c. $H_2O$ was expelled at 100°.

**Pyr., etc.**—Same as for copiapite.

**Obs.**—From the Tierra Amarilla near Copiapo, Chili, in delicately fibrous masses, associated with coquimbite; also from the mines of Paillières, Dept. du Gard, France (cf. pastreite below). An iron sulphate of similar appearance (anal. 8) occurs at the Black Iron mine, Red Cliff, Colorado.

The name alludes to the fibrous structure. There is no reason to doubt the identity of Prideaux's *fibroferrite* of 1841 with the mineral analyzed by Rose, Smith, and others, and which Hausmann named stypticite in 1847.

**789. RAIMONDITE.** Raimondit *Breith.*, B. H. Ztg., 25, 149, 1866.

Hexagonal or rhombohedral. In thin six-sided tables with replaced basal edges, scale-like.

Cleavage: basal, perfect. H. = 3–3·25. G. = 3·190–3·222. Luster pearly. Color between honey- and ocher-yellow. Streak ocher-yellow. Opaque. Optically uniaxial, negative.

**Comp.**—$2Fe_2O_3.3SO_3.7H_2O$ = Sulphur trioxide 35·0, iron sesquioxide 46·6, water 18·4 = 100.

**Anal.**—Rube, l. c.

Bolivia $SO_3$ 36·08 $Fe_2O_3$ 46·52 $H_2O$ 17·40 = 100

Rg. refers here the mineral from Greenland analyzed by Pisani; this analysis is given under carphosiderite below.

**Pyr., etc.**—Probably the same as for copiapite, but in water insoluble.

**Obs.**—From the tin mines of Ehrenfriedersdorf, in scales on cassiterite; also from the tin mines of Bolivia (unless the two localities have been confounded), cf. Raimondi, Min. Pérou, 231, 1878.

PASTREITE *Norman, Bergemann*, Vh. Ver. Rheinl., 17, 1866. This may be the above species, if part of the iron is present as limonite. According to Bergemann, it occurs amorphous or reniform, of a yellow color, at Paillières, near Alais, Dept. du Gard, with cerussite, limonite, calcite, gypsum, fibroferrite (cf. anal. 7, above); B.B. infusible, in hydrochloric acid easily soluble. The analyses gave:

| | $SO_3$ | $SiO_2$ | $As_2O_5$ | $Fe_2O_3$ | PbO | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. *Yellow* | 30·47 | 2·40 | 1·86 | 46·50 | 1·25 | 16·04 | $Al_2O_3$, MnO, CaO 0·89 = 99·41 |
| 2. *Yellowish brown* | 30·55 | — | 2·05 | 52·80 | — | 13·95 | $Al_2O_3$, CaO, sand 0·63 = 99·98 |

Received by Dr. Bergemann from Dr. Normann, of Marseilles, who named it after President Pastré, of that city. It approaches jarosite except in the absence of alkalies.

APATELITE *Meillet*, Ann. Mines, 3, 808, 1841.

In small friable nodules or balls. Color clear yellow. Resembles copiapite. Composition, perhaps. $4Fe_2O_3.6SO_3.3H_2O$ = Sulphur trioxide 40·9, iron sesquioxide 54·5, water 4·6 = 100.

Anal.—Meillet.

$SO_3$ 42·90 $Fe_2O_3$ 53·30 $H_2O$ 3·96 = 100·16

Occurs at Meudon and Auteuil, disseminated in an argillaceous bed connected with the plastic clay.

**790. CARPHOSIDERITE.** Karphosiderit *Breith.*, Schw. J., 50, 314, 1827.

Rhombohedral? In reniform masses, and incrustations; also in lamellæ grouped as in mica.

Cleavage: basal, easy. H. = 4–4·5. G. = 2·49–2·50 Breith.; 2·728 Pisani. Luster resinous. Color pale and deep straw-yellow. Streak yellowish. Feel greasy. Optically uniaxial, positive. Double refraction strong.

**Comp.**—A basic ferric sulphate, perhaps $3Fe_2O_3.4SO_3.10H_2O$ = Sulphur trioxide 32·7, iron sesquioxide 48·9, water 18·4 = 100.

The $P_2O_5$ is regarded (Lcx.) as partly replacing the $SO_3$.

**Anal.**—1, Pisani, C. R., 58, 242, 1864, after deducting 15 p. c. sand, 9 p. c. gypsum. 2, Lacroix, Bull. Soc. Min., 10, 142, 1887.

| | $SO_3$ | $Fe_2O_3$ | $H_2O$ |
|---|---|---|---|
| 1. Greenland G. = 2·728 | 31·82 | 49·88 | 18·30 = 100 |
| 2. St. Léger | 30·18 | 48·52 | 18·48 $P_2O_5$ 2·72 = 99·90 |

Supposed by Harkort after blowpipe trials to be a hydrous phosphate; but shown by Pisani's analysis of an original specimen to be a sulphate.

**Pyr., etc.**—B.B. nearly like copiapite, but insoluble in water. Readily soluble in hydrochloric acid.

**Obs.**—Occurs in fissures in mica slate, and was first distinguished by Breithaupt among some specimens which he says were from Labrador. Pisani's specimens were from the Kölburg collection in Paris, and were labeled Greenland, most probably the true locality. In the sandstone quarries at Saint-Léger near Mâcon, France.

The name alludes to the color, and is from *κάρφος, straw, σίδηρος, iron.*

**791. ALUMINITE.** Reine Thonerde (fr. Halle) *Wern.*, Ueb. Cronstedt, 176, 1780. Native Argill *Kirwan*, Min., **1**, 175. Aluminit *C. C. Haberle*, Das Mineralreich, etc., 1807; *Karst.*, Tab., 48, 1808. Hallite *Delameth.*, Min., **2**, 1812. Websterite *Levy*, in Brooke, 1823. Hydrosulphate d'alumine, Websterite, *Beud.*, Tr., 449, 1824.

Monoclinic. Usually in compact, reniform masses.

Fracture earthy. H. = 1–2. G. = 1·66. Luster dull, earthy. Color white. Opaque. Adheres to the tongue; meager to the touch.

**Comp.**—A hydrous aluminium sulphate, $Al_2O_3.SO_3.9H_2O$ = Sulphur trioxide 23·3, alumina 29·6, water 47·1 = 100.

Analyses agree closely, see 5th Ed., p. 658; also App. II, III.

**Pyr., etc.**—In the closed tube gives much water, which, at a high temperature, becomes acid from the evolution of sulphurous and sulphuric acids. B.B. infusible. With cobalt solution a fine blue color. With soda on charcoal a hepatic mass. Soluble in acids.

**Obs.**—Occurs in connection with beds of clay in the Tertiary and Post-tertiary formations. First found in 1730 in the Garden of the Pædagogium at Halle; afterward suspected to be an artificial product from a manufactory near by; subsequently found elsewhere in the plastic clay of the region, and proved to be native. Since discovered by Mr. Webster at Newhaven, Sussex, in reniform and botryoidal concretions, embedded in ferruginous clay, which rests on the Chalk strata; under similar circumstances at Epernay, in Lunel Vieil, and Auteuil, in France; also at Mühlhausen near Kralup; at Kuchelbad in Bohemia.

WERTHEMANITE *Raimondi*, Min. Pérou, p. 244, 1878; Domeyko, 5th Append., Min. Chili, 1876.

Massive, easily reduced to powder. G. = 2·80. Color white. Gives an argillaceous odor, and adheres to the tongue. Composition, $Al_2O_3.SO_3.3H_2O$ = Sulphur trioxide 33·9, alumina 43·2, water 22·9 = 100. Analysis:

$SO_3$ 34·50 $Al_2O_3$ 45·00 $Fe_2O_3$ 1·25 $H_2O$ 19·25 = 100

B.B. infusible. Soluble in acids. B.B. infusible; after ignition gives a blue color with cobalt solution. Insoluble in acids. Found in a bed of clay near the city of Chachapoyas, Peru. It differs from aluminite only in containing less water.

WINEBERGITE *Gümbel* [Ostbayer. Grenzgeb., 260] Roth, Allg. Ch. G., **1**, 239, 1879.

A basic sulphate of aluminium occurring with pissophanite at the Löwmühl near Passau; also at Bodenmais. Analysis:

$SO_3$ 15·61 $Al_2O_3$ 40·80 FeO 2·60 MgO 0·78 $H_2O$ 40·21 = 100

**792. GLOCKERITE.** Vitriolocker *Berz.*, Afh., **5**, 157, 1816. Fer sous-sulfaté terreux *Berz.*, N. Min. Syst., 1819. Vitriol Ocher. Pittizite *Beud.*, Tr., 447, 1824. Glockerit *Naum.*, Min., 254, 1855.

Massive, sparry or earthy. Stalactitic.

Luster resinous or earthy. Color brown to ocher-yellow, also brownish black to pitch-black; dull green. Streak ocher-yellow to brown. Opaque to subtranslucent.

**Comp., Var.**—$2Fe_2O_3.SO_3.6H_2O$ = Sulphur trioxide 15·7, iron sesquioxide 63·0, water 21·3 = 100. This formula was given by Berzelius for a brown to ocher-yellow variety, occurring with botryogen at Falun, containing according to him: $SO_3$ 15·9, $Fe_2O_3$ 62·4, $H_2O$ 21·7 = 100.

The same for a stalactitic variety from Obergrund, near Zuckmantel, the stalactites of which are sometimes 2 feet long, brown to pitch-black, yellowish brown, and dark green in color, with yellowish brown to ocher-yellow streak, shining luster to earthy, and insoluble in water. It is the *Glockerite* of Naumann, who cites Hochstetter's analysis: $SO_3$ 15·19, $Fe_2O_3$ 64·34, $H_2O$ 20·7, agreeing closely with that by Berzelius.

Jordan obtained for a compact and earthy vitriol ocher from the Rammelsberg mine near Goslar (J. pr. Ch., **9**, 95, 1836), and Scheerer for another from Modum, Norway (Pogg., **45**, 188, 1838):

| | $SO_3$ | $Fe_2O_3$ | $H_2O$ | |
|---|---|---|---|---|
| 1. Goslar, *compact* | 13·59 | 63·85 | 18·46 | ZnO 1·23, CuO 0·87, gangue 2·00 = 100 |
| 2. " *earthy* | 9·80 | 68·75 | 15·52 | ZnO 1·29, CuO 0·50, gangue 4·14 = 100 |
| 3. Modum, *brown* | 6·00 | 80·73 | 13·57 | = 100·30 |

**Obs.**—A result of the alteration of pyrite or marcasite.

*Glockerite* was named after the mineralogist E. F. Glocker. Pitticite is the name of pitch ore (p. 867).

**793. FELSÖBANYITE.** Felsöbanyt *Kenng.*, Ber. Ak. Wien, **10**, 294, 1853; *Haid.*, ib., **12**, 183, 1854.

Orthorhombic. Massive, and in concretions, grouped or single, consisting of scales, which are hexagonal, and have two angles of 112°.—Cleavage perfect. Optically biaxial.

H. = 1·5. G. = 2·33. Luster of cleavage-face pearly. Color snow-white, surface often yellowish. Translucent to subtransparent.

**Comp.**—$2Al_2O_3.SO_3.10H_2O$ = Sulphur trioxide 17·2, alumina 44·0, water 38·8 = 100.

**Anal.**—Hauer, Ber. Ak. Wien, **12**, 188, 1854.

$\frac{2}{2}$ $SO_3$ 16·47 $Al_2O_3$ 45·53 $H_2O$ 37·27 = 99·27

**Pyr., etc.**—Nearly as for aluminite.

**Obs.**—From Kapnik near Felsöbánya in Hungary, the concretions sometimes grouped on barite.

**794. PARALUMINITE.** Paraluminit *Steinberg*, J. pr. Ch., **32**, 495, 1844.

Massive, and like aluminite. White to pale yellow.

**Comp.**—Near aluminite, but supposed to be $2Al_2O_3.SO_3.15H_2O$ = Sulphur trioxide 14·5, alumina 36·8, water 48·7 = 100.

**Anal.**—Schmid, l. c.

$SO_3$ 14·54 $Al_2O_3$ 36·17 $H_2O$ 49·03 = 99·74.

Other analyses (5th Ed., p. 661) correspond more or less closely. The species cannot be regarded as well established.

**Obs.**—Similar in its modes of occurrence to aluminite. Found in Pressler's Mountain and elsewhere, near Halle, and at Huelgoat in Brittany.

PISSOPHANITE. Pissophan *Breith.*, Char., 101, 1832. Garnsdorfite.

Amorphous or stalactitic, somewhat pitch-like in appearance. Fracture conchoidal. Very fragile. H. = 1·5. G. = 1·93–1·98. Luster vitreous. Color pistachio-, asparagus-, or olive-green. Transparent. Analyses.—Erdmann, Schw. J., **62**, 104, 1831.

| | | $SO_3$ | $Al_2O_3$ | $Fe_2O_3$ | $H_2O$ | |
|---|---|---|---|---|---|---|
| 1. *Green* | $\frac{2}{2}$ | 12·59 | 35·23 | 9·77 | 41·69 | 0·72 = 100 |
| 2. *Yellow ocherous* | | 11·90 | 6·80 | 40·06 | 40·13 | 1·11 = 100 |

For the most part insoluble in water. Easily soluble in hydrochloric acid. B.B. becomes black. In a glass tube gives off alkaline water.

Occurs at Garnsdorf, near Saalfeld, and at Reichenbach, Saxony, on alum slate. Named from πίσσα, *pitch*, and φαίνεσθαι, *to appear*. Probably not a simple mineral.

**795. CYPRUSITE.** *P. F. Reinsch*, Proc. Roy. Soc., **33**, 119, 1881. *J. Deby*, J. R. Micr. Soc., **4**, 186, 1884.

Hexagonal? An aggregation of microscopic crystals with hexagonal cross-sections.

Soft, chalk-like. H. = 2. G. = 1·7–1·8. Color yellowish; in powder intense sulphur-yellow.

**Comp.**—A hydrous ferric sulphate, perhaps $7Fe_2O_3.Al_2O_3.10SO_3.14H_2O$ = Sulphur trioxide 35·2, iron sesquioxide 49·2, alumina 4·5, water 11·1 = 100.

**Anal.**—H. Fulton, after deducting insoluble portion, J. R. Micr. Soc., **4**, 187, 1884.

$SO_3$ 35·34 $Fe_2O_3$ 49·68 $Al_2O_3$ 3·89 $H_2O$ 11·06 = 99·97

The amount of alumina is variable. An earlier approximate analysis was made by Reinsch, l. c.

Insoluble or but slightly soluble in water. Soluble in acids, leaving a residue.

**Obs.**—Forms veins of considerable magnitude in a doleryte on the island of Cyprus, in the district of Chrysophone, especially on the right bank of the Balahussa. The veins are marked on the surface by a series of ridges several hundred meters long and 25 to 90 broad, having a yellow or vermilion color. The mineral incloses great quantities of the siliceous shells of Radiolaria.

Erusibite *Shepard*, Rep. Mt. Pisgah Copper Mine, N. Haven, 1859; Am. J. Sc., **28**, 129, 1859. A "rusty insoluble ferric sulphate" of undetermined nature. His *copperasine* (ib.) is announced as a "hydrous cuprous and ferric sulphate," from the same place. His *leucanterite* (ib.) is an efflorescence on the copperasine. These are names without descriptions.

**796. VOLTAITE.** Voltaite *A. Scacchi*, Accad. Sci. Nap., 1840. Zs. G. Ges., **4**, 163, 1852.

Isometric? In octahedrons, cubes, and dodecahedrons, and combinations of these forms[1].

Fracture conchoidal. H. = 3–4. G. = 2·79. Luster resinous. Color dull oil-green, greenish black, brown, or black. Streak grayish green. Opaque.

**Comp.**—Perhaps $5RO.2R_2O_3.10SO_3.15H_2O$ Blaas. Tschermak calculates for anal. 1, $K_2O : FeO : Fe_2O_3 : SO_3 : H_2O = 1 : 5·5 : 3·4 : 15·6 : 22·6$.

**Anal.**—1, Tschermak, Ber. Ak. Wien, **56** (1), 831, 1867. 2, Blaas, ibid., **87** (1), 143, 1883. An early incorrect analysis was made by Dufrénoy, and another on artificial crystals by Abich (5th Ed., p. 652).

| | G. | $SO_3$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Kremnitz | 2·79 | 48·0 | 5·1 | 12·9 | 15·6 | — | 3·6 | *tr.* | 15·3 | = 100·5 |
| 2. Persia | 2·6 | 49·12 | 3·72 | 13·85 | 5·24 | 7·35 | 2·37 | 1 62 | 16·60 | = 99·87 |

**Pyr., etc.**—Soluble in water with difficulty, and at the same time decomposes.

**Obs.**—This species was first observed at the solfatara near Naples, by Breislak (1792). It has been found by F. Ulrich at the Rammelsberg mine near Goslar in the Harz. The last contains manganese protoxide as well as iron. From Kremnitz in melanterite.

In a pyritiferous trachyte from the region of Madeni Zakh, Persia; the crystals (anal. 2) are described by Blaas, l. c., as tetragonal, having $\dot{c}$ = nearly 1 and with the forms: 111, 100, 101, and 102. Complex twins, fourlings resembling hausmannite, as inferred from the optical examination. Optically uniaxial. Color greenish black.

**Ref.**—[1] On the form see Blaas, above, and Ber. Ak. Wien, **87** (1), 143, 1883; but cf. Streng, Jb. Min., **2**, 164 ref., 1884. Tschermak describes the crystals examined by him as isometric, and, in habit, octahedral with cubic and dodecahedral faces. Both the form and composition are hence somewhat uncertain; it is possible that analyses 1, 2, were made on different minerals.

Pettkoite. *A. Paulinyi*, Jb. Min., 457, 1867. Described as isometric, in cubes. H. = 2·5. Luster bright. Color pure black. Streak dirty greenish. Taste sweetish. Anal.—A. Paulinyi:

$SO_3$ 45·32 $Fe_2O_3$ 44·92 FeO 6·66 $H_2O$ 1·51 = 98·41

From Kremnitz, in a breccia, along with iron-vitriol (melanterite), in crystals from the size of peas to millets, and in grains. Named after Bergrath v. Pettko.

Tschermak has shown that pettkoite is only voltaite, the analysis being incorrect. Ber. Ak. Wien, **58** (1), 831, 1867.

**797. METAVOLTINE.** *J. Blaas*, Ber. Ak. Wien, **87** (1), 155, 1883.

Hexagonal. In aggregates of minute six-sided scales. H. = 2·5. G. = 2·53. Color yellow. Dichroic: $\omega$ yellow, $\epsilon$ green.

**Comp.**—Perhaps $5(K_2,Na_2,Fe)O.3Fe_2O_3.12SO_3.18H_2O$. Analysis.—Blaas, l. c.

$SO_3$ 46·90 $Fe_2O_3$ 21·20 FeO 2·92 $K_2O$ 9·87 $Na_2O$ 4·65 $H_2O$ 14·58 = 100·12

Dissolves slowly and imperfectly in cold water; upon heating a red powder separates. Slowly soluble in hydrochloric acid.

**Obs.**—Occurs with voltaite in a pyritiferous trachyte from Madeni Zakh in Persia. The author states that much so-called *misy* belongs here.

The above is very near the compound sometimes named Maus's salt (Maus, Pogg., **11**, 78, 1827) (the *mausite* of Haidinger, Ber. Ak. Wien, **11**, 393, 1853).

**798. BOTRYOGEN.** Rother Eisen-Vitriol *Berz.*, Afh., **4**, 307, 1815. Red Iron Vitriol. Fer sulfaté rouge *Fr.* Botryogen *Haid.*, Pogg., **12**, 491, 1828. Neoplase pt. *Beud.*, Tr., **2**, 483, 1832. Botryt *Glock.*, Syn., 300, 1847.

Monoclinic. Axes $\grave{a} : \bar{b} : \dot{c} = 0·65215 : 1 : 0·5992$; $\beta = 62° 26\frac{1}{6}' = 001 \wedge 100$ Haidinger[1].

$100 \wedge 110 = 30° 2'$, $001 \wedge 101 = 54° 47\frac{1}{4}'$, $001 \wedge 011 = 27° 58\frac{2}{3}'$.

**Forms:** *b* (010, *i*-ì), *c* (001, *O*); *m* (110, *I*), *f* (120, *i*-2̀); *x* ($\bar{1}$01, 1-ī); *v* (023, $\frac{2}{3}$-ì); *n* ($\bar{1}$11, 1).

Angles: $mm''' = {}^*60° 4'$, $ff' = 81° 42'$, $a'x = 62° 46\frac{1}{2}'$, $vv' = {}^*39° 0'$, $cm = {}^*66° 23'$, $cn = 59° 24\frac{1}{2}'$, $nn' = 56° 6'$.

Crystals short prismatic, small; faces *m*, *f* vertically striated. Usually in reniform and botryoidal shapes, consisting of globules with a crystalline surface.

Cleavage: *m* rather distinct; *f* (120) in traces. H. = 2–2·5. G. = 2·04–2·14. Luster vitreous. Color deep hyacinth-red; massive varieties sometimes ocher-yellow. Streak ocher-yellow, a little shining. Translucent. Taste slightly astringent. Pleochroic: vibrations ∥ $\acute{c}$ orange, ⊥ $\acute{c}$ orange-gray.

**Comp.**—Perhaps $MgO.FeO.Fe_2O_3.4SO_3.18H_2O$ (Hockauf) = Sulphur trioxide 34·9, iron sesquioxide 17·4, iron protoxide 7·9, magnesia 4·4, water 35·4 = 100. Some manganese protoxide is also present.

**Anal.**—1, Hockauf, l. c., 0·3 p. c. insol. residue deducted. 2. Blaas, Ber. Ak. Wien, **87** (1), 161, 1883. Cf. also ibid., **88** (1), 1134.

| | | $SO_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 1. Falun | | $\frac{2}{2}$ 36·94 | 16·38 | 2·23 | 1·93 | 7·63 | 0·90 | 33·99 = 100 |
| 2. Persia | G. = 2·138 | 40·95 | 20·50 | 4·12 | — | 3·59 | — | 30·82 = 99·98 |

For the early results of Berzelius, see 5th Ed., p. 657.

**Pyr., etc.**—B.B. intumesces and gives off water, producing a reddish-yellow earth. On charcoal becomes magnetic; with soda gives a hepatic mass. Remains unaltered if kept dry, but in a moist atmosphere it becomes covered with a dirty yellowish powder. Partly soluble in boiling water, leaving an ocherous residue.

**Obs.**—Occurs at the copper mine of Falun, in Sweden, coating gypsum or pyrite. Much of the so-called botryogen is not this mineral, but a mixture of other sulphates, cf. Blaas, Hockauf, l. c. From the region of Madeni Zakh, Persia, where it incloses crystals of voltaite. Also noted by Raimondi (called *alcaparossa amarilla*) as occurring in Peru (and Chili).

Named from *βότρυς, a bunch of grapes*, and *-γένης, producing* (from *γίγνεσθαι, to become*). This last part of the name is bad and is well thrown aside by Glocker, who makes it *botryte; botryite* would be more correct.

**Ref.**—[1] L. c.; this is Miller's position. There is some uncertainty about the true symbol of *n*, cf. Hockauf, Zs. Kr., **12**, 240, 1886, who also calls attention to the resemblance in angle to anorthite and the possible asymmetry of the crystals, based upon an extended series of measurements.

### 799. SIDERONATRITE. *Raimondi*, Minéraux du Pérou, 212, 233, 1878. *Domeyko*, 3d Ed. Min. Chili, p. 158, 1879. Urusit *Frenzel*, Min. Mitth., 2, 133, 359, 1879.

Orthorhombic Pfd.[1] In crystalline masses of fine fibrous structure, separating into thin splinters.

Cleavage: probably pinacoidal. H. = 2–2·5. G. = 2·153; 2·355 G. & P. Color orange-yellow to straw-yellow. Streak pale yellow to yellowish white. Optically +. $\mathfrak{c}$ (= $Bx_a$) ∥ fibers, Pfd.[1]

**Comp.**—$2Na_2O.Fe_2O_3.4SO_3.7H_2O$ (Genth) = Sulphur trioxide 43·8, iron sesquioxide 21·9, soda 17·0, water 17·3 = 100.

The above description applies to sideronatrite. *Urusite*, which seems to be the same mineral, occurs in pulverulent, earthy forms; also in lumps, consisting of minute prismatic crystals. Soft. G. = 2·22. Color lemon- to orange-yellow. Streak ocher-yellow. Transparent in minute crystals.

**Anal.**—1, Raimondi, l. c. 2, Frenzel, Min. Mitth., **11**, 214, 1890. 3, Genth, Am. J. Sc., **40**, 201, 1890. 4, Frenzel, Min. Mitth., **2**, 133, 1879. 5, Id., ib., p. 359.

| | | $SO_3$ | $Fe_2O_3$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|
| 1. *Sideronatrite* | | 43·26 | 21·60 | 15·59 | 15·35 NaCl 1·06, gangue 3·20 = 100·06 |
| 2. " | G. = 2·31 | 42·93 | 22·86 | 17·49 | 15·66 = 98·94 |
| 3. " | | 44·22 | 21·77 | 16·39 | 17·07[a] = 99·45 |
| 4. *Urusite* | | 42·08 | 21·28 | 16·50 | 19·80 = 99·66 |
| 5. " | | 41·64 | 22·00 | 17·24 | [19·12] = 100 |

[a] At 110° loses 4 molecules $H_2O$, Genth.

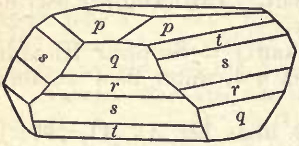
Both sulphates are insoluble in cold water, but decomposed by boiling water with separation of iron sesquioxide; soluble in acids.

**Obs.**—Sideronatrite is from the mine San Simon, Huantajaya, province of Tarapacá, Chili. Urusite is found underlying deposits of iron vitriol (melanterite) on the Urus plateau, near Sarakaya, on the naphtha island, Cheleken, in the Caspian Sea.

**Ref.**—[1] Am. J. Sc., **40**, 201, 1890.

**800. ALUNITE.** Alumen de Tolpha, quod primum fossum est in Italia, Pii 2di Pontificis temporibus (Piccolomini, 1458–1464), *Gesner*, Foss., 13, 1565. Romersk Alunsten *Wall.*, Min., 163, 1747. Alaunstein (fr. Tolfa) *Wern.*, Bergm. J., 376, 1789. Alumstone. Aluminilite *Delameth.*, T. T., 2, 113, 1797. Alun de Rome pt. *H.*, Tr., 1801. Pierre alumineuse de la Tolfa *Fr.* Alunite *Beud.*, 449, 1824. Alaun-Spath *Breith.*, Char., 1823.

Rhombohedral. Axis $\dot{c} = 1{\cdot}2520$; $0001 \wedge 10\bar{1}1 = 55° \, 19\frac{2}{3}'$ Breithaupt[1].



Bereghszasz, Breithaupt.

**Forms**[2]: *a* $(11\bar{2}0, i\text{-}2)^3$ *w* $(70\bar{7}9, \frac{7}{9})^3$ *s* $(60\bar{6}5, \frac{5}{6})$
*c* (0001, *O*) *p* $(1{\cdot}0{\cdot}\bar{1}{\cdot}64, \frac{1}{64})$ *r* $(10\bar{1}1, R)$ *t* $(02\bar{2}1, -2)$
*m* $(10\bar{1}0, I)^3$ *v* $(30\bar{3}4, \frac{3}{4})^3$ *q* $(60\bar{6}7, \frac{6}{7})$

*cp* = 1° 18′ *cs* ≐ 60° 2′ *rr′* = *90° 50′
*cv* = 47° 19′ *ct* = 70° 55′ *qq′* = 84° 45′
*cw* = 48° 21′ *pp′* = 2° 14½′ *ss′* = 97° 14′
*cr* = 55° 20′ *vv′* = 79° 5′ *tt′* = 109° 51½′
*cq* = 51° 6′ *ww′* = 80° 39′

In rhombohedrons, resembling cubes (*rr′* = 90° 50′); often terminated by the vicinal rhombohedron *p*. Faces *r* often striated ∥ edge *c*/*r*. Also massive, having a fibrous, granular, or impalpable texture.

Cleavage: *c* distinct; *r* in traces. Fracture flat conchoidal, uneven; of massive varieties splintery; and sometimes earthy. Brittle. H. = 3·5–4. G. = 2·58–2·752; 2·594 Erem. Luster of *r* vitreous, basal plane somewhat pearly. Color white, sometimes grayish or reddish. Streak white. Transparent to subtranslucent. Optically positive.

**Comp.**—Hydrous sulphate of aluminium and potassium, $K_2O.3Al_2O_3.4SO_3.6H_2O$ = Sulphur trioxide 38·6, alumina 37·0, potash 11·4, water 13·0 = 100.

The formula may be written $K(AlO)_3(SO_4)_2 + 3H_2O$.

Analyses agree closely, cf. 5th Ed., p. 659; also Rev. Geol., **13**, 38, 1877; Lsx., Jb. Min., 142, 1875.

**Pyr., etc.**—B.B. decrepitates, and is infusible. In the closed tube yields water, sometimes also ammonium sulphate, and at a higher temperature sulphurous and sulphuric oxides. Heated with cobalt solution affords a fine blue color. With soda and charcoal infusible, but yields a hepatic mass. Soluble in sulphuric acid.

**Obs.**—Forms seams in trachytic and allied rocks, where it has been formed as a result of the alteration of the rock by means of sulphurous vapors.

Met with at Tolfa, near Civita Vecchia, in the neighborhood of Rome, in crystals; at Montioni in Tuscany; at Musaz and Bereghszasz in Hungary; on Milo, Argentiera, and Nevis, Grecian Archipelago, and with opal on Santorin; at Mt. Dore, France; near Hadji-Khan, Buchará; with the hyalite and opal of Queretaro, Mexico.

In the U. S., occurs, associated with diaspore, in rhombohedral crystals, tabular through the presence of *c* (0001) at the Rosita Hills, Custer Co., Colorado, particularly Democrat Hill and Mt. Robinson. The crystals are dull and opaque with rough faces and consist of alunite but with a granular structure, they being pseudomorphs after an earlier formation of alunite. The formation of the alunite is explained by the action of sulphurous gases upon the highly aluminous andesytes.

The compact varieties from Hungary are so hard as to admit of being used for millstones. Alum is obtained from it by repeatedly roasting and lixiviating, and finally crystallizing by evaporation.

This species was first observed at Tolfa, near Rome, in the 15th century, by J. de Castro, a Genoese who had been engaged in the manufacture of alum, from an alumstone or "Rock-alum" found near Edessa in Syria. It was named *Aluminilite* by Delamétherie in 1797, a long name well changed to *Alunite* by Beudant in 1824.

**Ref.**—[1] Vh. G. Reichs., **4**, 25, 1852. [2] Breith., l. c. [3] Eremeyev, Buchará, Vh. Min. Ges., **18**, 221, 1883.

**801. JAROSITE.** Gelbeisenerz Rg., Pogg., **43**, 132, 1838. Misy *Haid.*, Handb., 512, 1845. Vitriolgelb, Gelbeisenerz, *Hausm.*, Handb., 1205, 1847 [not Gelbeisenerz fr. Harz *Breith.*, Char., 1832]. Jarosit *Breith.*, B. H. Ztg., **6**, 68, 1852. Moronolite *Shep.*, Suppl. Append. Min., p. 4, 1857.

Rhombohedral. Axis $\dot{c} = 1{\cdot}2492$; $0001 \wedge 10\bar{1}1 = 55° \, 16'$, Koenig[1].

**Forms**[2]: *c* (0001, *O*), *r* $(10\bar{1}1, R)$, *s* $(02\bar{2}1, -2)^2$. Angles: *rr′* = *90° 45′, *cs* = 70° 53′, *ss′* = 109° 49′.

Often in druses of minute indistinct crystals; less often crystals rhombohedral in habit, or with *c*, and then somewhat resembling cubes with tetrahedral planes. Also fibrous, and granular massive. Also in nodules, or as an incrustation with a tuberose or coralloidal surface.

Cleavage: *c* distinct. Fracture uneven. Brittle. H. = 2·5–3·5. G. = 3·15–3·26 cryst. Luster vitreous to subadamantine; brilliant, also dull. Color ocher-yellow, yellowish brown, clove-brown. Streak yellow, shining.

**Var.**—(1) *Crystallized; Jarosite,* which occurs also fibrous and granular: G. = 3·256, Spain; 3·244, Maryland, Breith.; 3·144 Arizona; 3·163 Utah. (2) *Concretionary,* the ordinary form of the Norway and Bohemian mineral, and the *moronolite* of Orange Co., N. Y.; G. = 2·62 (moronolite)–2·79.

**Comp.**—$K_2O.3Fe_2O_3.4SO_3.6H_2O$ = Sulphur trioxide 31·9, iron sesquioxide 47·9, potash 9·4, water 10·8 = 100.

The formula may be written $K(FeO)_3(SO_4)_2 + 3H_2O$.

**Anal.**—1, Ferber, B. H. Ztg., **23**, 10, 1864. 2, Penfield, Am. J. Sc., **21**, 160, 1881. 3, Koenig, l. c. 4, 5, Genth, Am. J. Sc., **39**, 73, 1890. See also 5th Ed., p. 660.

| | G. | $SO_3$ | $Fe_2O_3$ | $K_2O$ | $Na_2O$ | $H_2O$ | $SiO_2$ | |
|---|---|---|---|---|---|---|---|---|
| 1. Spain | | 31·76 | 49·24 | 5·90 | 0·80 | 11·35 | — | $Al_2O_3$ 1·25=100·30 |
| 2. Vulture M., Arizona | 3·09 | 30·42 | 48·27 | 8·53 | 0·28 | [11·42] | 1·08 | = 100 |
| 3. Arrow M., Colorado | 3·144 | 29·33 | 52·36 | 7·30 | 0·90 | 10·55 | — | = 100·44 |
| 4. Tintic distr., Utah | 3·163 | 29·60 | 50·41 | 9·23 | | 10·68 | 0·08 | = 100 |
| 5. " " | | 28·93 | 51·16 | 9·05 | 0·33 | 10·24 | 0·29 | = 100 |

The water determined in 2, viz., 12·91, was too high; the result obtained by difference is more nearly correct. In 3, the silica has been deducted, and 8·8 p. c. of turgite remains to be rejected.

For the *Gelbeisenerz* from near Bilin, Rammelsberg calculates $K_2O.4Fe_2O_3.5SO_3.9H_2O$, and for that from Modum $Na_2O.4Fe_2O_3.5SO_3.9H_2O$. Analyses.—1, Rg., l. c. 2, Scheerer, Pogg., **45**, 188, 1838.

| | $SO_3$ | $Fe_2O_3$ | $K_2O$ | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|
| 1. Bilin | 32·11 | 46·74 | 7·88 | — | 13·56 | CaO 0·64 = 100·93 |
| 2. Modum | $\frac{2}{2}$ 32·45 | 49·63 | — | 5·20 | 13·11 | = 100·39 |

Both of the above come very near jarosite. Weisbach has used the name *kolosorukite* for the above, Synops. Min., 42, 1875.

**Pyr., etc.**—Nearly as for coquimbite, p. 956.

**Obs.**—The original Gelbeisenerz (cf. above) was from Luschitz, between Kolosoruk and Bilin, Bohemia, in brown coal; and later from Modum, Norway, in alum slate.

The jarosite was from Barranco Jaroso, in the Sierra Almagrera, Spain, on limonite; also, according to Breithaupt (B. H. Ztg., **25**, 149, 1866), from Maryland, of granular form, with quartz and a magnetite altered to hematite; Mexico; Saxony, Thekla mine, near Hauptmanngrün in Voigtland, in small crystals on turgite (hydrohematite) and limonite; Erzgebirge, near Schwarzenberg, at the Frisch Glück mine. In the Ural near Berezov, 15 versts from Ekaterinburg. Also from the province of Cajamarca, Peru.

In the U. S., occurs on quartz at the Vulture mine, Arizona; at the Arrow mine, Chaffee County, Col.; at the Mammoth mine, Tintic district, Utah, lining cavities in a siliceous limonite.

Moronolite is from Monroe, N. Y., where it occurs on gneiss. It contains less alkali (viz. 3·81 p.c. Tyler) than is required for the formula. Named *moronolite* from *μῶρον, mulberry,* alluding to a resemblance to the mulberry calculus.

**Ref.**—[1] Am. Ch. J., **2**, 375, 1880; cf. Kk., Min. Russl., **6**, 227, 1874, **8**, 242. Breithaupt gives $rr' = 91° 2'$, and Koksharov 90° 49½'. [2] Pfd., Utah, Am. J. Sc., **39**, 73, 1890, he obtained $rr' = 91° 33'$.

**Bartholomite** *Cleve,* Ak. H. Stockholm, **9**, Nov. 1870; Geol. W. I. Islands, p. 31. A hydrous sulphate of ferric iron and sodium of uncertain nature. An analysis on impure material, after deducting 2·88 NaCl (halite), 3·87 $MgSO_4 + 7H_2O$ (epsomite), 3·56 insol. yielded:

$SO_3$ 48·66 $Fe_2O_3$ 25·41 $Na_2O$ 19·11 $H_2O$ 6·82 = 100

Occurs with mendozite in yellow nodules composed of small needles, an alteration-product of pyrite, at St. Bartholomew, West Indies.

**Plagiocitrite** *Sandberger; Singer,* Inaug. Diss., p. 13, Würzburg, 1879.

Monoclinic or triclinic. In microscopic prismatic crystals. G. = 1·881. Color lemon-yellow. Translucent. Taste astringent.

Composition, perhaps $(K,Na)_2O.2FeO.3(Al,Fe)_2O_3.6SO_3.27H_2O$. Analysis, after deducting 9·85 p. c. hygroscopic water:

| $SO_3$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | NiO | CoO | MgO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 35·44 | 14·37 | 7·95 | 1·64 | 0·97 | 0·58 | 1·19 | 0·43 | 4·04 | 4·23 | 29·42 = 100·26 |

Easily soluble in water, the solution giving an acid reaction; by boiling, $Fe_2O_3$ separates out free from $SO_3$. Decomposes on exposure, becoming orange-yellow. B.B. swells up, fuses in its own water of crystallization, and leaves a reddish brown spongy residue.

Occurs with other related sulphates at the Bauersberg near Bischofsheim vor dem Rhön; derived from the decomposition of pyrite.

Clinophæite. Klinophaeit *Sandberger; Singer*, Inaug. Diss., Würzburg, p. 16, 1879.

In microscopic crystals, probably monoclinic, with planes *c* (001), *m* (110), *d* (101); prismatic angles 85° and 95°. G. = 2·979. Color blackish green. Streak light grayish green. Luster vitreous. Translucent to opaque. Taste astringent.

Composition, perhaps $4(K,Na)_2O.FeO.(Fe,Al)_2O_3.5SO_3.8H_2O$. Analysis, after deducting 7·88 p. c. hygroscopic water:

| $SO_3$ | $Fe_2O_3$ | $Al_2O_3$ | FeO | NiO(CoO) | MgO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| 37·01 | 9·48 | 4·04 | 6·06 | 0·76 | 1·88 | 0·77 | 6·35 | 21·79 | 14·72 = 102·86 |

Difficultly soluble in water; on boiling, iron sesquioxide separates from the aqueous solution. B.B. fuses with intumescence, leaving finally a black magnetic residue. Occurs with other sulphates at the Bauersberg, near Bischofsheim, as a result of the decomposition of pyrite.

Clinocrocite. Klinocrocit *Sandberger; Singer*, Inaug. Diss., Würzburg, p. 9, 1879.

A mineral of a deep saffron-yellow, occurring in microscopic crystals, probably monoclinic. According to a qualitative examination, a hydrous sulphate of aluminium, ferric iron, sodium, and potassium (lime in traces). From the Bauersberg, near Bischofsheim, formed by the decomposition of pyrite in basalt tufa. Related to the more clearly defined mineral, *clinophæite*.

**802. LÖWIGITE.** Alaunstein *Römer*, Zs. G. Ges., 8, 246, 1856. Löwigit *A. Mitscherlich*, J. pr. Ch., 83, 474, 1861. Loewigite.

In rounded masses, similar to compact alunite.

H. = 3–4. G. = 2·58. Luster feeble. Color pale straw-yellow. Slightly subtranslucent. Fracture perfectly conchoidal.

**Comp.**—Perhaps $K_2O.3Al_2O_3.4SO_3.9H_2O$ (Rg.) = Sulphur trioxide 36·3, alumina 34·7, potash 10·7, water 18·4 = 100.

This is like alunite except in the presence of more water.

**Anal.**—1, Löwig, Zs. G. Ges., 8, 246, 1856. 2. Mitscherlich, J. pr. Ch., 83, 474, 1861.

|  | $SO_3$ | $Al_2O_3$ | $Fe_2O_3$ | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|
| 1. | 34·84 | 33·37 | — | 10·10 | — | 18·32 $SiO_2$, etc., 3·37 = 100 |
| 2. | 34·81 | 34·95 | 0·68 | 9·30 | 0·39 | 17·87 $SiO_2$, etc., 2·00 = 100 |

**Pyr., etc.**—B.B. nearly like alunite. The water is expelled at a lower temperature than in alunite; and the compound resulting after heating, instead of containing a mixture affording alum and insoluble hydrated alumina, affords to water sulphate of potassium and subsulphate of aluminium. Partially soluble in hydrochloric acid, while alunite is not at all so.

**Obs.**—Found in a coal bed at Tabrze in Upper Silesia, in compact lumps, having the luster, color, and texture of the Solenhofen lithographic stone, but blackish externally from a coaly crust; also with alunite at Tolfa

Ignatievite. Ignatiewit *K. K. Klug*, Vh. Min. Ges., 23, 116, 1887. Occurs in nodules and reniform masses, having a fibrous structure in white sand in the district of Bakhmut, Ekaterinoslav, South Russia. An impure hydrous sulphate of aluminium and potassium.

**803. ETTRINGITE.** *Lehmann*, Jb. Min., 273, 1874.

Hexagonal. Axis $\dot{c} = 0·94345$; $0001 \wedge 10\bar{1}1 = 47° 27'$ Lehmann.

**Forms:** *c* (0001, *O*); *m* ($10\bar{1}0$, *I*); *o* ($10\bar{1}2$, $\frac{1}{2}$), *p* ($10\bar{1}1$, 1).

Angles: $co = 28° 35'$, $oo' = 30° 53'$, $cp = 47° 27'$, $pp' = 43° 14'$, $mp = {}^*42° 33'$.

In minute needle-like prismatic crystals, seldom more than 3 mm. in length, thickness $\frac{1}{10}$ to $\frac{1}{2}$ mm.

Cleavage: *m* perfect. H. = 2–2·5. G = 1·75. Colorless. Transparent. Optically uniaxial, negative, Btd.

**Comp.**—Perhaps $6CaO.Al_2O_3.3SO_3.33H_2O$ (Rg.) = Sulphur trioxide 18·9, alumina 8·0, lime 26·4, water 46·7 = 100. The small quantity analyzed makes the complex formula doubtful.

**Anal.**—Lehmann, l. c., on 0·36 gr.

| $SO_3$ | $Al_2O_3$ | $CaO$ | $H_2O$ | loss ($SO_3$?) | |
|---|---|---|---|---|---|
| 16·64 | 7·76 | 27·27 | 45·82 | 2·51 | = 100 |

**Pyr.**—B.B. swells up but does not fuse. Soluble in acids, also to a considerable extent in water, giving an alkaline solution.

Occurs in cavities in the limestone-inclusions in lava of the Bellenberg at Ettringen and Mayen, in the district of Laach.

### 804. QUETENITE. *A. Frenzel*, Min. Mitth., **11**, 217, 1890.

Monoclinic or triclinic? Massive and in indistinct prismatic crystals embedded in chalcanthite.

Cleavage: prismatic, rather perfect. H. = 3. G. = 2·08–2·14. Luster greasy, feeble. Color reddish brown. Translucent to opaque. Taste slightly astringent.

**Comp.**—$MgO.Fe_2O_3.3SO_3.13H_2O$ = Sulphur trioxide 35·6, iron sesquioxide 23·7, magnesia 6·0, water 34·7 = 100.

**Anal.**—Frenzel, l. c., after deducting admixed chalcanthite.

$SO_3$ 37·37 $Fe_2O_3$ 22·70 $MgO$ 5·92 $H_2O$ 34·01 = 100

Decomposed by water with the separation of iron sesquioxide.

**Obs.**—From the Salvador mine in Quetena, eight kilometers west of Calama, Chili; intimately associated with chalcanthite.

### 805. ZINCALUMINITE. *Bertrand* and *Damour*, Bull. Soc. Min., **4**, 135, 136, 1881.

In minute crystals, forming very thin hexagonal plates. Optically uniaxial, negative, and hence hexagonal, or possibly orthorhombic with a prismatic angle of about 60° (Bertrand).

H. = 2·5–3. G. = 2·26. Color white, or slightly bluish.

**Comp.**—$2ZnSO_4.4Zn(OH)_2.6Al(OH)_3 + 5H_2O$, or $6ZnO.3Al_2O_3.2SO_3.18H_2O$ = Sulphur trioxide 12·5, alumina 24·0, zinc protoxide 38·1, water 25·4 = 100.

**Anal.**—Damour, after deducting a little clay.

| $SO_3$ | $Al_2O_3$ | $ZnO$ | $CuO$ | $H_2O$ |
|---|---|---|---|---|
| 12·94 | 25·48 | 34·69 | 1·85 | 25·04 = 100 |

**Pyr., etc.**—B.B. in the closed tube gives off abundance of water, Slightly alkaline, With cobalt solution on strong ignition gives a greenish gray mass with blue at some points. On charcoal a zinc coating. Soluble in nitric acid, leaving 5 to 7 p. c. clay.

**Obs.**—From the zinc mines of Laurium, Greece, associated with smithsonite, serpierite, etc.

ENYSITE *Collins*, Min, Mag., **1**, 14, 1876; *C. Le Neve Foster*, ibid., p. 9.

Forms a bluish green stalagmitic crust. H. = 2–2·5. G. = 1·59. An analysis gave: $SO_3$ 8·12, $Al_2O_3$ 29·85, $CuO$ 16·91, $CaO$ 1·35. $SiO_2$ 3·40, $CO_2$ 1·05 $H_2O$ (over $H_2SO_4$ after 3 days) 14·04, at 150° C. 18·21, at a red heat 7·17, $Fe_2O_3$,Cl,$Na_2O$ *tr.* = 100·10. Compare analyses of woodwardite by Flight, J. Ch. Soc., **24**, 1, Jan., 1871; and Pisani, Phil. Mag., **35**, 320, 1868.

Found at St. Agnes, Cornwall, in one of the caves at the old quay. Named after John S. Enys, F.G.S. Probably a mechanical mixture. Cf. Groth, Zs. Kr., **1**, 75, 1877.

LAMPROPHANITE. Lamprophan *Igelström*, Öfv. Ak. Stockh., **23**, 93, 1866.

In thin cleavable folia. H. = 3. G. = 3·07. Luster pearly. Color and streak white. An analysis afforded Igelström:

| $SO_3$ | $PbO$ | $MnO$ | $MgO$ | $CaO$ | $Na_2O,K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|
| 11·17 | 28·00 | 7·90[a] | 5·26 | 24·65 | 14·02 | 8·35 = 99·35 |

[a] FeO *tr.*

Yields water. With soda on charcoal yields metallic lead and a hepatic mass. Not wholly soluble in acids.

From Långban in Wermland, Sweden. Named in allusion to the luster from λαμπρός, *shining*.

**806. JOHANNITE.** Uranvitriol *John*, Ch. Unters., 5, 254, 1821. Johannit *Haid.*, Abhandl., Böhm. Ges. Prag, 1830. Sulphate of Uranium. Sulfate vert d'urane *Beud.*

Monoclinic. Prismatic angle 111° and 69°, $\beta = 85° 40'$. Crystals flattened, resembling those of trona, and from one to three lines in length; arranged in concentric druses or reniform masses.

H. = 2–2·5. G. = 3·19. Luster vitreous. Color beautiful emerald-green, sometimes passing into apple-green. Streak paler. Transparent to translucent; sometimes opaque. Soluble in water. Taste bitter, rather than astringent.

**Comp.**—A hydrous sulphate of uranium and copper, formula uncertain.

**Anal.**—Lindacker, Vogl. Min. Joach., 1857.

$SO_3$ 20·02 $UO_3$ 67·72 CuO 5·99 FeO 0·20 $H_2O$ 5·59 = 99·52

**Pyr., etc.**—In a glass tube at a low heat does not change; highly heated gives off water and sulphur dioxide, and becomes brown and finally black. B.B. on charcoal gives sulphurous fumes and a scoria of black color and dull green streak. With salt of phosphorus reacts for copper and uranium. Somewhat soluble in water.

**Obs.**—Discovered by John near Joachimsthal in Bohemia. Found also at Johanngeorgenstadt. Reported from the Middletown feldspar quarry by Shepard.

Named after the Archduke Johann of Austria.

**807. URANOPILITE.** *Weisbach*, Jb. Min., 2, 258, 1882. Uranocher pt.

A velvety incrustation on uraninite or mica schist at Johanngeorgenstadt; a similar substance occurs at Joachimsthal. Crystals minute flattened, acicular and terminated obliquely (79½°); extinction oblique (9°). G. = 3·75–3·97. Color yellow.

**Comp.**—Perhaps $CaU_8S_2O_{31}.25H_2O$ or $CaO.8UO_3.2SO_3.25H_2O$ = Sulphur trioxide 5·4, uranium trioxide 77·6, lime 1·9, water 15·1 = 100.

**Anal.**—H. Schulze, l. c.

| | $SO_3$ | $UO_3$ | CaO | $H_2O$ | insol. | | |
|---|---|---|---|---|---|---|---|
| 1. | 3·18 | 77·17 | 2·08 | 16·59 | 0·39 | = | 99·41 |
| 2. | 4·56 | 77·46 | 1·96 | 14·69 | 1·33 | = | 100 |

A *basisches Uransulphat* from Joachimsthal, like the above, gave Dauber: $SO_3$ 4·0, $UO_3$ 79·9, $H_2O$ 14·3 = 98·2. In microscopic lemon-yellow crystals, Pogg., 92, 251, 1854.

MEDJIDITE *J. L. Smith*, Am. J. Sc., 5, 337, 1848. Sulphate of Uranium and Lime.

Massive, with an imperfectly crystalline structure. H. = 2·5. Luster vitreous in the fracture. Color dark amber. Transparent. A hydrous sulphate of uranium and calcium according to some qualitative trials by Smith.

Occurs near Adrianople, Turkey, on pitchblende, associated with liebigite, in some places with crystals of gypsum; also at Joachimsthal, with liebigite on uranium ore. Externally often dull from loss of water. Named after the Turkish sultan Abdul Medjid.

The following are uncertain uranium sulphates from Joachimsthal, Bohemia, derived from the alteration of uraninite.

URANOCHALCITE. Urangrün *Hartmann*. Uranochalzit *Breith.*, Handb., 173, 1841. In small nodular crusts and velvety druses, consisting of acicular crystals. H. = 2–2·5. Color fine grass-green to apple-green; streak apple-green.

ZIPPEITE. Basisches schwefelsaures Uranoxyd (verwitterter Uran-Vitriol) *J. F. John*, Unters., 5, 1821, Jb. Min., 299, 1845. Uranblüthe *Zippe*, Vh. Ges. Böhm., 1824. Zippeit *Haid.*, Handb., 510, 1845. Dauberite *Adam*, Tabl. Min., 64, 1869.

In delicate needles; acicular rosettes; warty crusts. H. = 3. Color fine sulphur-yellow, lemon-yellow, orange-yellow.

VOGLIANITE. Basic Sulphate of Uranium *Vogl*, Min. Joach., 1857. Voglianite *Dana*. In soft globular, and nodular, earthy coatings. Color pistachio- to verdigris-green; streak pale green or apple-green.

URACONITE. Uranocker *Vogl*, Min. Joach. ? Uraconise *Beud.*, Tr., 2, 672, 1832. Uraconite *Dana*. Amorphous, earthy, or scaly, and of a fine lemon-yellow color, or orange. Uraconise of Beudant was described as a yellow pulverulent ore; its composition is unknown.

Analyses of these substances, Lindacker, Vogl, Min. Joach., 1857, 5th Ed., pp. 667, 668.

| | $SO_3$ | $UO,U_2O_3$ | FeO | CuO | CaO | $H_2O$ | | |
|---|---|---|---|---|---|---|---|---|
| *Uranochalcite* | 20·03 | 36·14 | 0·14 | 6·55 | 10·10 | 27·16 | = | 100·12 |
| *Zippeite* | 13·06 | 67·86 | $Fe_2O_3$ 0·17 | — | 0·61 | 17·69 | = | 99·39 |
| " | 17·36 | 62·04 | — | 5·21 | — | 15·23 | = | 99·84 |
| *Voglianite* | 12·34 | 79·50 | 0·12 | — | 1·66 | 5·49 | = | 99·11 |
| " | 12·13 | 79·69 | 0·36 | 2·24 | 0·05 | 5·25 | = | 99·72 |
| *Uraconite*, yellow | 7·12 | 70·94 | $Fe_2O_3$ 0·41 | 0·24 | — | 20·88 | = | 99·58 |
| " orange | 10·16 | 66·05 | " 0·86 | — | 2·62 | 20·06 | = | 99·76 |

## Tellurates; also Tellurites, Selenites.

| | | | | | |
|---|---|---|---|---|---|
| 808. **Montanite** | $Bi_2(OH)_4TeO_6$? | | | | |
| 809. **Emmonsite** | Ferric tellurite | Monoclinic | | | |
| 810. **Durdenite** | $Fe_2(TeO_3)_3 + 4H_2O$ | | | | |
| | | | | $\grave{a} : \bar{b} : \dot{c}$ | $\beta$ |
| 811. **Chalcomenite** | $CuSeO_3 + 2H_2O$ | Monoclinic | | 0·7222 : 1 : 0·2460 | 89° 9′ |
| Molybdomenite | | | | | |
| Cobaltomenite | | | | | |

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**808. MONTANITE.** *F. A. Genth,* Dana Min., 668, 1868; Am. J. Sc., **45**, 318, 1868.

Incrusting; without distinct crystalline structure.

Soft and earthy. Luster dull to waxy. Color yellowish, greenish to white; also brownish red. Opaque.

**Comp.**—$Bi_2O_3.TeO_3.2H_2O$ = Tellurium trioxide 25·7, bismuth trioxide 68·9, water 5·4 = 100.

**Anal.**—1–3, Genth, l. c. 4, Mingaye, Rec. G. Surv., N. S. W., **1**, 28.

| | $TeO_3$ | $Bi_2O_3$ | $Fe_2O_3$ | $H_2O$ | |
|---|---|---|---|---|---|
| 1. Montana | 26·83 | 66·78 | 0·56 | [5·44] | $Fe_2O_3$ 0·56, PbO 0·39 = 100 |
| 2. " | 25·45 | 68·78 | 1·26 | [3·47] | $Fe_2O_3$ 1·26, $Cu_2O$ 1·04 = 100 |
| 3. " | 23·90 | 71·90 | 0·32 | [2·80] | $Fe_2O_3$ 0·32, $Cu_2O$ 1·08 = 100 |
| 4. Norongo, N. S. W. | 27·65 | 50·68 | 14·38 | 6·16 | gangue 1·00 = 99·87 |

**Pyr., etc.**—Yields water in a tube when heated. B.B. gives the reactions of bismuth and tellurium. Soluble in dilute hydrochloric acid.

**Obs.**—Incrusts tetradymite, from whose alteration it has been formed, at Highland, in Montana. The waxy luster is observed when the incrustation has separated from the scales of tetradymite; also with the tetradymite of Davidson Co., N. C. Occurs with tetradymite at Norongo near Captain's Flat, New South Wales; it has in part a pale yellow color, also brownish red color with G. = 3·789. The former incrusts tetradymite; the latter (anal. 4) is in small cubical forms, and is regarded (T. W. E. David) as a pseudomorph after pyrite.

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**809. EMMONSITE.** *W. F. Hillebrand,* Proc. Col. Soc., **2**, pt. 1, 20, 1885.

Monoclinic (?) In thin scales, formed by perfect cleavage ‖ *b* (010), whose outlines are formed by two unequal cleavages giving the plane angles 85° and 95°.

Hardness about 5. Color of scales clear yellow-green. Extinction on *b* in obtuse angle (95°) inclined 13° to the better cleavage direction and 82° to the other, E. S. D.

**Comp.**—Probably a hydrated ferric tellurite, but exact composition undetermined.

**Anal.**—1, 2, Hillebrand, l. c.: 1, of the brown substance; 2, of green portions. From 3–5 p. c. quartz have been deducted.

| | Te(Se) | Fe | ZnO | CaO | $H_2O$ |
|---|---|---|---|---|---|
| 1. | $\frac{3}{3}$ 59·32 | 14·32 | — | — | 3·28 |
| 2. | 59·14 | 14·20 | 1·94 | 0·56 | — |

**Pyr.**—In a closed tube fuses to a deep red globule, water collects in the upper part, a faint sublimate of selenium and a stronger one of selenous oxide, lower down one of tellurous oxide fusible to colorless drops. Readily dissolved in strong acids.

**Obs.**—Obtained from Arizona, near Tombstone, exact locality unknown. The yellowish green scales are in part embedded in a hard brown gangue consisting of lead carbonate, quartz, and a brown substance containing iron and tellurium.

Named after S. F. Emmons of the U. S. Geological Survey.

**810. DURDENITE.** *E. S. Dana* and *H. L. Wells*, Am. J. Sc., **40**, 80, 1890.

Massive; in small mammillary forms showing but little structure and exerting almost no action on polarized light.

H. = 2–2·5. Friable. Luster vitreous, dull. Color greenish yellow. Translucent to nearly opaque.

**Comp.**—Hydrous ferric tellurite, $Fe_2(TeO_3)_3 + 4H_2O$ or $Fe_2O_3.3TeO_2.4H_2O$ = Tellurium dioxide 67·1, iron sesquioxide 22·7, water 10·2 = 100. Selenium replaces a small part of the tellurium.

**Anal.**—1, H. L. Wells, l. c.; 1*a*, same after deducting insoluble matter (quartz).

| | $TeO_2$ | $SeO_2$ | $Fe_2O_3$ | $H_2O$ | insol. | |
|---|---|---|---|---|---|---|
| 1. | 47·20 | 1·60 | 19·24 | 7·67 | 23·89 | = 99·60 |
| 1*a*. | 64·41 | 2·28 | 22·97 | 10·34 | — | = 100 |

**Pyr., etc.**—Gives the usual reaction for tellurium in the open tube; fuses on charcoal and leaves a magnetic residue. Soluble in hydrochloric acid.

**Obs.**—From the El Plomo mine, Ojojoma district, Dept. Tegucigalpa, Honduras. It occurs disseminated in grains and narrow veins in a quartzose conglomerate containing much nearly pure metallic tellurium. The same locality affords the selen-tellurium noted on p. 11.

Named after Henry S. Durden of the State Mining Bureau of San Francisco.

FERROTELLURITE *F. A. Genth*, Am. Phil. Soc., **17**, 119, 1877. Described as occurring in delicate radiating tufts, also in very minute prismatic crystals, as a coating on quartz associated with native tellurium and tellurite, at the Keystone mine, Magnolia District, Colorado. Color between straw- and lemon-yellow, inclining to greenish yellow. Insoluble in ammonia; soluble in HCl. A qualitative examination showed the presence of iron and tellurium, and the composition $FeTeO_4$ is suggested; the quantity, however, was too minute to allow of a satisfactory examination, and Dr. Genth states (priv. contr.) that it is not impossible that the crystals were tellurous oxide colored yellow by a salt of ferric oxide.

MAGNOLITE *F. A. Genth*, Am. Phil. Soc., **17**, 118, 1877.

In radiating tufts of very minute acicular or capillary crystals. Color white. Luster silky. Contains mercury and tellurium, and composition inferred to be $Hg_2TeO_4$. Blackened by ammonia. A decomposition-product of coloradoite, found in the upper part of the Keystone mine Magnolia District, Colorado.

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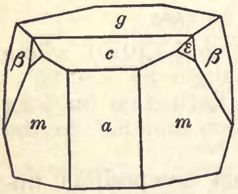
**811. CHALCOMENITE.** *Des Cloizeaux* and *Damour*, Bull. Soc. Min., **4**, 51, 164, 1881.

Monoclinic. Axes $\grave{a} : \overset{|}{\bar{b}} : \grave{c} = 0·72219 : 1 : 0·24604$ ; $\beta = 89° 9' = 001 \wedge 100$ Des Cloizeaux.

$100 \wedge 110 = {}^*35° 50'$, $001 \wedge 101 = {}^*18° 54'$, $001 \wedge 011 = 13° 49\frac{1}{4}'$.



*a* (100, *i*-ī) *m* (110, *I*) *f* (801, – 8-ī) ϵ (261, – 6-3̀)
*c* (001, *O*) *g* (1̄01, 1-ī) δ (421, – 4-2̄) β (2·12·1, – 12-6)

$mm''' = 71° 40'$ $cm = 89° 19'$ $\beta\beta' = 135° 9'$
$cf = 69° 6'$ $c\epsilon = 58° 9'$ $a\epsilon = 68° 40'$
$cg = 18° 54'$ $\delta\delta' = 32° 15'$ $a\beta = 77° 24\frac{1}{2}'$
$a'g = {}^*71° 57'$ $\epsilon\epsilon' = 100° 55\frac{1}{2}'$

Crystals small; faces *c*, *g* often horizontally striated.

G. = 3·76. Luster vitreous. Color bright blue. Transparent. Optically –. Ax. pl. ⊥ and $Bx_a \parallel b$ (010). Angle small. Dispersion strong, $\rho < v$.

**Comp.**—Hydrous cupric selenite, $CuSeO_3 + 2H_2O$ or $CuO.SeO_2.2H_2O$ = Selenium dioxide 49·1, cupric oxide 35·0, water 15·9 = 100.

**Anal.**—Damour, l. c.

$SeO_2$ 48·12 CuO 35·40 $H_2O$ 15·30 = 98·82

**Pyr., etc.**—B.B. on charcoal fuses to a black slag, giving off selenium fumes, and coloring the flame deep blue. In the closed tube yields a little water and a sublimate of $SeO_2$ in white needles. In salt of phosphorus gives in O.F. a greenish blue glass, which becomes blood-red when reduced with the addition of metallic tin. Soluble in acids.

**Obs.**—Occurs in minute crystals with the various selenides of silver, copper, and lead, which are found in small veins in the Cerro de Cacheuta, Mendoza, Argentine Republic. Often intimately mixed with azurite, iron oxide, and lead carbonate, which have been formed by the alteration of the selenides and of the pyrites which forms the gangue.

Named from χαλκός, *copper*, and μήνη, *moon*, in allusion to selenium, derived from the more common σελήνη, *moon*.

**Artif.**—MM. Friedel and Sarasin have made artificially (Bull. Soc. Min., **4**, 176, 225, 1881, Zs. Kr., **6**, 302. 1881) a copper selenite having the same form and composition as chalcomenite, and another differing in crystalline form (orthorhombic).

MOLYBDOMENITE. Selenite de plomb *Bertrand*, Bull. Soc. Min., **5**, 90, 1882.

Orthorhombic. In very thin, fragile scales. Cleavage in two directions; easy ‖ large face of the scales. Luster pearly. Color white. Transparent to translucent. Optically +. Ax. pl. normal to intersection of two cleavages, and obtuse bisectrix normal to easy cleavage.

Contains lead and selenium, and regarded as a lead selenite; some varieties also contain copper. Occurs associated with chalcomenite and various selenides at Cacheuta, Mendoza, Argentine Republic. Named from μόλυβδος, *lead*, and μήνη, *moon*.

COBALTOMENITE *Bertrand*, ibid. Associated with molybdomenite. In minute rose-red monoclinic crystals, resembling erythrite. Optically −. Ax. pl. parallel to direction of elongation of crystals, and acute bisectrix normal to it, but strongly inclined to the cleavage direction. Contains cobalt and perhaps a cobalt selenite. There also occur with the lead selenide at the same locality minute white acicular crystals, entirely volatile and apparently consisting only of selenous oxide (p. 201).

KERSTENITE. Selenichtsaures Bleioxyd *Kersten*, Pogg., **46**, 277, 1839. Selenbleispath. Kerstenite *Dana*. Bleiselenit *Germ*.

In small spheres and botryoidal masses. Cleavage distinct in one direction. H. = 3–4. Luster greasy to vitreous. Color sulphur-yellow. Streak uncolored. Brittle. Fracture fibrous. According to Kersten, it consists of selenous oxide and lead oxide, with a small proportion of copper. On coal it fuses readily to a black slag, giving off a strong selenium odor, and is finally reduced to a metallic globule. With borax it fuses and forms a yellowish-green pearl, which is of the same color on cooling. With soda on charcoal metallic lead is obtained. Occurs with selenide of antimony and lead, malachite, etc., at the Friedrichsglück mine, near Hildburghausen, on the west side of the Thüringerwald.

ONOFRITE *Köhler*, Abhandlung, etc. (Programm zur Prüfung der Zöglinge der Gewerbeschule am 23 März, 1853), Berlin, 1853; also Pogg., **89**, 146. 1853. Köhlerite *Adam*, Tabl. Min., 71, 1865. Selenigsaures Quecksilberoxydul, Quecksilberselenit, *Germ*.

An earthy yellow mineral from S. Onofre, Mexico, intimately mixed with calomel; regarded as probably mercurous selenite; but very doubtful.

# Oxygen Salts.

## 7. TUNGSTATES, MOLYBDATES.

| | | $\grave{a} : \bar{b} : \grave{c}$ | $\beta$ |
|---|---|---|---|
| 812. **Wolframite** | $(Fe,Mn)WO_4$ | 0·8300 : 1 : 0·8678 | 89° 22′ |
| 813. **Hübnerite** | $MnWO_4$ | 0·8362 : 1 : 0·8668 | 89° 7½′ |
| Ferberite? | $FeWO_4$ | | |

**Scheelite Group.** Tetragonal.

| | | |
|---|---|---|
| 814. **Scheelite** | $CaWO_4$ | $\grave{c} = 1·5360$ |
| 815. **Cuprotungstite** | $CuWO_4$ | |
| Cuproscheelite | $(Ca,Cu)WO_4$ | |
| 816. **Powellite** | $Ca(Mo,W)O_4$ | $\grave{c} = 1·5445$ |
| 817. **Stolzite** | $PbWO_4$ | $\grave{c} = 1·5667$ |
| 818. **Wulfenite** | $PbMoO_4$ | $\grave{c} = 1·5771$ |

| | | |
|---|---|---|
| 819. **Reinite** | $FeWO_4$ | $\grave{c} = 1·279$ |
| 820. **Belonesite** | $MgMoO_4$? | $2\grave{c} = 1·3211$ |

### 812, 813. WOLFRAMITE—HÜBNERITE.

812. **Wolframite.** Lupi Spuma, Lapis niger ex quo conflatur candidum plumbum [= Tin], *Agric.*, Foss., 255, 1546. Volfram, Ferrum arsenico mineralisatum, Spuma Lupi (fr. tin veins). *Wall.*, Min., 268, 1747. Magnesia [= Manganese] parva cum portione martis et jovis mixta, Wolfram (fr. Altenberg), *Cronst.*, Min., 107, 1758. Wolfram = TUNGSTIC ACID, Iron, and Mang., *d'Elhuyar*, Chem. Zergl. Wolframs., 1785. Tungstate of Iron and Manganese. Scheelin ferrugìné *H.*, Tr., 4, 1801. Wolframit *Breith.*, Char., 227, 1832.

813. **Hübnerite.** *E. Riotte*, Reese River (Cal.) Reveille, 1865; *H. Credner*, in B. H. Ztg., **24**, 370, 1865. Manganowolframit *Weisb.*, Synops. Min., 40, 1875.
Megabasit *Breith.*, B. H. Ztg., **11**, 189, 1852. Blumit *Breith.*, *K. L.T. Liebe*, Jb. Min., 652, 1863.

Monoclinic. Axes $\grave{a} : \overset{\mid}{b} : \grave{c} = 0·83000 : 1 : 0·86781$; $\beta = 89° 21·6′ = 001 \wedge 100$ Des Cloizeaux[1].

$100 \wedge 110 = 39° 41\tfrac{1}{2}′$, $001 \wedge 101 = 45° 56\tfrac{1}{2}′$, $001 \wedge 011 = 40° 57′$.

**Forms**[2]:
$a$ (100, $i\text{-}\bar{\imath}$)
$b$ (010, $i\text{-}\grave{\imath}$)
$c$ (001, $O$)
$n$ (810, $i\text{-}\bar{8}$)[5]
$h$ (310, $i\text{-}\bar{3}$)[6]
$l$ (210, $i\text{-}\bar{2}$)
$q$ (830, $i\text{-}\bar{\tfrac{8}{3}}$)[9]

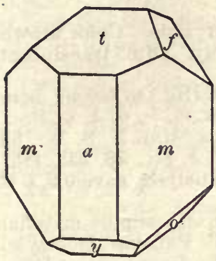
$m$ (110, $I$)
$r$ (120, $i\text{-}\grave{2}$)
$u$ (104, $-\tfrac{1}{4}\text{-}\bar{\imath}$)[4]
$g$ (103, $-\tfrac{1}{3}\text{-}\bar{\imath}$)[4]
$t$ (102, $-\tfrac{1}{2}\text{-}\bar{\imath}$)
$x$ (101, $-1\text{-}\bar{\imath}$)[6]
$\gamma$ ($\bar{1}·0·11$, $\tfrac{1}{11}\text{-}\bar{\imath}$)[5]

$y$ ($\bar{1}02$, $\tfrac{1}{2}\text{-}\bar{\imath}$)
$\lambda$ ($\bar{1}01$, $1\text{-}\bar{\imath}$)[5]
$\delta$ ($\bar{3}04$, $\tfrac{3}{4}\text{-}\bar{\imath}$)[5]
$\beta$ ($\bar{4}03$, $\tfrac{4}{3}\text{-}\bar{\imath}$)[6]
$\zeta$ ($\bar{5}02$, $\tfrac{5}{2}\text{-}\bar{\imath}$)[6]
$k$ (023, $\tfrac{2}{3}\text{-}\grave{\imath}$) as tw. pl.
$f$ (011, $1\text{-}\grave{\imath}$)

$\phi$ (095, $\tfrac{9}{5}\text{-}\grave{\imath}$)
$w$ (021, $2\text{-}\grave{\imath}$)
$z$ (113, $-\tfrac{1}{3}$)[8]
$\Delta$ (112, $-\tfrac{1}{2}$)[9]
$\omega$ (111, $-1$)
$e$ ($\bar{1}12$, $\tfrac{1}{2}$)
$o$ ($\bar{1}11$, 1)

$\psi$ ($\bar{5}52$, $\tfrac{5}{2}$)[6]
$\kappa$ (211, $-2\text{-}\bar{2}$)[7]
$\tau$ (321, $-3\text{-}\bar{\tfrac{3}{2}}$)[7]
$d$ ($\bar{2}11$, $2\text{-}\bar{2}$)
$\sigma$ (121, $-2\text{-}\grave{2}$)
$s$ ($\bar{1}21$, $2\text{-}\grave{2}$)
$\alpha$ ($\bar{1}32$, $\tfrac{3}{2}\text{-}\grave{3}$)[6]

1.



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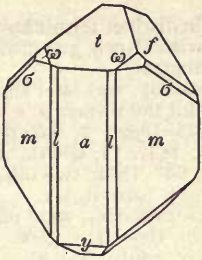

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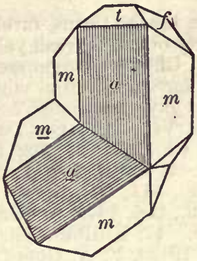

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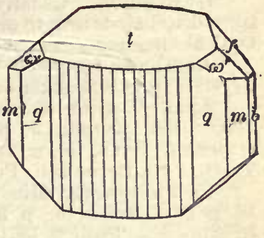


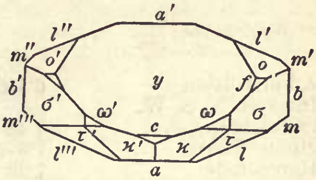
Figs. 1–3, *Wolframite*, 1, 2, Zinnwald. 3, Zinnwald, Rose. 4, *Hübnerite*, Silverton, Col. (anal. 20), Pfd.

$hh''' = 30° 56'$
$ll''' = 45° 4\frac{1}{2}'$
$mm''' = 79° 23'$
$rr' = 62° 8'$
$at = 61° 54'$
$ax = 43° 25'$
$a'y = 62° 54'$
$ty = 55° 12'$
$kk' = 60° 6'$
$ff' = *81° 54'$
$ww = 120° 6'$

$m\varDelta = 55° 28'$
$m\omega = 36° 11'$
$mc = 89° 31'$
$m'e = 56° 9'$
$m'o = 36° 31\frac{1}{2}'$
$a\omega = 51° 24'$
$af = *89° 31'$
$a'o = *52° 0'$
$a'd = 32° 29'$
$a'e = 68° 52'$

$\varDelta\varDelta' = 41° 53'$
$\omega\omega' = 61° 38'$
$ee' = 42° 14\frac{1}{2}'$
$oo' = 62° 11\frac{1}{2}'$
$dd' = 41° 13'$
$\sigma\sigma' = 100° 3'$
$ss' = 100° 41'$
$ft = 58° 19'$
$mt = 56° 1'$
$m'y = 70° 41'$

5.



*Wolframite*, Sierra Almagrera, after Slg.

For hübnerite from Silverton, Colorado (f. 4 and anal. 20) Penfield calculates (priv. contr.):

$$\grave{a} : \bar{b} : \grave{c} = 0{\cdot}83623 : 1 : 0{\cdot}86684; \qquad \beta = 89° 7\tfrac{1}{2}'.$$

Angles: $mm' = *100° 12'$, $bf = *49° 5'$, $bm' = *65° 43'$.

Twins: (1) tw. axis $\grave{c}$ with $a$ as comp.-face; (2) tw. pl. $k$ (023) Rose, f. 3. Crystals commonly tabular ∥ $a$; also prismatic with $a$ $b$ $d$, or $l$ $b$ $c$. Faces in prismatic zone vertically striated. Often in bladed crystals; also irregular lamellar; coarse divergent columnar; massive granular, the particles strongly coherent.

Cleavage: $b$ very perfect; also parting sometimes observed ∥ $a$, and ∥ $t$ (102) (Dx.). Fracture uneven. Brittle. H. = 5–5·5. G. = 7·2–7·5. Luster submetallic; metallic-adamantine; resinous. Color dark grayish or brownish black, brownish red, hair-brown. Streak nearly black to dark reddish brown; yellowish brown; greenish gray. Opaque or sometimes translucent. Sometimes weakly magnetic.

For *hübnerite*, ax. pl. and $Bx_o \perp b$. $Bx_{a.y} \wedge \grave{c} = 17° 39\frac{1}{2}'$ Na. Measurements (approx.) on artif. cryst.:

$2H_{a.r} = 93°$  $2H_{o.r} = 141°$  $2V_r = 75°$ (Li) Groth & Arzruni[8]

Hübnerite from Colorado, with extinction-angle = 17°, is pleochroic (Pfd.[9]) with 𝔠 green, 𝔟 yellowish brown. The color varies in the same section presumably from variation in amount of FeO.

**Comp., Var.**—Tungstate of iron and manganese $(Fe,Mn)WO_4$. In WOLFRAMITE Fe : Mn = chiefly 4 : 1 and 2 : 3, but varying from 9 : 1 to 2 : 3. HÜBNERITE is nearly pure $MnWO_4$.

The percentage composition for the pure tungstates, and the compounds in various ratios between them, is as follows:

| FeO : MnO | $WO_3$ | FeO | MnO | | |
|---|---|---|---|---|---|
| 1 : 0 | 76·3 | 23·7 | — | = | 100 |
| 5 : 1 | 76·4 | 19·7 | 3·9 | = | 100 |
| 4 : 1 | 76·4 | 18·9 | 4·7 | = | 100 |
| 1 : 1 | 76·4 | 11·9 | 11·7 | = | 100 |
| 2 : 3 | 76·5 | 9·5 | 14·0 | = | 100 |
| 0 : 1 | 76·6 | — | 23·4 | = | 100 |

**Wolframite.** Often in crystals as above described. Color and streak nearly black. Opaque Chiefly ferrous tungstate.

**Hübnerite.** Usually in bladed forms, rarely in distinct terminated crystals. Color brownish red to hair-brown to nearly black. Streak yellowish brown, greenish gray. Often translucent. Optical characters as above. Chiefly manganese tungstate.

*Megabasite*, supposed to have a different composition, was later shown (Rg.) to belong here. Crystals from Schlackenwald gave Groth and Arzruni the forms: *a*, *b*, *c*, *n*, *m*, *γ*, *δ*, *λ*, *ω*, *d*.

**Anal.**—1, Beck & Teich, Vh., Min. Ges., **4**, 314, 1869. 2, Liversidge, Min. N. S. W., 85, 1888. 3–6, Kerndt, J. pr. Ch., **42**, 81, 102, 105, 1847. 7, Genth, Am. J. Sc., **28**, 253, 1857. 8, Beck & Teich, ib., p. 317. 9, Carnot, C. R., **79**, 637, 1874; two other analyses gave 0·9, 0·95 $Ta_2O_5$. 10, Bernouilli, Pogg., **111**, 603, 1860. 11–14, Kerndt, l. c.

15, Philipp, Rg. Min. Ch., 286, 1875, earlier analyses (Rg.) were made on less pure material. 16, Beck & Teich, ib., p. 315. 17, Kulibin, Vh. Min. Ges., 3, 1, 1868. 18, Pflücker, Domeyko, 3d App. Min. Chili, 9, 1871. 19–22, F. A. Genth, priv. contr.; the hübnerite from Cement Creek has also been analyzed by H. F. Keller, J. Frankl. Inst., **128**, 153, 1889. 23, W. F. Hillebrand, Am. J. Sc., **27**, 357, 1884. 24, A. H. Low, ibid., p 358. See further Kerndt, Schaffgotsch, l. c., also 5th Ed., pp. 602–605.

| | | G. | $WO_3$ | FeO | MnO | CaO | |
|---|---|---|---|---|---|---|---|
| | *Wolframite.* | | | | | | |
| 1. | Adun–Chalon | 6·405 | $\frac{4}{4}$ 75·55 | 21·31 | 2·37 | 0·26 | MgO 0·51 = 100 |
| 2. | Inverell, N. S. W. | | 77·64 | 18·76 | 4·12 | — | = 100·52 |
| 3. | Chanteloup | 7·48–7·51 | 75·83 | 19·32 | 4·84 | — | = 99·99 |
| 4. | Monte Video | 7·5–7·51 | 76·02 | 19·21 | 4·75 | — | = 99·98 |
| 5. | Harzgerode | 7·23 | 75·90 | 19·25 | 4·80 | — | = 99·95 |
| 6. | Ehrenfriedersdorf | 7·50 | 75·88 | 19·16 | 4·96 | — | = 100 |
| 7. | Flowe Mt., N. C. | 7·50 | 75·79 | 19·80 | 5·35 | 0·32 | $SnO_2$ *tr.* = 101·26 |
| 8. | Altai | 6·968 | $\frac{2}{2}$ 75·56 | 16·22 | 8·42 | — | = 100·20 |
| 9. | Meymac | 6·54? | 74·25 | 15·85 | 6·51 | 0·80 | MgO 0·04, $Ta_2O_5$ 1·10, $H_2O$ 0·70 = 99·25 |
| 10 | Traversella | | 75·99 | 16·29 | 3·45 | 4·03 | = 99·76 |
| 11. | Altenberg | 7·19 | 75·44 | 9·64 | 14·90 | — | = 99·98 |
| 12. | Schlackenwald | 7·48–7·54 | 75·68 | 9·56 | 14·30 | — | = 99·54 |
| 13. | Monroe, Ct. | 7·41–7·49 | 75 47 | 9·53 | 14·26 | — | = 99 26 |
| 14. | Zinnwald | 7·22 | 76·34 | 9·61 | 14·21 | — | = 100·16 |
| | *Hübnerite.* | | | | | | |
| 15. | Schlackenwald *Megabasite* | | 73·60 | 3·74 | 22·24 | — | = 99·58 |
| 16. | Bayevka, Ural | 7·267 | 76·61 | 4·64 | 18·59 | 0·17 | MgO 0·20=100·21 |
| 17. | " " | 7·357 | 74·32 | 2·11 | 20·90 | 1·30 | $SiO_2$ 0·28 = 98·91 |
| 18. | Morochocha | | 75·12 | 1·42 | 23·21 | — | = |
| 19. | Bonita Mt., N. M. | | 76·33 | 3·82 | 19·72 | 0·13 | MgO *tr.* = 100 |
| 20. | N. Star M., Silverton | 6·713 | 74·75 | 2·91 | 21·93 | 0·11 | MgO *tr.* = 99·70 |
| 21. | Cement Cr., Silverton | 6·891 | 76·63 | 1·61 | 21·78 | 0·09 | MgO *tr.* = 100·11 |
| 22. | Nye Co., Nevada | | 74·88 | 0·56 | 23·87 | 0·14 | MgO 0·08, Cu 0·08=99·61 |
| 23. | Ouray Co., Col. | 7·177 | 75·58 | 0·24 | 23·40 | 0·13 | $SiO_2$0·62, $Nb_2O_5$0·05? = 100·02 |
| 24. | Phillipsburg, Mont. | | 74·82 | 0·06 | 25·00 | — | = 99·88 |

**Pyr., etc.**—Wolframite fuses B.B. easily (F. = 2·5–3) to a globule, which has a crystalline surface and is magnetic. With salt of phosphorus gives a clear reddish yellow glass while hot, which is paler on cooling; in R.F. becomes dark red; on charcoal with tin, if not too saturated, the bead assumes on cooling a green color, which continued treatment in R.F. changes to reddish yellow. With soda and niter on platinum foil fuses to a bluish green manganate. Decomposed by aqua regia with separation of tungstic acid as a yellow powder, which, when treated B.B., reacts as under tungstite (p. 202). Wolframite is sufficiently decomposed by concentrated sulphuric acid, or even hydrochloric acid, to give a colorless solution, which, treated with metallic zinc, becomes intensely blue, but soon bleaches on dilution.

Hübnerite is less fusible than wolframite and gives a strong manganese reaction.

**Obs.**—Wolframite is often associated with tin ores; also in quartz, with native bismuth, scheelite, pyrite, galena, sphalerite, etc. It occurs in fine crystals at Schlackenwald, Schneeberg, Geyer, Freiberg, Altenberg, Ehrenfriedersdorf, Zinnwald, and Nerchinsk, and other places mentioned above; at Chanteloup, near Limoges, in France; near Redruth and elsewhere in Cornwall with tin ores; in Cumberland (the ratio 2 : 3 at Lochfells, that of 4 : 1 at Godolphin's Ball); on the Island of Rona, one of the Hebrides; in the auriferous sand of the Wicklow rivers, Ireland, with tin. Also in S. America, at Oruro in Bolivia. With tin stone at various points in New England, New South Wales; in quartz veins at Inverell and elsewhere in Gough Co.

In the U. States it occurs at Lane's mine, Monroe, Conn., in quartz, associated with native bismuth and the other minerals above mentioned, often pseudomorphous after scheelite; in small quantities at Trumbull, Conn., at the topaz vein; massive and in crystals on Camdage farm, near Blue Hill Bay, Me.; at the Flowe mine, Mecklenburg Co., N. C., with scheelite; in Missouri, near Mine la Motte, and in St. Francis Co., 1½ m. from St. Francis River; in a gneiss boulder on the W. shore of Chief Island, L. Couchiching, Ontario.

The original hübnerite was from the Erie and Enterprise veins, in Mammoth dist., Nevada, in a vein 3–4 feet wide in argillyte, with scheelite, fluorite, and apatite. Occurs also in quartz of the Royal Albert vein, Uncompahgre district, Ouray County, Col.; at the North Star mine, Sultan Mt., and Cement Creek, Bonita Mt., both near Silverton, San Juan Co. At Phillipsburg, Montana; at the Comstock mine, Black Hills, S. Dakota; Bonita Mt., near White Oaks, Lincoln Co., New Mexico.

Also found in Peru, Morococha, province of Tarma, and in rhodochrosite with friedelite and alabandite at Adervielle in the Pyrenees. The original megabasite was from Schlackenwald.

**Alt.**—Wolframite occurs altered to scheelite by a substitution of calcium for iron; the opposite exchange is more common, and wolframite pseudomorphs after scheelite are often met with.

**Ref.**—[1] Ann. Ch. Phys., **19**, 168, 1870. Krenner gives for Ehrenfriedersdorf 0·82447 : 1 : 0·86041, $\beta = 89° 39' 38''$, Min. Mitth., p. 9, 1875. Seligmann, for Sierra Almagrera (FeO 19·95, MnO 3·15 Doelter) 0·82144 : 1 : 0·87111, $\beta = 89° 34'$, Zs. Kr., **11**, 347, 1886. The species was formerly regarded as orthorhombic; its monoclinic character was first suggested in 1850, Dx., ib., **28**, 163. See also Rose, Pogg., **64**, 171, 1845 (relation to columbite), Kerndt, l. c., and Groth and Arzruni for measurements of artif. $FeWO_4$, $MnWO_4$, etc., Pogg., **149**, 237, 1873.

[2] Dx., l. c., 1850 and 1870. [3] Mlr., Min., 473, 1852. [4] Eremeyev, Vh. Min. Ges., **17**, 301 1872. [5] Groth and Arzruni, on megabasite, l. c. [6] Knr., Felsöbánya, l. c. [7] Slg., Sierra Almagrera, Spain, l. c. [8] L. c., cf. also Dx., Bull. Soc. Min., **5**, 105, 1882. [9] Pfd., priv. contr., N. Star mine, Silverton, Colorado.

Ferberite. Ferberit *K. L. T. Liebe,* Jb. Min., 641, 1863, attributing the name to Breithaupt. Ferrowolframit *Weisb.*, Synops. Min., 43, 1875.

Monoclinic. Axes $\grave{a} : \bar{b} : \dot{c} = 0·8229 : 1 : 0·8462$, assuming $\beta = 89° 22'$ as with wolframite Forms on artif. cryst. ($FeWO_4$) : *a* (100, $i$-$\bar{i}$), *b* (010, $i$-$\grave{i}$); *m* (110, *I*), *g* (120, $i$-$\grave{2}$); *d* (102, $-\frac{1}{2}$-$\bar{i}$) *e* (011, 1-$\grave{i}$); *π* (111, 1). Angles: $mm''' = 78° 53'$, $gg' = 62° 34'$, $cd = 27° 5'$, $ce = 40° 14'$. See Groth and Arzruni, Pogg., **149**, 237, 1873.

The original "ferberite" was massive, granular, with some imperfect planes of crystallization. Cleavage: *b* perfect. H. = 4–4·5. G. = 6·801 Breith.; 7·109 Rg. Luster imperfectly vitreous, a little submetallic-adamantine. Color black. Streak brownish black to blackish brown. Opaque.

Composition of artif. cryst., ferrous tungstate, $FeWO_4$ = Tungsten trioxide 76·3, iron protoxide 23·7 = 100. A little manganese is also present.

Analyses of "ferberite" from Spain: 1. Liebe, l. c., deducting 1·39 limonite (Rg.). 2, Rg., Ber. Ak. Berlin, 175, 1864, and J. pr. Ch., **92**, 263, 1864.

| | $WO_3$ | $SnO_2$ | FeO | MnO | MgO | CaO | |
|---|---|---|---|---|---|---|---|
| 1. Spain | 70·11 | 0·14 | 23·29 | 3·02 | 0·42 | 1·75 | $Al_2O_3$ 1·17 = 99·90 |
| 2. " | [69·27][a] | 0·16 | 26·00 | 3·00 | — | 1·57 | = 100 |

[a] Direct determinations, 69·49–69·88.

These analyses do not conform to $FeWO_4$, rather to $2FeWO_4 + FeO$ or $3FeWO_4 + FeO$; further note that a "ferberite" stated to come from Sierra Almagrera proved (as described by Seligmann, ref., above) to be wolframite with Fe : Mn = 5 : 1. The existence of the pure $FeWO_4$ in nature is hence not proved, though made artificially. The original ferberite was from the Sierra Almagrera in southern Spain, in argillaceous schist, with quartz. Named after R Ferber of Gera.

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## **Scheelite Group.** Tetragonal.

**814. SCHEELITE.** Tennspat. Lapides stanniferi spathacei "lik en huit spat" (fr. Bohemia), *Wall.*, Min., 303, 1747. Not Tungsten von Bastnaes [= Cerite] *Cronst.*, Ak. H. Stockh., 1751, Min., 183, 1758. Stannum spathosum subdiaphanum album *Linn.*, Syst., 1768. Tungsten (= Tungstic Acid and Lime) *Scheele,* Ak. H. Stockh., 1781. Schwerstein *Wern.*, Bergm. J., 386, 1789; *Karst.*, Tab., 26, 1791. Scheelerz *Karst.*, Tab., 56, 1800, 74, 1808. Tungstate of Lime. Tungstein. Scheelin calcaire *H.*, Tr., **4**, 1801. Scheelspath *Breith.*, Char., 23, 1820. Scheelit *Leonh.*, Handb., 594, 1821.

Tetragonal; with pyramidal hemihedrism. Axis $\dot{c} = 1·5356$; $001 \wedge 101 = 56° 55\frac{3}{4}'$ Dauber[1].

**Forms**[2]:
*c* (001, *O*)

*a* (100, *i*-*i*)
*m* (110, *I*)
*r* (430, *i*-$\frac{4}{3}$)
*q*, (120, *i*-2)

*d* (105, $\frac{1}{5}$-*i*)
*z* (205, $\frac{2}{5}$-*i*)[4]
*o* (102, $\frac{1}{2}$-*i*)
*γ* (708, $\frac{7}{8}$-*i*)[3]
*e* (101, 1-*i*)

*f* (114, $\frac{1}{4}$)

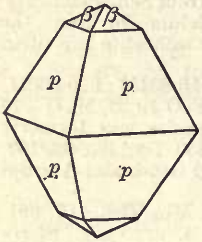
*β* (113, $\frac{1}{3}$)
*v* (112, $\frac{1}{2}$)
*p* (111, 1)

*x* (416, $\frac{2}{3}$-4)
*s* (311, 3-3)

*l* (12·1·12, 1-12)
*k* (515, 1-5)
*i* (414, 1-4)
*h* (313, 1-3)
*g* (212, 1-2)
*δ*, (121, 2-2)[5]
*s*, (131, 3-3)

*g*, (122, 1-2)
*y*, (135, $\frac{3}{5}$-3)
*h*, (133, 1-3)
*w*, (153, $\frac{5}{3}$-5)
*t*, (142, 2-4)[2]

1.



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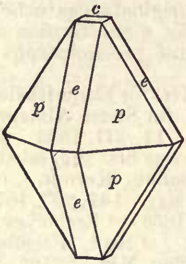

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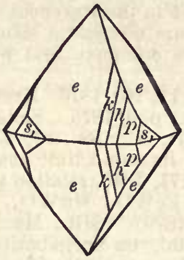

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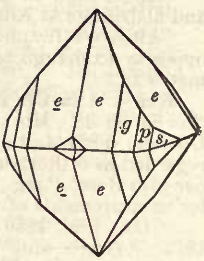

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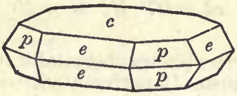

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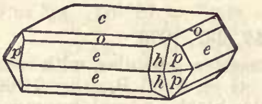

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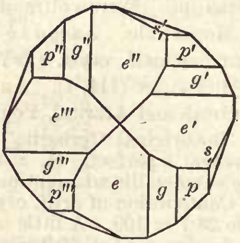


Figs. 1, Traversella, Bauer. 2, Trumbull, Conn. 3, 7, Schlackenwald, Bauer. 4, 5, 6, Zinnwald, Id.

*dd′* = 23° 58′
*zz′* = 43° 26½′
*oo′* = 51° 1′
*ee′* = 72° 40½′

*ff′* = 39° 26′
*ββ′* = 48° 59½′
*vv′* = 62° 41′
*pp′* = 79° 55½′
*ep* = 39° 58′

*co* = 37° 31′
*ce* = 56° 56′
*dd″* = 34° 9′
*zz″* = 63° 7′
*oo″* = 75° 2′

*ee″* = 113° 51′

*cp* = 65° 16½′
*ff″* = 57° 0′
*ββ″* = 71° 48′
*vv″* = 94° 43′
*pp″* = 130° 33′
$pp^{iv}$ = *49° 27′

*cs*, = 78° 22′
*cg* = 59° 47′
*ch* = 58° 17½′
*ci* = 57° 43′
*ck* = 57° 26′
$s_{,}s_{,}^{iv}$ = 23° 16′
$gg^{iv}$ = 60° 26′

$hh^{iv}$ = 63° 25′
$ii^{iv}$ = 64° 34′
$kk^{iv}$ = 65° 7′

*el* = 3° 59½′
*ek* = 9° 31′
*ei* = 11° 50′
*eh* = 15° 36′
*eg* = 22° 44′
*ep* = 39° 58′
*es*, = 68° 18½′

*ps*, = 28° 21′
*pg* = 17° 14′
*ph* = 24° 22′
*pi* = 28° 8′

*pk* = 30° 27′
*pl* = 35° 59′

*e′w*, = 15° 44′
*e′t*, = 20° 1′
*e′s*, = 27° 17′

*a′t*, = 22° 19′
*a′g*, = 39° 23′
*a′v* = 58° 39′

*ss*, = 51° 57′
*hh*, = 41° 40′
*ss*,‴ = 6° 56′
*hh*,‴ = 31° 13′

Twins: (1) tw. pl. *a*, both contact- and penetration-twins; the comp.-face usually *a*, also *c*. Habit octahedral, *e* predominating, also with *p*; again tabular ‖ *c*. Faces *c* rough; *e* striated ‖ edge *e*/*s*,; in the twins a feather-like striation meeting in a medial line. Also reniform with columnar structure; and massive granular.

Cleavage: *p* (111) most distinct; *e* (101) interrupted. Fracture uneven. Brittle. H. = 4·5–5. G. = 5·9–6·1; 6·059 Beauce Co., Quebec, Ferrier. Luster vitreous, inclining to adamantine. Color white, yellowish white, pale yellow, brownish, greenish, reddish; sometimes almost orange-yellow. Streak white. Transparent to translucent. Optically +. Indices:

$$\omega = 1{\cdot}918\text{–}1{\cdot}919 \qquad \epsilon = 1{\cdot}934\text{–}1{\cdot}935 \text{ red, Dx.}$$

**Comp.**—Calcium tungstate, $CaWO_4$ = Tungsten trioxide 80·6, lime 19·4 = 100.

Molybdenum is usually present and may replace a considerable part of the tungsten (cf. below). Copper replaces calcium, see cuproscheelite (p. 988). Didymium (Ce,La) may be present, a section of the mineral showing strong absorption bands (Cossa). Carnot found 0·4 p. c. $Ta_2O_5$ in scheelite from Meymac, Corrèze, C. R., **79**, 637, 1874.

Analyses, 5th Ed., p. 505. R. A. A. Johnston obtained for the crystallized scheelite of Beauce Co., Quebec:

G. = 6·059 Ferrier $WO_3$ 79·90 CaO 19·37 $SiO_2$ 0·29 $Fe_2O_3$ 0·70 = 100·26

Traube (Jb. Min., Beil. Bd., **7**, 232, 1890) has shown that molybdenum is usually present in scheelite, and sometimes replaces a considerable part of the tungsten. The white and light yellow varieties contain the least, and the dark colored the most; the amount varies widely even in crystals from the same locality. The presence of the molybdenum probably exerts an important influence upon the angles of the species, cf. ref. [1].

The following are Traube's analyses:

| | | G. | $WO_3$ | $MoO_3$ | CaO | | |
|---|---|---|---|---|---|---|---|
| 1. | Zinnwald, *red brn., cryst.* | 5·88 | 71·08 | 8·23 | 20·33 | | = 99·64 |
| 2. | “ *yw. brn.* “ | 6·03 | 75·29 | 3·98 | 20·34 | | = 99·61 |
| 3. | “ *light yw.* “ | 6·01 | 76·78 | 3·69 | 19·86 | | = 100·33 |
| 4. | “ *light yw. brn., cryst.* | 6·03 | 77·84 | 2·23 | 19·48 | | = 99·55 |
| 5. | “ *gr. wh., mass.* | 6·06 | 78·04 | 1·92 | 19·57 | | = 99·53 |
| 6. | Altenberg, *gr. wh., cryst.* | 6·07 | 77·54 | 2·03 | 19·91 | | = 99·48 |
| 7. | Schwarzenberg, *wh., kernel* | 6·12[b] | 79·94 | *tr.* | 19·57 | MgO *tr.* | = 99·51 |
| 8. | “ *yw. brn., shell* | 6·02[b] | 80·17 | 0·07 | 19·49 | MgO *tr.* | = 99·83 |
| 9. | Schlackenwald, *wh., cr. mass.* | 6·13 | 79·76 | *tr.* | 19·67 | | = 99·43 |
| 10. | Haslithal, *transp. cryst.* | 6·14 | 80·16 | *tr.* | 19·65 | | = 99·81 |
| 11. | Traversella, *yw. gray, cryst.* | 6·06 | 78·57 | 1·62 | 19·37 | $Ce_2O_3$[a] *tr.* | = 99·56 |
| 12. | “ *honey-yw.,* “ | 6·04 | 79·68 | 0·76 | 19·29 | $Ce_2O_3$[a] *tr.* | = 99·73 |
| 13. | Carrock Fells, *yw. wh., mass.* | 6·01 | 79·97 | 0·35 | 19·27 | | = 99·59 |
| 14. | Pot M., S. Africa, *gray, mass.* | 5·96 | 70·56 | 8·09 | 20·05 | CuO 0·34 | = 99·04 |
| 15. | “ “ “ “ | | 71·59 | 7·63 | 20·51 | | = 99·73 |
| 16. | Mt. Ramsay, Tasmania | 6·09 | 79·77 | *tr.* | 19·65 | | = 99·42 |
| 17. | New Zealand | 6·01 | 80·29 | *tr.* | 19·44 | | = 99·73 |

[a] $(Ce,Di,La)_2O_3$. [b] By Frenzel.

Molybdenum is also present in the scheelite of Yxsjö, Igelström, G. För. Förh., **13**, 122, 1891.

**Pyr., etc.**—B.B. in the forceps fuses at 5 to a semi-transparent glass. Soluble with borax to a transparent glass, which afterward becomes opaque and crystalline. With salt of phosphorus forms a glass, colorless in outer flame, in inner green when hot, and fine blue when cold; varieties containing iron require to be treated on charcoal with tin before the blue color appears. In hydrochloric or nitric acid decomposed, leaving a yellow powder soluble in ammonia.

**Obs.**—Scheelite is usually associated with crystalline rocks, and is commonly found in connection with cassiterite, topaz, fluorite, apatite, molybdenite, or wolframite, in quartz; also associated with gold.

Occurs at Schlackenwald and Zinnwald in Bohemia, Altenberg in Saxony, and Fürstenberg near Schwarzenberg; from Riesengrund in the Riesengebirge; the Knappenwand in the Untersulzbachthal, Tyrol, and the Krimlerthal; the Kammegg near Gutannen in the Bernese Oberland; in fine crystals at Carrock Fells in Cumberland, with apatite, molybdenite, and wolframite. Also at Schellgaden in Salzburg; from the Meiseberg near Neudorf in the Harz; Ehrenfriedersdorf in Saxony; Pösing in Hungary; Traversella in Piedmont, in fine crystals, sometimes transparent, also very large (1 pound); and in the Val Toppa gold-mine, near Domo d'Ossola, Piedmont; Meymac, Corrèze, France (containing $Ta_2O_5$); Dalecarlia and Bitsberg in Sweden; Pitkäranta in Finland at the tin mines (G. = 6·084); Framont in the Vosges, with pyrite in polished crystals, often twins; at the copper mines of Llamuco, near Chuapa in Chili, of a reddish-gray color, mixed with green, due to chrysocolla.

In New South Wales, at Adelong, from a gold mine. New Zealand, massive; Mt. Ramsay, Tasmania, with cassiterite; at the Pot mine, in south-western Africa.

In the U. States, crystallized and massive at Lane's Mine, Monroe, and at Huntington, Conn., with wolframite, pyrite, rutile, and native bismuth, in quartz; at Trumbull, sometimes in large crystals an inch or more in length, often partly altered to wolframite; the crystals are embedded in quartz. Also at Chesterfield, Mass., in albite, with tourmaline; at Bangle mine, in Cabarrus Co., N. C.; and Flowe mine, Mecklenburg Co., some crystals at the latter locality having a nucleus of wolframite; in the Mammoth mining district, Nevada; with gold at the Charity mine, Warren's, Idaho; at Murray, Idaho, on the west slope of Cœur d'Alène Mts.; also at the Golden Queen mine, Lake Co., Colorado.

Fine crystals of scheelite, some over two inches long, occur, with pulverulent tungstite, in quartz veins cutting the slates and sandstones of the lower Cambrian or gold-bearing series in the townships of Risborough and Marlow, Beauce County, Quebec; the associated minerals are argentiferous galena, sphalerite, pyrite, chalcopyrite, etc. (Ferrier).

Tungstic acid was discovered in this species by the Swedish chemist Scheele, in 1781. The word *tungsten*, first used by Cronstedt, is Swedish for *heavy stone*.

**Alt.**—Occurs altered to wolframite, tungstate of iron and manganese, by the action of a solution of bicarbonate of iron and manganese, or perhaps mainly through sulphate of iron arising from the decomposition of pyrite; crystals more or less altered to wolframite are common at many localities. Also to kaolinite (Ehrenfriedersdorf).

**Ref.**—[1] Pogg., **107**, 272, 1859; confirmed by Rg., Zs. G. Ges., **19**, 493, 1867, also by Bauer. Traube (l. c.), in discussing the presence of molybdenum in scheelite, obtains the value *ee'* = 72° 36½' and $\dot{c} = 1{\cdot}5315$, for pure scheelite from Schwarzenberg and Riesengrund, containing only a trace of $MoO_3$. He also gives the following table, reproducing the results of the authors named; to these the value for powellite (p. 989) is added.

| | $\dot{c}$ | | $\dot{c}$ |
|---|---|---|---|
| Schwarzenberg<br>Riesengrund | 1·5315 Traube | Zinnwald<br>Neudorf | 1·5355 Dbr. (Mean result.) |
| Neudorf | 1·5329 Dbr. | Traversella | 1·5364 Rath |
| Zinnwald | 1·5354 Dbr. | Powellite | 1·5445 Melville |
| Neudorf | 1·5349 Dbr. | $CaMoO_4$ | 1·5458 Hiortdahl[6] |
| Krimlerthal | 1·5349 Zeph. | | |

[2] Bauer, who gives a monograph for the species, with many figures, calculated angles, adding 13 new forms, Jahr. Ver. Württ., 129, 1871. [3] Groth, Riesengrund, Min.-Samml. Strassb., 157, 1868. [4] Rath, Traversella, Ber. nied. Ges., Dec. 4, 1882, and Zs. Kr., **8**, 298, 1883. [5] Zeph., Krimlerthal, Lotos, 1885. [6] On the form of $CaMoO_4$, $SrMoO_4$, $BaMoO_4$, see Hiortdahl Zs. Kr., **12**, 411, 1887.

**815. CUPROTUNGSTITE.** Cuproscheelite *J. D. Whitney*, Proc. Cal. Acad., 3, 287, 1866. Tungstate de cuivre, *Domeyko*, Ann. Mines, **16**, 537, 1869. Cuprotungstite *Adam*, Tableau Min., p. 32, 1869.

Crystalline-granular. Also in crusts.

Cleavage distinct in one direction. H. = 4·5–5. Luster highly vitreous. Color pistachio-green, passing to olive- and leek-green. Streak light greenish gray to greenish yellow.

**Comp.**—Tungstate of copper, $CuWO_4$; also tungstate of copper and calcium, $(Ca,Cu)WO_4$.

**Anal.**—1, Domeyko, Ann. Mines, **16**, 537, 1869. 2, Whitney, l. c. 3, Domeyko, l. c. 4, Id., ibid., 3, 15, 1843.

| | $WO_3$ | CuO | CaO |
|---|---|---|---|
| 1. Chili, *Cuprotungstite* | 56·48 | 30·63 | 2·00 $Fe_2O_3$ 2·53, $SiO_2$ 3·87, $H_2O$ 4·62 = 100·13 |
| 2. La Paz., *Cuproscheelite* | 79·69 | 6·77 | 10·95 FeO 0·31, $H_2O$ 1·40 = 99·12 |
| 3. Chili " | [76·00] | 5·10 | 15·25 $Fe_2O_3$ 1·55, $SiO_2$ 0·40, $H_2O$ 1·70 = 100 |
| 4. " " | 75·75 | 3·30 | 18·05 $SiO_2$ 0·75 = 97·85 |

**Pyr., etc.**—In the closed tube blackens, and gives off water. B.B. fuses to a black glass, and colors the flame an intense green. On charcoal blackens, fuses with a little intumescence, forming finally a slag containing minute particles of metallic copper. With fluxes gives reactions for tungsten and copper. Easily soluble in hydrochloric acid, tungsten trioxide being separated from the solution.

**Obs.**—Cuprotungstite is from the copper mines of Llamuco, near Santiago, Chili, and is stated to envelop kernels of cuproscheelite. Ordinary scheelite is said to occur also, and the cupreous varieties may be the result of alteration. The original cuproscheelite was from the vicinity of La Paz, Lower California, in a red metamorphic rock, associated with black tourmaline. Also mentioned by Traube (l. c., p. 241) as enveloping the scheelite from the Pot mine, southwestern Africa.

**816. POWELLITE.** *W. H. Melville*, Am. J. Sc., **41**, 138, 1891.

Tetragonal. Axis $\dot{c}$ = 1·5445; 001 ∧ 101 = 57° $4\frac{2}{3}'$ Melville.

In minute octahedral crystals with *c* (001, *O*), *e* (101, 1-*i*), *p* (111, 1).

Angles: $ee'$ = 72° 49′, $ee''$ = 114° 9′, $pp'$ = 80° 1′, $pp''$ = 130° 48′, $pp^{\text{iv}}$ = *49° 12′.

No distinct cleavage. Fracture uneven. Brittle. H. = 3·5. G. = 4·526. Luster resinous. Color yellow with marked greenish tinge. Subtransparent.

**Comp.**—Essentially calcium molybdate, $CaMoO_4$ = Molybdenum trioxide 72·0, lime 28·0 = 100. Calcium tungstate is also present.

**Anal.**—Melville, l. c.

$MoO_3$ 58·58 $WO_3$ 10·28 CaO 25·55 $SiO_2$ 3·25 MgO 0·16 $Fe_2O_3$ 1·65 = 99·47

**Pyr., etc.**—Fuses about 5 to a gray mass. Reacts for molybdenum with salt of phosphorus, cf. scheelite. Decomposed by nitric and by hydrochloric acid.

**Obs.**—Found at the Peacock lode in the "Seven Devils" mining district in western Idaho. It is associated with an argentiferous bornite and dark brown garnet. Cf. ref.[6], p. 988.

Named for Major J. W. Powell, Director of the U. S. Geological Survey.

**817. STOLZITE.** Scheel-Bleispath *Breith.*, Char., 14, 1820. Tungstate of Lead. Bleischeelat, Wolframbleierz, Scheelsaures Blei, *Germ.* Scheelitine *Beud.*, Tr., 2, 662, 1832. Stolzit *Haid*, Handb., 504, 1845.

Tetragonal; with pyramidal hemihedrism. Axis $\dot{c}$ = 1·5667; 001 ∧ 101 = 57° 27′ Kerndt[1].

**Forms**: *c* (001, *O*); *m* (110, *I*); *e* (101, 1-*i*); *v* (112, ½), *n* (111, 1), *o* (221, 2).

Angles: $ee'$ = 73° 10′, $vv'$ = 63° 19′, $ee''$ = 114° 54′, $vv''$ = 95° 51′, $nn'$ = 80° 15′, $nn''$ = 131° 25′, $nn^{\text{iv}}$ = *48° 35′, $oo'$ = 87° 13′, $oo''$ = 154° 34′.

Habit acute octahedral. Crystals often indistinctly aggregated.

Cleavage: *c* imperfect; *n* more so. Fracture conchoidal to uneven. Brittle. H. = 2·75–3. G. = 7·87–8·13. Luster resinous, subadamantine. Color green, yellowish gray, brown, and red. Streak uncolored. Faintly translucent.

**Comp.**—Lead tungstate, $PbWO_4$ = Tungsten trioxide 51·0, lead oxide 49·0 = 100. Analyses, 5th Ed., p. 607.

1.

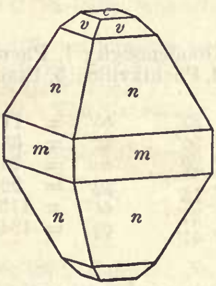


Fig. 1, Des Cloizeaux.

2.

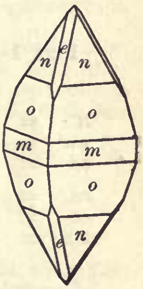


Fig. 2, Lévy.

**Pyr., etc.**—B.B. decrepitates and fuses at 2 to a crystalline, lustrous, metallic pearl. With soda on charcoal yields metallic lead. With salt of phosphorus gives in O.F. a colorless glass, which in R.F. becomes blue on cooling. Decomposed by nitric acid, leaving a yellow residue of tungsten trioxide.

**Obs.**—Stolzite occurs at Zinnwald in Bohemia, with quartz and mica; in Chili, province of Coquimbo; at Southampton, Mass.

This species was first made known, according to Breithaupt, by Dr. Stolz, of Teplitz.

**Ref.**—[1] J. pr. Ch., 42, 113, 1847, he gives $nn^{\text{iv}}$ = 48° 35′ 14″, but the seconds are of no value as the crystals did not admit of exact measurement. Lévy, Pogg. Ann., 8, 513, 1826.

**818. WULFENITE.** Plumbum spatosum flavo-rubrum, ex Annaberg Austr. *v. Born*, Lithoph., 1, 90. 1772. Kärntherischer Bleispath *v. Jacquin*, Miscell. Austr., 2, 1781, Vienna; *Wulfen*, Abhandl. K. Bleisp., Wien, 1785, fol. Plomb jaune *de Lisle*, 3, 387, 1783. Gelbbleierz *Wern.*, Bergm. J., 384, 1789. Yellow Lead-spar, Molybdenated Lead Ore, *Kirwan*, Min., 2, 212, 1796. Plomb molybdaté *H.*, Tr., 3, 353, 1801. Molybdate of Lead. Molybdänbleispath, Bleimolybdat, *Germ.* Melinose *Beud.*, Handb., 2, 664, 1832. Wulfenit *Haid.*, Handb., 504, 1841. Chromowulfenite *Schrauf*, Ber. Ak. Wien, 63 (1), 184, 1871.

Tetragonal, with pyramidal hemihedrism. Axis $\dot{c}$ = 1·57710; 001 ∧ 101 = 57° $37\frac{1}{3}'$ Dauber[1].

**Forms**[2]:
*c* (001, *O*)
*a* (100, $i\text{-}i$)
*m* (110, *I*)
*g* (310, $i\text{-}3$)
*k* (210, $i\text{-}2$)
*l* (740, $i\text{-}\frac{7}{4}$)[3]

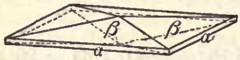
δ (530, $i\text{-}\frac{5}{8}$)[4]
*f* (320, $i\text{-}\frac{3}{2}$)
μ (430, $i\text{-}\frac{4}{3}$)
ν (650, $i\text{-}\frac{6}{5}$)
ω (1·0·264, $\frac{1}{264}\text{-}i$)$_3$
*b* (1·0·16, $\frac{1}{16}\text{-}i$)[3]
β (1·0·12, $\frac{1}{12}\text{-}i$)

*t* (103, $\frac{1}{3}\text{-}i$)
*z* (205, $\frac{2}{5}\text{-}i$)[3]
*u* (102, $\frac{1}{2}\text{-}i$)
*y* (203, $\frac{2}{3}\text{-}i$)
*e* (101, $1\text{-}i$)
*q* (302, $\frac{3}{2}\text{-}i$)

*w* (1·1·16, $\frac{1}{16}$)
*v* (118, $\frac{1}{8}$)[3]
ρ (117, $\frac{1}{7}$)[3]
*h* (229, $\frac{2}{9}$)
*s* (113, $\frac{1}{3}$)
*n* (111, 1)

*r* (332, $\frac{3}{2}$)
*d* (221, 2)
φ (7·1·75, $\frac{7}{75}\text{-}7$)?
*x* (311, 3-3)
ζ (432, $2\text{-}\frac{4}{3}$)
ψ (8·9·18, $\frac{1}{2}\text{-}\frac{9}{8}$)[3]?

1.



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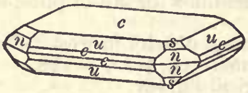

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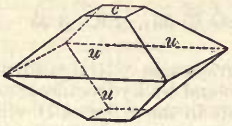

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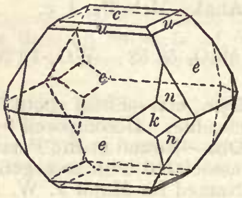

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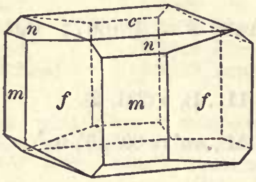
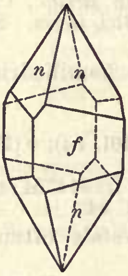


6.



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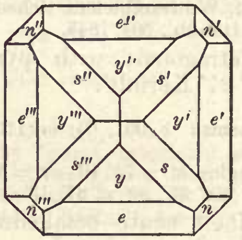

Figs. 1–5, Goodenough: 1, Phenixville; 2, 3, Red Cloud mine, Yuma Co., Arizona; 4, Phenixville; 5, Utah. 6, After Dx. 7, Bleiberg, after Haid.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *tt'* | = | 38° 25′ | *bb''* | = | 11° 15½′ | *ww'* | = | 11° 12′ | *vv''* | = | 31° 9′ |
| *uu'* | = | 51° 56′ | *tt''* | = | 55° 28′ | *ss'* | = | 49° 54′ | *ρρ''* | = | 35° 21′ |
| *ee'* | = | 73° 20′ | *uu''* | = | 76° 31′ | *nn'* | = | 80° 22′ | *ss''* | = | 73° 15½′ |
| *cu* | = | 38° 15′ | *yy''* | = | 92° 52′ | *cs* | = | 36° 38′ | *nn''* | = | *131° 42′ |
| *ce* | = | 57° 37′ | *ee''* | = | 115° 15′ | *cn* | = | 65° 51′ | *rr''* | = | 146° 43′ |
| *ωω''* | = | 0° 41′ | *qq''* | = | 134° 10′ | *ww''* | = | 15° 52′ | *dd''* | = | 154° 44′ |

Crystals commonly square tabular, sometimes extremely thin, with a vicinal pyramid replacing the basal plane; less frequently octahedral in habit; also prismatic, the prismatic faces showing the hemihedrism characteristic of the species. Also granularly massive, coarse or fine, firmly cohesive.

Cleavage: *n* (111) very smooth; *c*, *s* (113) less distinct. Fracture subconchoidal. Brittle. H. = 2·75–3. G. = 6·7–7·0. Luster resinous or adamantine. Color wax-yellow, passing into orange-yellow; also siskin- and olive-green, yellowish gray, grayish white to nearly colorless, brown; also orange to bright red. Streak white. Subtransparent to subtranslucent. Optically negative. Indices:

$$\omega = 2{\cdot}402 \qquad \epsilon = 2{\cdot}304, \text{ red, Dx.}^{5}$$

**Comp.**—Lead molybdate, PbMoO$_4$ = Molybdenum trioxide 39·3, lead oxide 60·7 = 100. Calcium sometimes replaces the lead.

Chromium is sometimes present, but according to Groth as an impurity, and not causing the occasional red color noted, though Schrauf gave the name *chromowulfenite* on this ground; vanadium was found by Smith in Phenixville crystals (cf. Groth); also by Wöhler (and Rg., cf. Min. Ch.), Lieb. Ann., **102**, 383, 1857.

**Anal.**—1, 3, F. Jost, Zs. Kr., **7**, 592, 1883. 2, J. L. Smith, Am. J. Sc., **20**, 245, 1855. 4, 5, Reinitzer, Zs. Kr., **8**, 587, 1884. 6, C. L. Allen, Ch. News, **44**, 203, 1881. Also 5th Ed., p. 608.

| | | $MoO_3$ | PbO | CaO | |
|---|---|---|---|---|---|
| 1. Phenixville | | 39·21 | 60·00 | — | $CrO_3$ 0·38 = 99·59 |
| 2. " | | 37·47 | 60·30 | — | $V_2O_5$ 1·28 = 99·05 |
| 3. Přibram | | 38·54 | 60·74 | — | = 99·28. |
| 4. Kreuth, Bleiberg, *light* | G. = 6·7 | 39·40 | 57·54 | 1·07 | CuO 0·09, $Al_2O_3$,$Fe_2O_3$ 1·96=100·06 |
| 5. " " *dark* | | 39·60 | 58·15 | 1·24 | CuO 0·40, $Al_2O_3$,$Fe_2O_3$ 0·50= 99·89 |
| 6. Eureka Co., Nev. | G. = 6·701 | 39·33 | 61·11 | 1·04 | $Fe_2O_3$ 0 38 = 101·86 |

Domeyko gives 6·88 p. c. CaO in a Chili variety.

**Pyr., etc.**—B.B. decrepitates and fuses below 2; with borax in O.F. gives a colorless glass, in R.F. it becomes opaque black or dirty green with black flocks. With salt of phosphorus in O.F. gives a yellowish green glass, which in R.F. becomes dark green. With soda on charcoal yields metallic lead. Decomposed on evaporation with hydrochloric acid, with the formation of lead chloride and molybdic oxide; on moistening the residue with water and adding metallic zinc, it gives an intense blue color, which does not fade on dilution of the liquid.

**Obs.**—This species occurs in veins with other ores of lead. Found first at Bleiberg, Schwarzenbach, in Carinthia; also at Ruskitza in Austria; at Rezbánya and Szaska in Hungary; at Přibram; at Moldawa in the Banat, where its crystals are red, and have considerable resemblance to crocoite; in the Kirghiz Steppes in Siberia; at Annaberg, Schneeberg, Johanngeorgenstadt, and Berggieshübel in Saxony; at Badenweiler in Baden; sparingly at Chalanches, Dept. of Isère, and at the abandoned mines of Beaujolais in France; in the gold sands of Rio Chico in Antioquia, Colombia, S. A.; in Lackentyre, Kirkcudbrightshire, Scotland; Zacatecas in Mexico.

In the U. States, it is found in small quantities at the Southampton lead mine, Mass.; sparingly near Sing Sing, N. Y., in tabular crystals associated with vanadinite, pyromorphite, etc., upon crystalline limestone; in fine yellow and reddish orange to red crystals (fig. 4, and also in thin tables) at Wheatley's mine, near Phenixville, Pa.; at the Comstock lode in Nevada; in large thin tables of an orange-yellow color at the Tecomah mine, Utah. In New Mexico, pale yellow crystals at the Organ Mts. In Arizona in fine large deep red crystals at the Hamburg and other mines, Yuma Co., often with red vanadinite; also at the Castle Dome district, 30 miles distant; at the Vulture mine, Maricopa Co.; at the Mammoth gold mine near Oracle, Pinal Co., with vanadinite and descloizite; at the Empire mine, Inyo Co., California.

Named in honor of the Austrian mineralogist Wülfen (1728–1805), who wrote a monograph on the Carinthia lead ores in 1785.

**Ref.**—[1] Bleiberg, Pogg., **107**, 267, 1859; crystals from different localities vary rather widely, and make a mean axial ratio unsatisfactory; cf. Dbr., Koch, Zs. Kr., **6**, 389, 1882, Kk., Min Russl., **8**, 408, Zeph., Zs. Kr., **8**, 583, 1884; Goodenough (priv. contr.) obtained on faultless red crystals from Yuma Co., *ss''* = 73° 16½', ∴ $\acute{c}$ = 1·57759. The Ca variety (anal. 4, 5) has $\acute{c}$ = 1·5744 Zeph., Zs. Kr., **8**, 583, 1884.

[2] See Koch (l. c.) for literature, list of planes with authorities, etc. [3] Koch, l. c. [4] Goodenough. [5] Dx., Propr. Opt., **2**, 18, 1859.

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**819. REINITE.** *K. v. Fritsch*, Zs. Nat. Halle, 3, 864, 1878; *Luedecke*, Jb. Min. 286, 1879.

In tetragonal pyramids, *p* (111, 1), with *e* (101, 1-*ī*). Axis $\acute{c}$ = 1·279; *pp'* = 76° 28'.

Cleavage: prismatic (110), indistinct. H. = 4. G. = 6·640. Luster dull, submetallic. Color blackish brown. Streak brown. Opaque, except in the thinnest splinters.

**Comp.**—$FeWO_4$ = Tungsten trioxide 76·3, iron protoxide 23·7 = 100.

**Anal.**—E. Schmidt, quoted by Luedecke, l. c.

$WO_3$ 75·47 FeO 24·33 CaO,MgO *tr.* = 99·80

**Obs.**—Occurs with large quartz crystals, from Kimbosan, in Kei, Japan. Named for Prof. Rein, of Marburg, who brought the mineral from Japan.

Reinite may prove to be only a pseudomorph after scheelite; such pseudomorphs are common at Trumbull and Monroe, Connecticut, and their angles vary somewhat widely from the original mineral.

PATERAITE. Paterait *Haidinger*, Jb. G. Reichs., 7, 196, 1856.

An impure massive mineral of black color, supposed to be a molybdate of cobalt. Analysis.—Laube, ib., 14, 303, 1864.

$MoO_3$ 30·0 $Bi_2O_3$ 2·0 $Fe_2O_3$ 16·6 CoO 27·0 $H_2O$ 8·6 S 12·0 insol. 3·8 = 100

It was so intimately mixed with pyrite and bismuthinite that, even with the greatest care, it could not be completely separated. Subtracting the bismuth, iron, and sulphur in the above analysis, molybdate of cobalt remains, which, according to Laube, is the true mineral.

Discovered by Vogl, in the Elias mine, Joachimsthal, with uranium ores. Named from A. Patera, who first examined it.

EOSITE *A. Schrauf*, Ber. Ak. Wien, **63** (1), 176, Feb. 1871.

Tetragonal, in minute square octahedrons. Axis $\dot{c}$ = 1·378; *cp* = *62° 50′, *pp′* = 77° 58′. H. = 3–4. Color deep aurora-red, between that of crocoite and realgar. Streak brownish orange-yellow.

Heated in the closed tube darkens, but regains its color on cooling. Fused with potassium bisulphate gives a mass which is light yellow while hot, becomes, on cooling, first reddish brown and finally brownish orange-yellow. This dissolved in water and boiled with tin-foil colors the solution faint greenish blue. Not so rapidly acted upon by hydrochloric acid as crocoite or wulfenite. When a splinter of eosite is placed on a glass plate, and treated with hydrochloric acid, with subsequent addition of alcohol, and then gently evaporated, it affords a blue to bluish green coating, with a green precipitate on the edges. From these reactions, and a series of comparative tests made with crocoite, wulfenite, and vanadinite, Schrauf concludes that eosite is vanado-molybdate of lead.

Found implanted in very minute crystals on pyromorphite and cerussite at Leadhills, Scotland.

ACHREMATITE *J. W. Mallet*, J. Ch. Soc., **28**, 1141, 1875.

Massive, crypto-crystalline. Fracture uneven to subconchoidal. Brittle. H. = 3–4. G. = 5·965; in powder, 6·178. Color pale sulphur-yellow to orange and red, in the mass liver-brown, from admixed limonite. Streak pale cinnamon-brown. Luster resinous to adamantine. Translucent on thin edges.

Analysis after deducting limonite, 10 to 15 p. c.

$\frac{3}{3}$ $As_2O_3$ 18·25 $MoO_3$ 5·01 PbO 68·31 Pb(for Cl) 6·28 Cl 2·15 = 100

The formula calculated is $3[3Pb_3As_2O_8.PbCl_2].4[Pb_2MoO_5]$. That the mineral is homogeneous is considered by the author as sufficiently proved. B.B. decrepitates slightly, turns dark brick-red, and fuses easily to a nearly black globule, which shows indistinct crystalline facets on cooling. On charcoal yields arsenical odors, a lead coating, and finally globules of lead. With the fluxes, reacts for iron, which, however, is only present as an impurity.

From the mines of Guanacevé, Chihuahua, Mexico. Named from ἀχρήματος, *useless*, in allusion to the fact that it was received as a silver ore, while, in fact, of no intrinsic value.

**820. BELONESITE.** Belonesia *A. Scacchi*, Mem. Acc. Napoli, **1**, No. 5, announced Sept. 8, 1883, published 1886.

Tetragonal. Axis $\dot{c}$ = 0·66054; 001 ∧ 101 = 33° 26¾′ Scacchi.

In minute acicular crystals with *a* (100, *i-i*) small, *m* (110, *I*), *p* (111, 1). Angles: *pp′* = 57° 43½′, *pp″* = 86° 6′, *mp* = *46° 57′.

Color white. Transparent.

**Comp.**—A qualitative analysis proved the presence of magnesium and molybdic acid. Regarded as probably magnesium molybdate, $MgMoO_4$ = Molybdenum trioxide 78·3, magnesia 21·7 = 100.

**Pyr.**—B.B. fuses with difficulty. Dissolves readily in salt of phosphorus, less easily in the borax bead. Insoluble in acids.

**Obs.**—From a fragment of an ancient rock enveloped in the lava of 1872 at Vesuvius. It is near in angle to the species of the rutile group.

Named from βελόνη, *needle.*

# VII. SALTS OF ORGANIC ACIDS.

## Oxalates, Mellates.

| | | | | $\grave{a} : \bar{\grave{b}} : \grave{c}$ | $\beta$ |
|---|---|---|---|---|---|
| 821. | **Whewellite** | $CaC_2O_4 + H_2O$. | Monoclinic | 0·8696 : 1 : 1·3695 | 72° 41½′ |
| 822. | **Oxammite** | $(NH_4)_2C_2O_4 + 2H_2O$ | | | |
| 823. | **Humboldtine** | $2FeC_2O_4 + 3H_2O$ | | | |
| 824. | **Mellite** | $Al_2C_{12}O_{12} + 18H_2O$ | Tetragonal | $\grave{c}$ = 0·7463 | |

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## Oxalates.

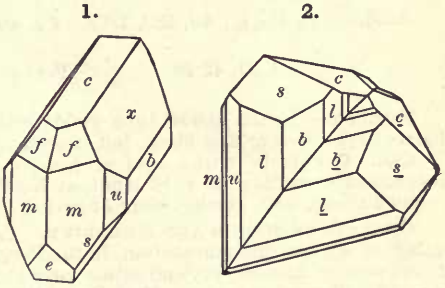
**821. WHEWELLITE.** Oxalate of Lime *H. T. Brooke*, Phil. Mag., **16**, 449, 1840. Oxacalcite *Shepard*, Min., 111, 1844. Whewellite *B. & M.*, Min., 623, 1852. Kohlenspath, *Frenzel*, Min. Mitth., **11**, 83, 1889.

Monoclinic. Axes $\grave{a} : \bar{\grave{b}} : \grave{c}$ = 0·8696 : 1 : 1·3695; $\beta$ = 72° 41½′ = 001 ∧ 100 Miller[1].

100 ∧ 110 = 39° 42′, 001 ∧ 101 = 45° 40½′, 001 ∧ 011 = 52° 35½′.

*b* (010, $i$-$\grave{i}$)
*c* (001, *O*)
*m* (110, *I*)
*u* (120, $i$-$\grave{2}$)
*l* (130, $i$-$\grave{3}$)[2]
*k* (102, $-\frac{1}{2}$-$\bar{i}$)[2]
*e* ($\bar{1}$01, 1-$\bar{i}$)
*z* (014, $\frac{1}{4}$-$\grave{i}$)[2]
*y* (012, $\frac{1}{2}$-$\grave{i}$)[2]
*x* (011, 1-$\grave{i}$)
*f* (112, $-\frac{1}{2}$)
*s* ($\bar{1}$32, $\frac{3}{2}$-$\grave{3}$)

*mm‴* = *79° 24′
*uu′* = 62° 7′
*ll′* = 43° 45′
*ck* = 31° 21′
*ce* = *70° 32′
*zz′* = 36° 12′
*yy′* = 66° 21′
*xx′* = 105° 11′
*cf* = 38° 54½′
*cm* = *76° 46′
*ff′* = 48° 41′
*ss′* = 122° 38′
*mx* = 49° 43½′



1, After Miller. 2, Burgk, Weisbach.

Twins common; tw. pl. *e* (101) often heart-shaped. Prismatic faces vertically striated; also *f* (112) ‖ edge *f/f*. Only in crystals.

Cleavage: *c*, *b*, *m*; also *e* Weisbach. Very brittle. Fracture conchoidal. H. = 2·5. Luster vitreous to greasy; on *b* somewhat pearly. Colorless. Transparent to opaque.

**Comp**—Calcium oxalate, $CaC_2O_4 + H_2O$ (E. E. Schmid) = $C_2O_3$ 49·4, CaO 38·3, $H_2O$ 12·3 = 100.

The related salt, $CaC_2O_4 + 3H_2O$ occurs in tetragonal crystals in the cells of certain plants (Cacti), Lieb. Ann., **97**, 225, 1856, and Pogg., **142**, 111, 1871.

**Obs.**—The original crystals described by Brooke were from an unknown locality; in size they were from $\frac{1}{16}$ to $\frac{1}{4}$ inch broad and occurred implanted upon calcite. Large crystals, 2 inches in thickness, have been found, associated with calcite, in a crevice of the foot-wall of a coal bed at Burgk near Dresden (Weisbach); also found with the coal of Zwickau in Saxony (Frenzel) associated with brown spar and chalcopyrite.

**Ref.**—[1] Miller, Phil. Mag., **16** 450, 1840, and Min., p. 623. [2] Weisbach, Burgk near Dresden, Jb. Min., **2**, 48, 1884.

**Thierschite** *Liebig*, Lieb. Ann., **86**, 113, 1853. A calcium oxalate, occurring as a grayish, warty, and somewhat opaline incrustation, about a line thick, on the marble of the Parthenon, Athens. Not analyzed. Its origin is attributed to the action of some kind of vegetation on the marble. It is probably identical with whewellite. Named after Fried. v. Thiersch, the discoverer.

**822. OXAMMITE.** *C. U. Shepard*, Rural Carolinian, p. 471, May, 1870. Guañapite *Raimondi*, Min. Pérou, 30, 33, 1878.

Rarely in small distinct prismatic crystals (orthorhombic); usually in small flattened grains, and pulverulent. Luster silky. Color yellowish white. Transparent. Inodorous.

**Comp.**—Ammonium oxalate, $(NH_4)_2C_2O_4 + 2H_2O = C_2O_4$ 55·0, $NH_4$ 22·5, $H_2O$ 22·5 = 100; or, $C_2O_3$ 45·0, $(NH_4)_2O$ 32·5, $H_2O$ 22·5 = 100.

**Anal.**—J. A. Tanner, Ch. News, **32**, 162, 1875; recalculated after deducting 5·5 p. c. organic matter.

| | $C_2O_4$ | $NH_4$ | $H_2O$ |
|---|---|---|---|
| Guañape Islands | 53·30 | 21·95 | 24·75 = 100 |

**Obs.**—Found with mascagnite, which it resembles, in the guano of the Guañape Islands, Peru

**823. HUMBOLDTINE.** Faser Resin (Honigsteinsaures Eisen ?) *Breith.*, Char., 75, 1820. Humboldtine, Oxalsaures Eisen, *M. de Rivero*, Ann. Ch. Phys., **18**, 207, 1821. Eisen-Resin *Breith.*, Gilb. Ann., **70**, 426, 1822. Oxalit *Breith.*, Char., 1823. Humboldtit *Leonh.*, Handb., 789, 1826.

In capillary forms; also botryoidal and in plates, or earthy; structure fibrous or compact.

Fracture uneven, earthy. H. = 2. G. = 2·13–2·489. Dull or slightly resinous. Color yellow. Negatively electrified by friction.

**Comp.**—Hydrous ferrous oxalate, $2FeC_2O_4 + 3H_2O = C_2O_3$ 42·1, FeO 42·1, $H_2O$ 15·8 = 100.

**Anal.**—Rg., Pogg., **46**, 283, 1839. Cf. also ibid., **53**, 633, 1841.

$C_2O_3$ 42·40 FeO 41·13 (loss) 16·47 = 100

**Pyr., etc.**—In the closed tube yields water, turns black, and becomes magnetic. B.B. on charcoal is colored at first black, but later red, and with the fluxes reacts for iron.

**Obs.**—Occurs in brown coal at Kolosoruk, near Bilin, Bohemia; at Gross-Almerode, in Hessia, and according to T. S. Hunt, at Kettle Point, in Bosanquet, Canada, as an incrustation on black shales, soft, earthy, sulphur-yellow.

**Oxalate of Sodium and Ammonium.** Lacroix notes the existence of a mineral, probably an oxalate of sodium and ammonium, in the Peruvian guano. It occurs in small masses consisting of micaceous laminæ; crystallization probably orthorhombic. Optically −. Bx ⊥ cleavage. 2E = 15°; dispersion $\rho < v$. Bull. Soc. Min., **9**, 51, 1886.

**824. MELLITE.** Honigstein (fr. Thuringia) *Wern.*, Bergm. J., **1**, 380, 395, 1789. Honigstein *Karst.*, Mus. Lesk., **2**, P. 1, 335, 1789. Succin transparent en cristaux octaèdres, Pierre de miel, *v. Born*, Cat. de Raab, **2**, 90, 1790. Mellites *Gmelin*, Linn. Syst., **3**, 282, 1793. Mellilite *Kirwan*, Min., **2**, 68, 1796. Mellite *H.*, **3**, 1801. Honigstein, Melilithus, = Honigsteinsäure (Acidum melilithicum) + Alaunerde + Wasser, *Klapr.*, Ak. Berlin, 1799, Beitr., **3**, 114, 1801.

Tetragonal. Axis $\dot{c} = 0·74628$; $001 \wedge 101 = 36° 44'$ Dauber[1]. In square pyramids, *o* (111, 1), with *a* (100, *i-ī*), *c* (001, *O*), *m* (110, *I*), *e* (101, 1-ī).

Angles: $oo' = {}^*61° 46'$, $oo'' = 93° 5'$, $oo^{iv} = 86° 55'$, $ao = 59° 7'$.

Also in massive nodules, granular in structure.

Cleavage: *o* (111) very indistinct. Fracture conchoidal. Sectile. H. = 2–2·5. G. = 1·55–1·65; 1·636–1·642 Kenngott. Luster resinous, inclining to vitreous. Color honey-yellow, often reddish or brownish; rarely white. Streak white. Transparent to translucent. Optically negative; sometimes abnormally biaxial, Dx.[2] ($2E_r = 8° 22'$). Refractive indices, Schrauf[2]:

For B $\omega = 1·53450$ $\epsilon = 1·50785$
D $\omega = 1·53928$ $\epsilon = 1·51101$
E $\omega = 1·54351$ $\epsilon = 1·51461$

Also, Dx.[2] $\omega_y = 1·541–1·550$ $\epsilon_y = 1·518–1·525$

**Comp.**—Hydrous aluminium mellate, $Al_2C_{12}O_{12} + 18H_2O$ = Mellitic acid 40·3 (= Carbon 20·15, oxygen 20·15), alumina 14·3, water 45·4 = 100.

**Anal.**—1, Klaproth, Beitr., **3**, 114, 1802. 2, Wöhler, Pogg., **7**, 325, 1826. 3, J. v. Ilenkov (Kk., Min., **3**, 217).

| | $C_4O_3$ | $Al_2O_3$ | $H_2O$ | | |
|---|---|---|---|---|---|
| 1. | 46 | 16 | 38 | = | 100 |
| 2. | 41·4 | 14·5 | 44·1 | = | 100 |
| 3. | 42·36 | 14·20 | 44·16 | = | 100·72 |

**Pyr., etc.**—Whitens in the flame of a candle, but does not take fire. Dissolves in nitric acid; decomposed by boiling water. In a matrass yields water.

**Obs.**—Occurs in brown coal at Arten in Thuringia; at Luschitz near Bilin in Bohemia; near Walchow in Moravia; in the Govt. of Tula, Russia in Europe; Nerchinsk, in Transbaikal, E. Siberia.

**Artif.**—An artificial crystal of mellite, see Friedel & Crafts, Bull. Soc. Min., **3**, 189, 1880; Friedel & Balsohn, ibid., **4**, 26, 1881.

**Ref.**—[1] Pogg., **94**, 410, 1855; Kupffer obtained *oo'* = 61° 46½', *oo''* = 93° 5', 93° 6', Preisschrift, 121, 1825; Koksharov gives *oo''* = 92° 48', Min. Russl., **3**, 217, 1858. [2] Dx., N. R., 15, 1867; Schrauf, Ber. Ak. Wien, **41**, 777, 1860. On the *pyroelectricity*, see Hankel, Wied., **18**, 422, 1883.

PIGOTITE *Johnston*, Phil. Mag., **17**, 382, 1840. A salt of alumina and an organic acid called mudescous acid by Johnston. Composition, $4Al_2O_3.C_{12}H_{10}O_8 + 27H_2O$. Formed on granite, in Cornwall, from the action of wet vegetation. Reported also from Wicklow, Ch. Gaz., 378, 1852.

ORGANIC SALTS OF IRON. Native compounds of iron and organic acids have been indicated by Berzelius and other chemists as common in marshes. But none of them has yet been properly investigated, the kinds of acids, as well as the proportions of acid to bases, being undetermined.

# VIII. HYDROCARBON COMPOUNDS.

The Hydrocarbon Compounds are divided into two classes: (1) the Hydrocarbons proper, and (2) the Oxygenated Hydrocarbons. As an appendix to the chapter are introduced the highly complex substance Petroleum, and the different kinds of Bitumen, Asphaltum, and Coal.

The Hydrocarbons proper, including the various kinds of mineral wax, also mineral tallow, etc., for the most part belong to the Paraffin Series, having the general formula $C_nH_{2n+2}$. To the paraffins also belong the chief part of the many compounds present in crude petroleum; the American oil particularly consists almost exclusively of paraffins, gaseous, liquid and solid, varying widely in boiling point. With these are present also some of the olefines with the general formula $C_nH_{2n}$, and further in some cases the benzenes, $C_nH_{2n-6}$. Some kinds of coal also yield large quantities of paraffin.

The compounds of the series $C_nH_{2n}$, $C_nH_{2n-6}$, with perhaps others of the series $C_nH_{2n-4}$, etc., may be also represented independently in nature, but the exact composition of the native substances is often in doubt, since in many cases analysis alone is hardly conclusive, as the difference in amounts of carbon required by the formulas of members of different series, or even of the same series, may be less than the errors of analysis. Further, members of two series in some cases have the same percentage composition.

The Oxygenated Hydrocarbons include chiefly the numerous kinds of native fossil resins, many of which are included under the generic term *amber*, also other more or less closely related substances. In general, in these compounds weak acids (succinic acid, formic acid, butyric acid, cinnamic acid, etc.) or acid anhydrides, are prominent.

The Hydrocarbon compounds in general, with perhaps a few exceptions, are *not homogeneous substances*, but mixtures, which by the action of solvents or by fractional distillation may be separated into two or more component parts. They are hence not definite mineral species and do not strictly belong to pure Mineralogy, rather, with the recent gums and resins, to Chemistry or, so far as they are of practical value, to Economic Geology. In the following pages they are treated with some fullness, though not accorded the rank of species. It may be added here that the original acounts given of these substances, in many cases leave much to be desired in the way of minuteness and accuracy of statement.

For a fuller discussion, more particularly of the economic products, petroleum, bitumen, asphaltum, and coal in its various forms, reference must be made to more technical works.

The microscopic and optical characters of various hydrocarbons, resins and coals have been investigated by H. Fischer & D. Rüst, Zs. Kr., **7**, 209, 1882.

## 1. Simple Hydrocarbons.

### Chiefly members of the Paraffin Series $C_nH_{2n+2}$.

**Scheererite.** Scheererit *Stromeyer*, Kastn. Arch., **10**, 113, 1827; Napthaline résineuse prismatique *Könlein*, Bibl. Univ., **36**, 316, 1827; Pogg., **12**, 336, 1828. Macaire-Prinsep, Bibl. Univ., **40**, 68, 1829, Pogg., **15**, 294, 1829. Schêrerite.

In monoclinic crystals, usually thin tabular (‖ 010), sometimes acicular. Also in loosely aggregated crystalline grains and folia. Soft. G. = 1–1·2. Luster pearly or resinous; feebly shining. Color whitish, gray, yellow, green, pale reddish. More or less translucent to transparent. Easily frangible. Tasteless. Inodorous. Feel not greasy.

**Comp., etc.**—According to an imperfect analysis by Prinsep contains: Carbon 73, hydrogen 24 = 97. This corresponds nearly to the ratio for H = 1 : 4, or the composition of marsh-gas = Carbon 75, hydrogen 25 = 100; whence, if the results may be trusted, it is a polymer of marsh-gas.

Soluble easily in alcohol, and also in ether. Melts at 44°, and then resembles a fatty oil, and like it penetrates paper; these spots, however, may be removed by heat. On cooling, the mineral crystallizes in acicular crystals. May be distilled without decomposition; boiling point near 100° (92°, Prinsep).

Soluble in sulphuric or nitric acid, and not in alkalies. Takes fire easily and burns without residue, giving out much smoke and a feeble aromatic odor.

**Obs.**—Found by Capt. Scheerer, in the year 1822, in the coal of a bed of brown coal in the Tertiary, at Uznach, near St. Gallen, in Switzerland. The bed of coal is two to three feet thick, and the pine stems in it are almost unchanged. Among the species of pine, there is the *P. sylvestris;* and the birches and firs are those of modern species. The age is the same with that of the peat-beds of Redwitz. Besides scheererite it affords also fichtelite and könlite. On cryst., Kenng., Ber. Ak. Wien, **14**, 272, 1854, and Min. Schweiz, 418, Leipzig, 1866.

**Hatchettite.** Hatchetine (fr. Merthyr-Tydvil) *Conybeare*, Ann. Phil., **1**, 136, 1822. Mineral Adipocire, Mountain Tallow (fr. Loch Fyne). *Brande*, Ed. Phil. J., **11**, 1824. Adipocerite. Hatchetine (fr. Glamorganshire) *J. F. W. Johnston*, Phil. Mag., **12**, 338, 1838.

In thin plates, or massive. Reported as sometimes occurring as large crystals in fresh specimens. H. like that of soft wax. Feel greasy. G. = 0·916 Johnston; 0·983 Loch Fyne, after melting and excluding air-bubbles, Brande; 0·608, same before melting, id. Luster slightly glistening and pearly. Color yellowish white, wax-yellow, greenish yellow; blackens on exposure. Subtransparent to translucent; but opaque on exposure. Without odor. Melting point 46° Merthyr-Tydvil, Johnston; 47° Loch Fyne, Brande.

**Comp., etc.**—Ratio of C to H = nearly 1 : 1, from Johnston's analysis, = Carbon 85·55, hydrogen 14·45 = 100. Anal.—Johnston, l.c.

Glamorganshire Carbon 85·91 Hydrogen 14·62 = 100·53

Very sparingly soluble in boiling alcohol, and precipitated from the solution on cooling. Also soluble sparingly in cold ether, and more largely in boiling; and from the latter deposited in a mass of minute fibers or prisms. After repeated boiling with ether there remains only a minute portion undissolved, mixed with particles of charcoal derived from the blackened surface of the specimen. Charred and decomposed by concentrated and boiling sulphuric acid. No apparent change in boiling nitric acid.

**Obs.**—From the crevices of iron-stone septaria, and often in geodes containing also quartz crystals, in the Coal-measures near Merthyr-Tydvil in Glamorganshire (and, Johnston adds, in some of the Midland Counties of England); also in a bog on the borders of Loch Fyne in Argyleshire, Scotland. The latter has not yet been analyzed. Also reported from Rossitz in Moravia (Jb. G. Reichs., **5**, 898, 1854), in the Segen-Gottes mine, with spherosiderite as a thin coating on calcite, having H. = 1, G. = 0·892 Patera.

Cesàro has found some hatchettite made up of thin laminæ which are optically biaxial and positive; a less distinct axial figure was obtained from ozocerite, but it was also positive and like the hatchettite was referred to the orthorhombic system. Ann. Soc. G. Belg., **18**, 1891; cf. also Dx., Min., **2**, 38, 1874.

Named after C. Hatchett, an English chemist (1765–1847).

This species (or at least the bog variety from Loch Fyne) is probably identical with the kind of paraffin that fuses at 45°–47°; and which has been obtained by the destructive distillation of Boghead coal and peat, and from other sources. Anderson obtained in his analyses of this paraffin:

| | | C | H | Melting T. |
|---|---|---|---|---|
| 1. From Boghead coal, *cryst.* | | 85·1 | 15·1–15·3 | 45·5° |
| 2. " " " *granular* | | 85·0–85·3 | 15·4 | 52 |
| 3. From peat | $\frac{2}{2}$ | 85·09 | 15·10 | 46·7 |

The Boghead coal (from Boghead and Torbane Hill, near Bathgate in Linlithgowshire) affords on destructive distillation a very large amount of different oils and paraffin, 70 p. c. of the dried mass being volatile. See BATHVILLITE beyond.

PARAFFIN. A native crystallized paraffin, like the above, is described by O. Silvestri as occurring in cavities in basaltic lava near Paterno, Sicily. It is in yellowish white, wax-like, transparent crystalline plates. Melts at 56°, volatilizes at about 300°. Nearly insoluble in cold alcohol, but readily dissolves in boiling ether. An analysis gave: $\frac{2}{2}$ Carbon 84·00, hydrogen 15·85 = 99·85. Boll. Com. G., **12**, 578, 1881; also earlier [Gazz. Ch. Ital., 1877].

CHRISMATITE. Chrismatin (fr. Wattin) *Germar*, Zs. G. Ges., **1**, 40, 1849. Ozokerit (fr. ib.) *Breslau*, Karst. u. Dech. Arch., **23**, 749, 1850. Hatchettin (fr. ib.) *Wagner*, Jb. Min., 687, 1864; *H. Fleck*, Steinkohlen Deutschl., **1**, 37. 4to, München, 1865.

Butter-like, or of semi-fluid consistence. Soft at 55° to 60°. G. below 1. Luster greasy to silky. Color greenish yellow to wax-yellow. Slightly translucent. Tasteless. Melts at a very low temperature to an oil, which is dark red by transmitted light, and apple-green by reflected.

H. Fleck obtained, 34 p. c. of ash having been removed: Carbon 78·51, hydrogen 19·19, oxygen 2·30 — 100. Excluding the oxygen as water, as done by Fleck, it leaves C 80·51, H 19·49 = 100, corresponding to $C_2H_6$ = Carbon 80, hydrogen 20; making it thus a polymer of $C_2H_6$, or the second member of the Marsh-gas series. Fleck adopted the formula $C_{13}H_{38}$. If the oxygen is an essential constituent, either view of the constitution is wholly at fault. Burns with a flame, without smell.

Occurs in cavities of calcite and quartz crystals in an argillaceous sandstone of the Carboniferous formation at Wettin, Saxony.

Named from *χρῖσμα*, *ointment.*

**Ozocerite.** Part of Native Paraffin. Ozokerit (brought by v. Meyer fr. Slanik, Moldavia) *Glocker*, Schw. J., **69**, 215, 1833; *Magnus*, Ann. Ch. Phys., **55**, 217, 1833. Cire fossile *Fr.* Erdwachs *Germ.* Mineral wax pt.

Like wax or spermaceti in appearance and consistency. G. = 0·85–0·90. Colorless to white when pure; often leek-green, yellowish, brownish yellow, brown; and when brown sometimes greenish by transmitted light. Often having a greenish opalescence. Translucent. Greasy to the touch. Fusing point 56° to 63°.

**Comp., etc.**—Essentially a paraffin, and consisting chiefly of one of the higher members of the series. The original ozocerite, from Slanik in Moldavia, as described by Glocker was wholly soluble in ether, and gave a yellow solution; also soluble in oil of turpentine and naphtha; and a little soluble in boiling alcohol. G. of the mass, 0·955 Glocker; 0·953 Schrötter. Melting point 62° Schrötter.

The mineral wax of Urpeth Colliery, after the separation of what was soluble in cold ether (see URPETHITE, p. 999), afforded Johnston another portion through its solubility in boiling ether; and this is apparently identical with true ozocerite. While soluble in boiling ether it is sparingly so in boiling alcohol. As obtained from the ether solution it was yellow, and had the consistence of soft wax.

A kind from Boryslaw in Galicia, examined by Hofstädter (Lieb. Ann., **91**, 326, 1854), resembled the preceding in its appearance, but was darker colored, being blackish brown, in thin pieces reddish brown to leek-green by transmitted light; G. = 0·944; melting point 60°. By fractional crystallization it was separated into parts varying in fusibility from 60° to 65·5°. That from Truscawitz, Galicia, examined by Walter (J. pr. Ch., **22**, 181, 1841) appears to be similar.

**Anal.**—1, Schrötter, Baumg. Zs., **4**, 2, 1836, Bibl. Univ., **3**, 184, 1836. 2, Johnston, l. c. 3, Walter, l. c. 4, 5, Hofstädter, l. c. 6, 7, Seal, J. Frankl. Inst., **130**, 402, 1890.

| | G. | C | H | | Melting T. | Boiling T. |
|---|---|---|---|---|---|---|
| 1. Slanik | 0·953 | 84·43 | 13·69 | = 98·12 | 62°–63° | 210° |
| 2. Urpeth C. | | 86·80 | 14·06 | = 100·86 | 58° | ? |
| 3. Truscawitz, *crude* | | 84·62 | 14·29 | = 98·91 | 59° | ov. 300° |
| 4. Boryslaw, A. | 0·944 | 84·94 | 14·87 | = 99·81 | 61° | |
| 5. " B. | | 85·78 | 14·29 | = 100·07 | 65·5° | |
| 6. Utah | 0·971 | 85·44 | 14·45 | = 99·89 | | |
| 7. " | | 85·47 | 14·57 | = 100·04 | | |

The A of Hofstädter was the portion separated by fractional crystallization which had 61° as the melting point, and the B that which had for this point 65·5°. The material analyzed by Seal was the white paraffin extracted from the crude material by alcohol, cf. below.

Hermann has described a wax-like mixture from seams in a rock in the vicinity of Lake Baikal, which he calls *Baikerite* (J. pr. Ch., **73**, 230, 1858). About 60·18 p. c. of it was soluble in boiling alcohol, 100 parts dissolving 1; and this portion appears to be ozocerite. It was tasteless and inodorous; melting point 59°; G. = 0·90. The rest (29·82 p. c.) of the baikerite consisted as follows: 7·02 wax-like substance insoluble in alcohol; 32·41 viscid resin; 0·39 earthy impurities.

The same compound has been obtained from mineral coal, peat, petroleum, mineral tar, etc., by destructive distillation. The following are examples. 1, Anderson, Rep. Brit. Assoc., p. 50, 1856, and J. pr. Ch., **72**, 379, 1857. 2, Hofstädter, l. c.

| | C | H | | Melting Point. |
|---|---|---|---|---|
| 1. Rangoon Tar | 85·15 | 15·29 | = 100·44 | 61° |
| 2. From bitum. shale, Bonn. | 86·16 | 14·36 | = 100·52 | 61° |

**Obs.**—Ozocerite occurs at the localities mentioned, in beds of coal, or associated bituminous deposits; that of Slanik, Moldavia, beneath a bed of bituminous clay shale; in masses of sometimes 80 to 100 lbs., at the foot of the Carpathians, not far from beds of coal and salt; that of Boryslaw in a bituminous clay associated with calciferous beds in the formation of the Carpathians in masses. Reported also from near Gaming in Austria; in Transylvania, near Moldavia, in the Carpathian sandstone; at Uphall in Linlithgowshire.

Ozocerite also occurs in southern Utah on a large scale, where it has been mined to some extent for technical purposes. The deposits are in the form of veins usually a few inches in thickness and extend over a wide area in Emery and Uintah counties; it is associated with fibrous gypsum.

The crude material has a dark-brown color, is of wax-like consistency and has a foliated structure. G. = 0·9285 Seal. It has a melting point of 51°–55° Seal; 61·5° Newberry: it is completely soluble in boiling ether, carbon disulphide and benzene; the dilute solution is highly fluorescent. Boiling alcohol extracts from it twenty per cent of a white wax-like substance (S. B. Newberry, Am. J. Sc., **17**, 341, 1879). Seal (l. c.) obtained 60 p. c. of this white solid after chilling the solution from the extractor, filtering and drying. This melts and becomes of a yellow-colored waxy consistency and has a specific gravity of 0·9708. It showed marked resistance to the action of a strong acid, agreeing with its character as a paraffin, one of the higher members of the series. Its composition is shown to be between $C_{18}H_{38}$ and $C_{25}H_{52}$.

Ozocerite has also been found in the clay fields of South Amboy, N. J. F. S. Smith obtained for a sample not purified: Carbon 86·46, hydrogen 12·83 = 99·29. This corresponds to $C_nH_{2n}$. Am. Ch. J., **6**, 247, 1884.

Named from *ὄζειν*, *to smell*, and *κηρός*, *wax*, in allusion to the odor.

On the occurrence and characters of ozocerite in general, see Rateau, Ann. Mines, **11**, 147, 1887.

Woehler has noted the existence in meteorites of a hydrocarbon (*Kabaite*) near ozocerite or scheererite, and Meunier has recently repeated the observation (C. R., **109**, 977, 1889). The composition of the substance is not yet determined.

**Zietrisikite.** Cire fossile de Moldavie *Magnus*, Ann. Ch. Phys., **55**, 217, 1833. Ozokerite (fr. Zietrisika) *Malaguti*, C. R., **4**, 410, 1837, Ann. Ch. Phys., **63**, 390, 1836, Pogg., **43**, 147. Zietrisikite *Dana*

A mineral like ozocerite in most physical characters and in composition, but distinguished by almost complete insolubility in ether and higher melting point. Hardness like that of beeswax, or harder. G. = 0·9; 0·946 Malaguti. Color brown. Melting point 90°; 82°–84° in the crude or impure mineral. Insoluble in ether.

1. Magnus, who made the first examination of the fossil wax brought by Meyer from Slanik, Moldavia, appears to have had a different substance in hand from that examined by Glocker (by whom *ozocerite* was named) and by Schrötter, as he states that only a very little of it was dissolved by alcohol or ether, and the rest, after the action of these solvents, was eroded with holes, showing the presence of insoluble and soluble constituents. The insoluble was soluble in oil of turpentine, and of this part the melting point was 82°, and the composition as given below.

2. The wax from Zietrisika, Moldavia, examined by Malaguti, is regarded by him as identical with that of Magnus. It was foliated, conchoidal in fracture, pearly in luster, deep red-brown in color with a greenish reflection, but in very thin pieces brown, and a little harder than beeswax. It was very slightly soluble in alcohol or boiling ether, and very soluble in oil of turpentine and naphtha, with no action from alkalies or cold sulphuric acid. It melts at 84°, and boils at above 300°. On subjecting it to boiling alcohol, a small portion was dissolved, whose melting point was 75°; by a second treatment another portion was obtained, having for the melting point 78°; and at the fourth, the portion dissolved was found to have the same melting point as that of the undissolved mass, which was 90°. This then, which he calls *brown* ozocerite, appears to be the point of fusion of the true zietrisikite, and this alone was analyzed; as the rest, his *yellow* ozocerite, he says, "est un mélange, j'ai jugé inutile d'en faire l'analyse."

Anal.—1, Magnus; 2, 3, Malaguti, l.c., and Rg., Min. Ch., 964, 1860.

| | C | H | Melting T. | Boiling T. |
|---|---|---|---|---|
| 1. Moldavia | 84·61 | 15·30 = 99·91 | 82° | |
| 2. Zietrisika, Mold. | 84·53 | 14·22 = 98·75 | 90° | Above 300° |
| 3. " " | 84·78 | 14·37 = 99·15 | 90° | " |

The wax from Zietrisika, in Moldavia, occurs in large masses, and under similar circumstances with that of Slanik.

**Urpethite.** Part of Ozocerite (fr. Urpeth Colliery) *J. F. W. Johnston*, Phil. Mag., **12**, 389, 1838. Urpethite *Dana*.

Consistence of soft tallow. G. = 0·885. Color yellowish brown to brown. Adheres to the fingers, and stains paper.

Analysis.—Johnston: Carbon 85·83, Hydrogen 14·17 = 100. Soluble readily in cold ether. Ethereal solution brown by transmitted light, but with a greenish opalescence by reflected; deposits the wax in brown flocks. Melts at 39° to a yellow-brown liquid.

Constitutes about *four-fifths* of the Urpeth Colliery ozocerite, and is separated from the latter through its solubility in *cold* ether. The crude wax, as found, was soft enough to be kneaded in the fingers; had a greasy feel, and gave a greasy stain to paper; was subtransparent; of a brownish yellow color by transmitted light, but yellowish green and opalescent by reflected; and had an odor slightly fatty, which was stronger when melted. It occurred in cavities near a fault in the Coal-measures, and part in the solid sandstone.

**Baikerinite.** Part of Baikerit. Dickflüssiges Harz. *Hermann* (see p. 998). A thick tar-like fluid at 15°, and a crystalline granular deposit in a viscid honey-like mass at 10°. Color brown. Translucent. Odor balsamic. Taste like that of wood-tar. Easily and perfectly soluble in alcohol and ether. The alcoholic solution becomes milky when diluted with water. Constitutes 32·61 p. c. of the baikerite. No analysis yet made.

**Neft-gil.** Naphtdachil, Nephatil, Jb. Min., 84, 1846. Naphthadil *Kenng.*, Ueb., 254, 1844–1849. Neftdegil *Herm.*, J. pr. Ch., **73**, 220, 1858 Neft-gil *Fritzsche*, ib., 321. A very abundant material in the naphtha region on Cheleken I., in the Caspian. It is a mixture of paraffins and a resin, but appears to be most nearly related to zietrisikite. G. = 0·956; color chocolate-brown; melting point 75°. Hermann found 66 p. c. of a wax-like substance insoluble in alcohol, and 18 p. c. of another soluble in alcohol, besides 13·33 p. c. of a resin. In ether a large part was insoluble; and this portion may be identical with the zietrisikite (see above), or with the insoluble paraffin from the Urpeth wax, called urpethite.

PYROPISSITE *Kenng.*, Ueb., 148, 1850–51. Kenngott has thus named an earthy, friable, coaly substance, of grayish-brown color, and without luster, and having G. = 0·493–0·522, which forms a layer 6 to 9 in. thick in brown coal at Weissenfels, near Halle. A small part is soluble in alcohol, especially in boiling, and this, precipitated by adding water, is a wax-like substance, paraffin-like in aspect. But whether true paraffin, or whether an oxygenated wax, related to geocerite, has not been ascertained. It melts easily to a pitch-like mass, and hence the name from *πῦρ, fire,* and *πίσσα, pitch.* It affords 62 p. c. of paraffin on dry distillation. Coals affording paraffin on distillation are sometimes called *Paraffin coal,* and in German *Wachskohle.* Kenngott refers here also an earthy brown substance from Mettenheim, which melts similarly to an asphalt-like substance. It occurs incrusting massive limestone.

HELENITE *A. Nawratil.* Dingl. Pol. J., 248, 513, 1883. Fossiles Kautschuk.

A wax near ozocerite, forming lamellæ 10 to 15 cm. long and 4 to 5 cm. broad. Elastic like caoutchouc. G. = 0·915. Color light to dirty yellow. Soluble in chloroform and carbon disulphide, but not in 94 p. c. alcohol. Anal.:

| | |
|---|---|
| Carbon 85·13 | Hydrogen 15·70 = 100·83 |
| 84·62 | 16·43 = 101·05 |
| 85·30 | 15·29 = 100·59 |

Formed in the Helena shaft of the petroleum region at Ropa in Galicia.

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**Fichtelite.** Tekoretin *Forchh.*, Vid. Selsk. Afh. Copenh., 1840, J. pr. Ch., **20**, 459, 1840. Fichtelit *Bromeis*, Lieb. Ann., **37**, 304, 1841; *T. E. Clark*, ibid., **103**, 236, 1857, Am. J. Sc., **25**, 164, 1858.

Monoclinic. Crystals tabular ‖ *c* or elongated ‖ $\overset{+}{b}$. Forms: *a* (100, $i$-$\bar{i}$), *c* (001, *O*), *m* (110, *I*), *i* ($\bar{1}01$, 1-$\bar{i}$). Angles (measured): *mm‴* = 97°, *ac* = 53°, *ai* = 52°, *ci* = 75° Clark.

Twins: tw. pl. *c*. H. = 1. Luster somewhat greasy. Color white. Translucent. Brittle. Without taste or smell. Distils over without decomposition. Solidifying temperature 36° Easily soluble in ether; less so in alcohol. Ax. pl. ‖ 010.

**Comp., etc.**—Formula doubtful; Rg. gives $C_5H_8$ = Carbon 88·4, hydrogen 11·6 = 100; Clark deduced $C_4H_7$ = Carbon 87·3, hydrogen 12·7 = 100. The latest analyses give from $C_{15}H_{26}$ to $C_{15}H_{28}$, see below.

**Anal.**—1, Bromeis, l. c. (Clark, recalc.). 2, Clark, l. c. 3, Forchhammer, l. c. 4, J. W. Mallet, Proc. Brit. Assoc., p. 79, 1872. 5, 6, Macadam, Min. Mag., 8, 137, 1889.

| | C | H | Melting T. | Boiling T. |
|---|---|---|---|---|
| 1. Redwitz | 87·95 | 10·70 = 98·65 | 46° | |
| 2. " | ⅜ 87·13 | 12·86 = 99·99 | 46° | above 320° |
| 3. *Tecoretin* | 85·89 | 12·81 = 98·70 | 45° | 360° |
| 4. Alabama | 87·82 | 11·91 = 99·73 | 45° | |
| 5. Handforth | 86·78 | 12·18 O 1·04 = 100 | | |
| 6. Shielding | 87·14 | 12·08 O 0·78 = 100 | | |

Hell has investigated (Ber. Ch. Ges. **22**, 498, 1889) fichtelite from a peat swamp near Redwitz, where it has been derived from *Pinus uliginosa.* Dissolves in a mixture of alcohol and ether, from which it is deposited as prismatic crystals upon the slow evaporation of the ether. The purified crystals thus obtained melt at 46° and gave on analysis:

Carbon 86·7–87·0, hydrogen 13·2–13·5.

Density of the vapor at 440°, 7·37–7·77, corresponding to the formula $C_{15}H_{28}$ to $C_{15}H_{26}$, perhaps $C_{15}H_{27}$; the last (= doubled, $C_{30}H_{54}$) requires: Carbon 87·0, hydrogen 13·0 = 100.

Bamberger (ibid., p. 635) confirms the above conclusion. He notes the occurrence at the Kolbermoor near Rosenheim in Upper Bavaria. Spiegel (ibid., p. 3369) gives the formula $C_{18}H_{32}$ = Carbon 87·1, hydrogen 12·9 = 100.

Decomposed by anhydrous sulphuric acid; also by heated fuming nitric acid; soluble in cold nitric acid.

Clark, after a revision of the investigations on fichtelite and the related resins, concludes that there is no doubt of the identity of the substance analyzed by him with Bromeis's *fichtelite.* for which is deduced the empirical formula $C_5H_8$.

**Obs.**—The mineral occurs in shining scales, flat crystals, and thin layers between the rings of growth and throughout the texture of pine wood (in part identical in species with the modern

*Pinus sylvestris*) from peat beds in the vicinity of Redwitz, in the Fichtelgebirge, North Bavaria. The crystals described by Clark were obtained artificially by means of ether and alcohol.

An *oily* substance was extracted by Schrötter by means of ether from wood of the same peat bed which afforded the fichtelite; and this solution yielded two substances, one of which was an oil, regarded by him as identical with fichtelite in ratio; it gave on analysis: Carbon 88·58, hydrogen 11·34 = 99·42. The other substance was crystallized and contained oxygen.

Fichtelite also occurs in crystals in peat beds at Salzendeich, Elsfleth, Oldenburg; near Sobeslau in peat. In England found in pine logs in a moss at Handforth in Cheshire, and in peat moss at Shielding in Ross-shire. Also from Alabama, in recent pine logs (*Pinus Australis*).

*Tecoretin* was obtained from pine trees of the same species in marshes near Holtegaard in Denmark. The resin from the wood, first observed by Steenstrup, was found by Forchhammer, after dissolving it in boiling alcohol, to contain two substances crystallizing from the solution at different temperatures. The *tecoretin* was the least soluble of the two, or that which crystallized out first (the other was his *phylloretin*, see p. 1002); its crystallization was *monoclinic*, and its fusing point 45°. From the analysis Clark writes the empirical formula $CH_2$; but states that the mineral resembles fichtelite in every other respect.

**Ref.**—[1] L. c.; cf. Schuster, Min. Mitth., **7**, 88, 1885.

**Hartite.** Hartit *Haid.*, Pogg., **54**, 261, 1841. Branchite *Savi*, N. Cimento, **1**, 342, Jb. Min., 459, 1842.

Triclinic or monoclinic. Resembling fichtelite in crystalline form, luster, color, translucency, and the reactions with alcohol, ether, and the acids. But melts at 74°–75° C. Boiling temperature very high.

**Comp., etc.**—Ratio of C to H = 12 : 20 = Carbon 87·8, hydrogen 12·2. Anal.—1, Schrötter, Pogg., **59**, 43, 1843. 2, Piria, JB. Ch., 984, 1855.

| | C | H | |
|---|---|---|---|
| 1. *Hartite* | 87·47 | 12·05 | = 99·52 |
| 2. *Branchite* | 87·0 | 13·4 | = 100·4 |

Piria's analysis corresponds nearly with the ratio 9 : 16.

**Obs.**—*Hartite* is found in a kind of pine, like fichtelite, but of a different species, the *Peuce acerosa* Unger, belonging to an earlier geological epoch. It is from the brown-coal beds of Oberhart, near Gloggnitz, not far from Vienna. Reported also from Rosenthal near Köflach in Styria, and Prävali in Carinthia. It occurs among the layers or tissues of the wood, and also in clefts in the coal or lignite.

*Branchite* is colorless and translucent, with G. = 1·044, and comes from the brown coal of Mt. Vaso in Tuscany. It is soluble in alcohol, like hartite.

Hartite is also found at Obersdorf near Voigtsberg in Styria (cf. Rumpf, who makes the crystals triclinic, Ber. Ak. Wien, **60** (2), 91, 1869).

DINITE *Meneghini*, Gaz. Med. Italiana, Firenze, Toscana, July, 1852. Occurs as an aggregation or druse of crystals; cleavage none; with the appearance of ice, but with a yellow tinge due to a foreign substance. Inodorous; tasteless; fragile, and easily reduced to powder.

Insoluble in water; little soluble in alcohol, very soluble in ether and in carbon disulphide. The ethereal solution on standing deposits large crystals of the dinite. Fuses with the warmth of the hand; heated in a close vessel distills over without undergoing any sensible decomposition. When melted it looks like a yellowish oil; crystallizes in large transparent crystals on cooling.

From a lignite deposit at Lunigiana, Tuscany, where it was found by Prof. Dini.

IXOLYTE. Ixolyt *Haid.*, Pogg., **56**, 345, 1842. Amorphous. Fracture imperfect conchoidal in the purer varieties. H. = 1. G. = 1·008. Luster greasy. Color hyacinth-red. Pulverized in the fingers, it becomes ocher-yellow and yellowish brown. Thin fragments subtranslucent. Softens at 76°, but is still tenacious at 100°, whence the name, from ἰξός, *gluey, like birdlime*, and λύειν, *to dissolve*.

This species is said to resemble hartite, though differing in the temperature of fusion and other characters. It occurs in a coal bed at Oberhart, near Gloggnitz; pieces sometimes half an inch thick, associated with hartite.

NAPALITE *G. F. Becker*, U. S. G. Surv., Monograph **13**, 372, 1888.

A yellow bituminous substance of the consistency of shoemaker's wax. It is dark reddish brown and shows green fluorescence, which, however, disappears on exposure to the air; garnet-red by transmitted light. Brittle, but easily molded when warmed by the hand. Not elastic; fracture conchoidal. H. = 2. Begins to fuse at 42° and becomes liquid at 46°; boils above 300°, and at 130° a heavy colorless oil distills over with an aromatic odor. Separated into various products by fractional distillation. Composition expressed by the formula, $C_3H_4$. Analyses, Melville:

| | | | | |
|---|---|---|---|---|
| Carbon | 89·84 | Hydrogen | 10·17 | = 100·01 |
| | 89·54 | | 10·36 | = 99·90 |
| | 89·35 | | 10·11 | = 99·46 |

Occurs at the Phœnix mercury mine in Pope Valley, Napa county, California.

**Könlite.** (Fr. Uznach) *Kraus*, Pogg., 43, 141, 1838. Könlit (fr. ib.) *Schrötter*, ib., **59**, 37, 1843; (fr. Redwitz) v. Trommsdorff, Ann. d. Pharm., 21, 126. Könleinit *Hausm.*, Handb., 1487, 1847; *Kenngott*, Ber. Ak. Wien, 14, 272, 1854, Min. Schweiz, 419, Leipzig, 1866.

In folia and grains; amorphous; stalactitic. Soft. G. = 0·88, Trommsdorff. Color reddish brown to yellow. Melting point 114°, Kraus; 107½°, Trommsdorff. Distills at 200°, undergoing decomposition at the same time, and leaving a brown residue. Very slightly soluble in cold and hot alcohol; much more soluble in ether; the latter solution affording wax-like folia.

**Comp.**—Ratio of C, H = 1 : 1; $n(C_6H_6)$ or a polymer of benzene. Anal.—1, Kraus, l. c. 2, v. Trommsdorff, l. c.

| | C | H |
|---|---|---|
| 1. Uznach, Switz. | 92·49 | 7·42 = 99·91 |
| 2. Redwitz, Bavaria | 90·90 | 7·58 = 98·48 |

The Redwitz mineral may be a different species. Könlite, unlike scheererite, is changed by distillation, yielding a substance which melts by the *warmth* of the hand. For this product Kraus proposed the name *pyroscheererite.*

**Obs.**—In brown coal at Uznach, at the same locality with scheererite; near Redwitz, Bavaria, in the Fichtelgebirge with fichtelite; reported by Kenngott from the brown coal of Fossa in the Eger valley (Ueb., 147, 1850–51). Named after Könlein, formerly superintendent of the coal works at Uznach.

PHYLLORETIN *Forchhammer*, J. pr. Ch., 20, 459, 1840. Near the above, and made identical with it by Fritzsche. It was obtained from an alcoholic solution of a resin from the marshes near Holtegaard in Denmark; the more soluble of the two resins obtained (see p. 1001) being the *phylloretin.* Fusing point 86°–87°. Dissolves easily in alcohol. Forchhammer obtained: Carbon 90·22, 90·12, hydrogen 9·22, 9·26; he deduces for the ratio of C to H. = 8 : 10.

NAPTHALENE, Naphtalin. Commonly, as artificially prepared, in rhombic tables of 122° and 78° with the acute angles truncated, or hexagonal tables. Luster brilliant. Color white. G. = 1·153 at 18°; 0·9778 at 79·2°, Kopp.; at which temperature it melts. Boiling point 218°. Dissolves readily in alcohol, ether, oil of turpentine, fatty oils, etc.

Comp.—$C_{10}H_8$ = Carbon 93·75, hydrogen 6·25 = 100. The first of the *Napthalene* series, the general formula for which is $C_nH_{2n-12}$. Burns with a dense smoking flame.

Found sparingly in Rangoon tar, by De la Rue and Müller, and by Warren and Storer. Formed easily from petroleum, coal-naphtha, essential oils, on passing them through red-hot tubes.

## 2. Oxygenated Hydrocarbons.

**Succinite.** "Ηλεκτρον *Homer*, etc. ? *Λυγγύριον Theophr., Demostr. Λυγγούριον Diosc.*, etc. Succinum, Electrum, Lyncurium, *Plin.*, **37**, 11, 12, 13. Amber pt. Succin, Ambre, *Fr.* Bernstein, Agstein, *Germ.* Succinite pt. *Breith.*, Char., 75, 1820, 140, 1823.

In irregular masses, without cleavage; fracture conchoidal. Optically anisotropic, showing bright interference-colors in polarized light.

H. = 2–2·5. G. = 1 050–1·096 Helm; the lowest values for kinds with numerous minute cavities. Luster resinous. Color yellow, sometimes reddish, brownish, and whitish, often clouded, sometimes fluorescent. Streak white. Transparent to translucent. Tasteless. Negatively electrified on friction. Heated to 150° begins to soften and finally melts at 250°–300°.

**Comp.**—Ratio for C, H, O = 40 : 64 : 4 = Carbon 78·94, hydrogen 10·53, oxygen 10·53 = 100. Anal.—1, Schrötter, Pogg., **59**, 64, 1843. 2, O. Helm, Schriften Ges. Danzig, **7**, No. 4, 192, 1891.

| | | | | |
|---|---|---|---|---|
| 1. | C 78·824 | H 10·229 | O 10·947 = 100 | |
| 2. | 78·63 | 10·48 | 10·47 | S 0·42 = 100 |

Sulphur, in the form of an organic compound, is present in amounts varying from 0·26 to 0.48 p. c. Helm.

Amber was early found to be not a simple resin. According to Berzelius (Pogg., **12**, 419, 1828), it consists mainly (85 to 90 p. c.) of a resin which resists all solvents along with two other resins soluble in alcohol and ether, an oil, and 2½ to 6 p. c. of succinic acid. Schrötter and Forchhammer state that after removing these soluble ingredients, true succinite has the ratio 40 : 64 : 4, which is the ratio deduced from the analyses of the whole mass.

The properties of succinite or amber in the narrow sense are given minutely by Helm, l. c., 1891, as follows:

Heated in the open air, it melts at from 250° to 300° without previously swelling up, boils quietly after the fusion, at the same time giving off dense white fumes which have a peculiar aromatic odor irritating to the respiratory organs. Heated in a glass retort, connected with a cooled receiver, the products of distillation, formed in the neck of the retort, are a reddish brown oil and a crystalline solid (succinic acid), while a watery fluid goes over into the receiver, leaving a blackish brown coke-like substance behind. This residue is easily rubbed to powder and is soluble in oil of turpentine (this is the so-called colophony of amber or Bernsteincolophonium *Germ.*). The oil noted above is thick, of a reddish brown color with greenish fluorescence and peculiar odor; it contains in solution a little sulphur and succinic acid. The watery liquid is a solution of succinic acid in water, and is also said to contain acetic acid and butyric acid.

In regard to the action of solvents, Helm notes that in alcohol 20 to 25 p. c. are dissolved; in ether 18–23 p. c.; in oil of turpentine 25 p. c.; in chloroform 20·6 p. c.; in amyl alcohol 20 p. c.; in carbon disulphide 24 p. c.; in methyl alcohol 13 p. c.; in benzol 9·8 p. c.; in petroleum ether 2·2 p. c.; in alcoholic solution of potash 40 to 55 p. c. The evaporation of the solution in alcohol or ether gives a brittle resin having the peculiar aromatic odor of succinite and melting at 146°. The amount of succinic acid present is usually from 5 to 6 p. c., or in some cases up to 8 p. c. The presence of this considerable quantity is taken as characteristic of true succinite or amber in the narrow sense. On the characters of amber and its occurrence in general see Helm, Schriften Ges. Danzig, **7**, No. 4, 189, 1891, and also several earlier papers in the same publication; also Conwenz, ibid., **7**, No. 3, 165, 1890.

**Obs.**—Amber occurs abundantly on the Prussian coast of the Baltic; occurring from Dantzig to Memel, especially between Pillau and Dorf Gross-Hubnicken. It occurs in England, near London, and on the coasts of Norfolk, Essex, and Suffolk; also on the coast of Denmark, Sweden, and the Russian Baltic provinces; also in western Russia and in Westphalia. It is mined extensively, and is also found on the shores cast up by the waves after a heavy storm.

Further, resins resembling amber in appearance and in many of their characters and of like use occur at many other points, but according to Helm they are to be distinguished from true succinite, or amber in the strict sense, chiefly by their containing very little or no succinic acid. Some of these other localities (see further special kinds described beyond) are: in Galicia, near Lemberg, and at Miszau; in Poland; in Moravia, at Boskowitz, etc.; in the Ural; near Christiania, Norway; in Switzerland, near Bâle; in France, near Paris, in clay, in the department of the Lower Alps, with bituminous coal; also in the department of l'Aisne, de la Loire, du Gard, du Bas-Rhin. It also occurs in various parts of Asia, as in Upper Burma. Also near Catania, on the Sicilian coast, sometimes of a peculiar opalescent blue or green tinge (see simetite, beyond); of a rich golden yellow in southern Mexico.

Amber-like resins have been found in various parts of the Green-sand formation of the United States, either loosely embedded in the soil, or engaged in marl or lignite, as at Gay Head or Martha's Vineyard; near Trenton and also at Camden and elsewhere in New Jersey, and at Cape Sable, near Magothy river, in Maryland. A mass found in the marl pits near Harrisonville, Gloucester Co., N. J., was 20 × 6 × 1 in. and weighed 64 oz. G. = 1·061 Kunz (this contains no succinic acid, Helm).

In the royal museum at Berlin there is a mass of amber weighing 18 lbs. Another in the kingdom of Ava, India, is nearly as large as a child's head, and weighs 2½ lbs.; it is intersected by veins of calcium carbonate, from the thickness of paper to one-twentieth of an inch.

It is now fully ascertained that amber and the similar fossil resins are of vegetable origin, altered by fossilization. This is inferred both from its native situation with coal, or fossil wood, and from the occurrence of insects incased in it. Of these insects, some appear evidently to have struggled after being entangled in the then viscous fluid; and occasionally a leg or wing is found some distance from the body, which had been detached in the effort to escape. Göppert has shown (Ber. Ak. Berlin, 450, 1853, Am. J. Sc., **18**, 287, 1854) that at least 8 species of plants besides the *Pinites succinifer* have afforded these fossilized resins, and he enumerates 163 species as represented by remains in them. Besides pines, species of the family *Abietineæ* and *Cupressineæ* have probably contributed to them. True succinite, however, is shown by H. Conwentz (Monograph der Baltischen Bernsteinbäume, Danzig, 1890, quoted by Helm) to have been derived from the *Pinus succinifer*.

Amber was early known to the ancients, and called *ἤλεκτρον*, *electrum*, whence, on account of its electrical susceptibilities, has been derived the word *electricity*. It was named by some *lyncurium*, though this name was applied by Theophrastus also to a stone, probably to zircon or tourmaline, both minerals of remarkable electrical properties.

Pliny mentions, as one proposed derivation of *electrum*, the fable, as he regards it, that the sisters of Phaëthon, changed into poplars, shed their tears on the banks of the Eridanus (or Padus), and that these tears were called *electrum*, from the fact that the sun was usually called *elector;* as another, that it comes from *Electrides*, the name of certain islands in the Adriatic; or another, *electrides*, the name of certain stones in Britannia, from which it exudes. He gives it as his opinion that "amber is an exudation from trees of the pine family, like gum from the cherry, and resin from the ordinary pine"; and, as proof that it was once liquid, alludes to the gnats, etc., in it. He observes that it had been long called *succinum*, because of this origin, "quod arboris succum prisci nostri credidere." He says that in his time it was "in request among women only." But "it had been so highly valued as an object of luxury that a very diminutive human effigy, made of amber, had been known to sell at a higher price than living men, even in stout and vigorous health."

**SUCCINELLITE.** Succinic acid obtained in orthorhombic crystals from amber; cf. Rg., Kr. Ch., **2**, 209, 1882. H. = 1. G. = 1·55. Luster vitreous. Colorless or white. An aromatic odor. Soluble in water. Composition corresponds to $C_4H_6O_4$ = Carbon 40·7, hydrogen 5·1, oxygen 54·2 = 100. Evaporates at a low temperature, and on cooling condenses in crystals.

Exists in amber, constituting 2½ to 6 p. c. of the mass (cf. p. 1003), and easily obtained from it by distillation. Its presence ready formed in this resin is shown by the fact that it may be separated either by water, ether, or alkalies, the amber being left after the treatment without its succinic acid.

The mineral resins immediately following are for the most part near succinite or amber. Other resins less closely related are appended to them.

**Retinite.** Amber pt. A general name applied to various resins, particularly those from beds of brown coal, which are near amber in appearance, but contain little or no succinic acid. It may conveniently serve as a generic name, since no two independent occurrences prove to be alike, and the indefinite multiplication of names, no one of them properly specific, is not to be desired.

A. A *retinite* from Halle afforded Bucholz (Schw. J., **1**, 290, 1811) 91 parts soluble in absolute alcohol, and 9 parts insoluble. The *former* gives a yellowish-brown deposit on dilution, and is more soluble in boiling dilute alcohol than in cold; and it is insoluble in pure ether and turpentine. The *latter* is also insoluble in ether. Both are soluble in alkalies. The resin fuses with more difficulty than most resins, blackens in the heat, and gives out a strong aromatic odor. By distillation yields a brown thick oil, some water containing a little acetic acid, besides carbonic acid and carburetted hydrogen.

B. Another *retinite* from the lignite at Walchow (Pogg., **59**, 61, 18—) has been called WALCHOWITE (p. 1005).

C. A resin described by Dietrich (Vh. G. Reichs., No. 8, 1875). It occurs at Skuc in Bohemia in a coal-bearing sandstone. Hard. G. = 1·092. Color dark honey-yellow. Slightly soluble in alcohol, better in benzene and chloroform. Melts to a compact mass and gives off a little succinic acid. Analysis: C 76·47, H 7·84, O 15·68. S 0·025, N *tr.*

D. Bronner (Jahr. Ver. Württ., p. 81, 1878) found in a resin from Lebanon a small amount of succinic acid, also formic acid. Analysis gave: C 74·8, H 12·3, O 12·9. 8 p. c. were dissolved in alcohol. Cf. Schraufite, p. 1006, also Helm, l. c., 1891, p. 199.

E. A resin from Japan called Japanese amber, analyzed by J. F. Eykmann in Tokio (quoted by Helm, l. c., 1891, p. 200) gave: C 83·48, H 10·45, O 6·12.

F. A resin from Greenland, analyzed by Chydenius (G. För. Förh., **2**, 549, 1878) gave: C 73·47, H 10·20, O 16·33 = 100; empirical formula deduced $C_6H_{10}O$. Helm found a small amount of succinic acid in this resin, though Chydenius obtained none.

Some other related resins, which have not received special names, are mentioned by Helm, l. c.

GEDANITE *Otto Helm*, Schriften Ges. Danzig, **4**, No. 3, 214, 1878. A resin resembling amber, but not containing succinic acid, and less rich in oxygen. Fracture conchoidal. Fragile. H. = 1·5–2. G. = 1·058–1·068. Color wine-yellow, more or less clear. Transparent. Analysis:

C 81·01 H 11·41 O 7·33 S 0·25 = 100 (ash 0·06)

Becomes opaque upon heating, finally milky, and at 140°–180° bubbles up and melts. Warm alcohol dissolves 18–25 p. c., and warm ether 40–52 p. c. Found with succinite on the shores of the Baltic. Named from *Gedanum*, Latin name of Danzig.

GLESSITE *O. Helm*. Schriften Ges. Danzig, **5**, No. 1–2, 291, 1881. A resin occurring, like gedanite, with succinite on the shores of the Baltic. It is peculiar in the presence of minute spherical cell-like forms, discerned by the microscope. Fracture conchoidal. H. = 2. G. = 1·015–1·027. Luster greasy. Color red-brown and translucent to brown or brownish black and opaque. Analysis:

C 79·36 H 9·48 O 10·72 S 0·44 = 100

Behaves nearly like succinite with solvents. When heated, begins to swell up at 120°, giving off white fumes, and at 200° melts to a thick liquid. Contains no succinic acid, but probably formic acid. Named glessite from *glessum* or *glæsum*, a name applied, as noted by Tacitus, to the amber.

RUMÄNITE *O. Helm*, Schrift. Ges. Danzig, **7**, No. 4, 186, 1891. Rumänischer Bernstein. A yellow amber-like resin obtained from different points in Rumania, as in sandstone in the Buseo district, at Telage in the Bohosa district, etc. Color brownish yellow to brown, seldom yellow. Transparent to translucent. Occurs in brittle masses, with flat conchoidal fracture. H. = 2·5–3. G. = 1·048–1·105. Analysis:

C 81·64 H 9·65 O 7·56 S 1·15 = 100

In alcohol 6·6 p. c. dissolves; in ether 14·4 p. c.; in chloroform 11·8; in benzene 14·2. Not acted upon by nitric acid in the cold, but when warmed oxidized to a yellow crumbling substance. Melts without previous swelling up at 300°. In a glass retort, a watery fluid is distilled over with evolution of hydrogen sulphide and carbon dioxide; then follows a thick reddish brown oil, while white fine crystals form in the neck which consist of succinic acid; the amount of the last varies in different samples, in four cases 0·3, 0·9, 1·35, 3·2 p. c.

SIMETITE *O. Helm & H. Conwentz*, Schriften Ges. Danzig, 5, No. 1–2, 293 *et al.*, 1881, [Malpighia, 1, 49, 1886;] *Helm*, Schriften Ges. Danzig, 7, No. 4, 198, 1891. A resin near amber from near Mt. Etna, Sicily. Remarkable for its deep red color and often showing a beautiful fluorescence. It is usually garnet-red to dark red in color and by reflected light appears nearly black; sometimes lighter yellowish red. G. = 1·052–1·068. Analysis gave Helm:

C 69·48 H 9·24 O 20·76 S 0·52 = 100

It contains only 0·4 p. c. succinic acid, but more sulphur in the form of an organic acid than succinite; Helm found 0·52 in a light colored kind, 0·67 in a dark red, and 2·4 p. c. in the black varieties. Ether dissolves 27 p. c., alcohol dissolves 21 p. c., and an alcoholic solution of potash 32 p. c.

Conwentz mentions a resin resembling amber from Yucatan, near simetite.

KRANTZITE (Fossiles Harz fr. Nienburg. Krantzit *C. Bergemann*, J. pr. Ch., **76**, 65, 1859). Near succinite. Occurs in small grains and masses of a light yellow or greenish yellow color, but reddish or brownish externally. G. = 0·968. Rather tender. Sectile and somewhat elastic. The exterior has G. = 1·002. Anal.—Landolt:

C 79·25 H 10·41 O 10·34 = 100

Corresponding nearly to the formula $C_{40}H_{64}O_4$.

Only 4 p. c. soluble in alcohol, and 6 p. c. in ether; and only softens in turpentine. In sulphuric acid gives a brown solution. Fuses at 225°, and becomes perfectly fluid at 288°; and at a higher temperature yields gas and products of distillation. The ether solution affords a brownish amorphous substance, which is elastic like caoutchouc at 12°, and fuses at 150°.

SIEGBURGITE *A. Lasaulx*, Jb. Min., 128, 1875.

A resin from the brown-coal formation in the neighborhood of Troisdorf and Siegburg in the region of the Lower Rhine. Occurs in concretionary masses in which the resin is mixed with some 50 p. c. or more of quartz sand, which, in the form of small granules, it cements together. H. = 2–2·5. Color gold-yellow to brownish red or hyacinth-red. Analyses, Lasaulx, of two samples after deducting sand:

| | | | |
|---|---|---|---|
| 1. | C 85·14 | H 7·90 | O 6·96 = 100 |
| 2. | 81·37 | 5·26 | 13·37 = 100 |

Partially soluble in alcohol; also partially in ether, which is colored yellow and after evaporation yields a yellow oil without separation of crystals. Melts and burns readily with a yellow, smutty flame giving an aromatic odor; yields a light greenish yellow oil on distillation, but no succinic acid.

Later investigated by Klinger and Pitschki (Ber. Ch. Ges., **17**, 2742, 1884). They obtained from 600 grams of the crude substance, 113 c.c. of a light oily liquid and 10 c.c. of an acid watery liquid; in the distillation styrol (25 gr.) and cinnamic acid (4·4 gr.) were deducted; benzene and toluene were present in small quantity only.

WALCHOWITE. Bergpech pt. (fr. Walchow) *Estner*, Min., 3, 1te Abth., 114, 1800. Retinit von Walchow *Schrötter*, **59**, 37, 1843. Walchowit *Haid.*, Ueb., 99, 1843, Handb., 574, 1845.

In yellow translucent masses, often striped with brown. Luster resinous. Fracture conchoidal. Translucent to opaque. H. = 1·5–2. G. = 1·0–1·069; an opaque variety 1·035.

Ratio for C, H, O = 40 : 64 : 3½. Anal.—Schrötter, Pogg., **59**, 61, 1843.

⅜ C 80·41 H 10·66 O 8·93

Fuses to a yellow oil at 250° and burns readily; becomes transparent and elastic at 140°. But it is a mixture, as alcohol takes up 1·5 p. c., and ether 7·5 p. c. Forms a dark brown solution in sulphuric acid.

Occurs in brown coal at Walchow, in Moravia, and formerly called *Retinite*. Estner also mentions a honey-yellow resin from Uttigshof in Moravia (called *Bernstein* in the Abh. Böhm. Ges., 3, 8), and another of a similar color, but a little greenish, from Litezko in Moravia.

CHEMAWINITE *B. J. Harrington*, Am. J. Sc., **42**, 332, 1891.

A resin related to amber occurring in small fragments, from the size of a pea to that of a robin's egg or larger, on a low beach on Cedar Lake near the mouth of the north Saskatchewan. It forms from five to ten per cent by volume of the sand and vegetable débris, and along a mile of the beach it was estimated to be found in a band thirty feet wide with a minimum depth of two feet (Tyrrell).

Fracture conchoidal. H. = 2·5. G. = 1·055. Color pale yellow to dark brown. Becomes electric on friction. Ratio for C : H : O = 40 : 62·79 : 3·56, or not far from recent copals from India. Analysis of material dried *in vacuo* over sulphuric acid :

$\frac{2}{2}$ C 79·96 H 10·46 O 9·49 Ash 0·09 = 100

In absolute alcohol, after 3½ hours, 21·01 p. c. were dissolved; in absolute ether, after 2 hours, 24·84 p. c. Heated in a closed tube, begins to soften at 150°, and at 180°–190° could be pressed into a single mass; at 300° became soft and elastic, but did not melt into a flowing liquid and had darkened somewhat from partial decomposition. Yielded no crystals of succinic acid in a retort.

Named Chemawinite from Chemahawin or Chemayin, the Indian name of a Hudson Bay post not far from where the resin occurs. Probably derived from one of the Tertiary or Cretaceous lignites occurring on the Saskatchewan. Some of these are known to contain resins, one of which was found by Harrington to be near the above, with H. = 2, G. = 1·066, and dissolved in absolute alcohol to 29·30 p. c.

DUXITE *Doelter*, Vh. G. Reichs., 145, 1874. A resin from the lignite of Dux, Bohemia. Opaque. Color dark brown. G. = 1·133. Melts at 246°. Fischer obtained, besides 2·72 water and 1·94 ash : C 78·25, H 8·14, O 13·19, S 0·42 = 100. Near walchowite.

MUCKITE *J. von Schröckinger*, Vh. G. Reichs., 387, 1878. A resin from the coal beds at Neudorf, Moravia, disseminated in minute particles, and in small bands. Color opaque yellow, or light brownish yellow, and transparent to translucent. H. = 1–2. G. = 1·0025. Anal.—Dietrich :

$\frac{4}{4}$ C 79·22 H 9·57 O 11·21, corresponding to $C_{20}H_{28}O_2$

Fuses between 290° and 310°. In alcohol, 14 p. c. dissolve; in ether, 40 p. c., both leaving a yellowish brown residue.

NEUDORFITE *J. von Schröckinger*, Vh. G. Reichs., 387, 1878. A resin occurring in a coal bed at Neudorf, Moravia. Color pale yellow. Luster waxy. Fracture conchoidal G. = 1·045–1·060. Anal.—Dietrich :

C 78·04, H 9·84, O 11·98, N 0·14, corresponding to $C_{18}H_{28}O_2$ = C 78·26, H 10·14, O 11·60 = 100.

Fuses at 280°. Dissolves in ether, leaving a whitish yellow resinous powder.

SCHRAUFITE *J. von Schröckinger*, Vh. G. Reichs., 134, 1875.

Occurs in small masses and in layers, in the schistose sandstone (Carpathian sandstone), near Wamma, in Bukowina. Fracture semi-conchoidal to splintery. H. = 2–3. G. = 1·0–1·12. Color hyacinth- to blood-red. Translucent. Melting point 326°, when decomposition goes on. Partially soluble in alcohol, benzene, and chloroform; completely soluble in sulphuric acid, the larger portion of the resin separating as a grayish yellow slimy mass, upon dilution with water. Formula : $C_{11}H_{16}O_2$, requiring : C 73·33, H 8·89, O 17·78 = 100. Anal.—Dietrich :

C 73·81 H 8·82 O 17·37

With this resin correspond also a resin from Mizun and Höflein, and less closely others from the neighborhood of Lemberg. Schröckinger proposes to include the several occurrences under the name *Schraufite*, after Prof. A. Schrauf, of Vienna.

This is near the resin from Lebanon, see p. 1004; cf. also John, Vh. G. Reichs., 255, 1876, and *Bronner*, Jahr. Ver. Württ., **34**, 86, 1878.

A resin near schraufite is mentioned by J. Stuart Thomson as found with the coal at Fauldhouse, Midlothian, Scotland, Min. Mag., **7**, 215, 1887.

JAULINGITE *Zepharovich*, Ber. Ak. Wien, **16**, 366, 1855.

A resin occurring in the Jauling, near St. Viet, in Lower Austria. It somewhat resembles amber, is hyacinth-red, translucent in thin splinters, may be rubbed to a yellow powder between the fingers, and has H. = 2·5, G. = 1·098–1·111. By the action of carbon disulphide a resin-like substance was obtained from this, which was brownish yellow in color ; brittle ; at 50°. softens, at 70° liquid. Easily soluble in alcohol and ether. Aromatic odor when heated. Ratio for C, H, O = 39 : 60 : 4½ = $C_{26}H_{40}O_3$, Ragsky, who obtained : $\frac{2}{2}$ C 77·97, H 10·14, O 11·89 = 100. Not soluble in a carbonated alkali, and scarcely at all in a potash solution.

A *Beta-jaulingite* was obtained from the residue, after the treatment with carbon disulphide, by the action of ether. Color brownish yellow. Softens at 135°, and becomes liquid at 160°. Dissolves easily in alcohol and ether, but not in carbonated alkali or carbon disulphide. Ratio for C, H, O = 40 : 53⅓ : 8$\frac{8}{9}$; or 18 : 24 : 4, Ragsky, who obtained : $\frac{2}{2}$ C 70·90, H 7·93, O 21·17 = 100. It contains double the oxygen of the preceding, with less, proportionally, of hydrogen.

REFIKITE *La Cava* [J. connais. médicale. Paris, 1852], *Dx.*, Min., **2**, 58, 1874.

A resin found in the lignite of Montorio, near Feramo, Abruzzes. It is amorphous, in small scales. Very soft. Fragile. Color white. Composition, $C_{20}H_{16}O_2$ = Carbon 79·0, hydrogen 10·5, oxygen 10·5 = 100. Analysis :

C 77·77 H 11·18 O 11·05 = 100

Soluble in ether and in absolute alcohol, and on boiling separates in masses or small crystals. Also soluble in boiling caustic potash.

**Köflachite** *Doelter*, Mitth. Ver. Steiermark, p. 93, 1878.

A resin from Laukowitz near Köflach in Styria, where it occurs in the Tertiary brown coal. Fracture conchoidal. G. = 1·2–1·25. Color dark brown, but reddish brown in fine splinters. Becomes electric with friction. Composition, $C_{29}H_{43}O_2$ = Carbon 82·3, hydrogen 10·2, oxygen 7·5 = 100. Analysis, Andreasch:

C 82·23 H 10·28 O 7·49 = 100

Melting point 98°, but becomes soft at a lower temperature. Easily soluble in ether; soluble in carbon disulphide, but insoluble in alcohol and caustic potash.

**Ambrite.** Ambrit (fr. N. Zealand) *Hochstetter, v. Hauer*, Vh. G. Reichs., 4, 1861. Amberite.

Amorphous; in large masses. H = 2. G. = 1·034. Luster greasy. Color yellowish gray. Subtransparent. Strong electric on friction. Fracture conchoidal.

Ratio deduced for C, H, O = 40 : 66 : 5 = Carbon 76·88, hydrogen 10·54, oxygen 12·77. Von Hauer makes the ratio 32 : 26 : 4, which is not nearer the analysis than the above. Anal.—R. Maly, l. c.:

$\frac{3}{3}$ C 76·53 H 10·58 O 12·70 Ash 0·19

Wholly insoluble in alcohol, ether, oil of turpentine, benzene, chloroform, and dilute acid. Burns with yellow smoking flame. The ash contains iron, lime, and soda.

Occurs in masses as large as the head in the province of Auckland, N. Zealand, at the Hawakawa colliery, Bay of Islands, at Waikato and at Uhangarei. It much resembles the resin of the *Dammara Australis*, or Kauri gum, which abounds on the island, and is often exported with it.

**Bucaramangite.** Resine de Bucaramanga *Boussingault*, Ann. Ch. Phys., **6**, 507, 1842. Resembles amber in its pale yellow color. G. above 1.

Ratio for C, H, O = 42 : 66 : 2½ = Carbon 82·7, hydrogen 10·8, oxygen 6·5 = 100. Insoluble in alcohol. In ether softens and becomes opaque. Fuses easily, and burns with a little smoky flame, leaving no residue. Yields no succinic acid.

An analysis gave Boussingault: C 82·7, H 10·8, O 6·5, N *tr.* = 100. C. R., **96**, 1452, 1883.

**Rosthornite** *H. Höfer*, Jb. Min., p. 561, 1871.

In lenticular masses in coal. G. = 1·076. Luster greasy. Color brown, with garnet-red reflections; in thin splinters wine-yellow. Composition, $C_{24}H_{40}O$. Anal.—Mitteregger, l. c.:

$\frac{2}{2}$ C 84·42 H 11·01 O 4·57 = 100

At 96° commences to melt to a viscous brownish red mass, which at 160° gives off bubbles and at 205° white fumes; heated to 225° the evolution of gas ceases, leaving a thin dark purplish red fluid. Insoluble in dilute nitric acid, as also in potash or alcohol. Slightly soluble in warm ether and entirely so in warm oil of turpentine. Completely soluble in benzene at ordinary temperatures. From Sonnberge, Carinthia.

**Copalite.** Fossil Copal, Highgate Resin, *Aikin*, Min., 64, 1815. Retinite pt. *Glock.*, Min., 372, 1831, *Haid*, Handb., 574, 1845. Fossil Copal *J. F. W. Johnston*, Phil. Mag., **14**, 87, 1839. Copaline *Hausm.*, Handb., 1500, 1847.

Like the resin copal in hardness, color, luster, transparency, and difficult solubility in alcohol. Color clear pale yellow to dirty gray and dirty brown. Emits a resinous aromatic odor when broken. G. = 1·010 Johnston; 1·05 Bastock; 1·053 E. Indies, Kenngott.

Ratio for C, H, O = 40 : 64 : 1 = Carbon 85·7, hydrogen 11·4, oxygen 2·9 = 100. Anal.—1, 2, Johnston. 3, Duflos [Min. Unters., **2**, 1831], Min., 5th Ed., p. 739.

| | C | H | O | Ash | |
|---|---|---|---|---|---|
| 1. *Yellow trp.* | 85·677 | 11·476 | 2·847 | — | = 100 |
| 2. *Gray* | 85·408 | 11·787 | 2·669 | 0·136 | = 100 |
| 3. E. Indies | 85·73 | 11·50 | 2·77 | — | = 100 |

Volatilizes in the air by a gentle heat. Burns easily with a yellow flame and much smoke, and hardly any perceptible ash. Slightly acted upon by alcohol. Kenngott's mineral closely resembles the Highgate copalite in its honey-yellow color, and its action with heat and alcohol.

From the blue clay (London clay) of Highgate Hill, near London, from whence it is called Highgate resin. It occurs in irregular pieces of a pale honey-yellow color.

**Ambrosine** *C. U. Shepard*, Rural Carolinian, **1**, p. 311. In rounded masses. Color yellowish to clove-brown. Fracture conchoidal. Luster resinous. Becomes electric on friction. Melts at about 250° to a clear yellowish liquid; softens at a lower temperature. Gives off "succinic acid before melting"; on fusion gives an agreeable balsam-like color, unlike that from the resins of ordinary pines, and a dark brown non-volatile fluid remains as long as the melting heat is kept up. Combustible, leaves no ash. Soluble for the most part in oil of turpentine, alcohol, ether, and chloroform, as also in potash. Stated to have been found in the phosphatic beds near Charleston, S. C. (It has been suggested that this may be only a modern resin which has been subjected to the action of salt water.)

AJKITE. A resin near amber, Ajka, Hungary (Bull. Soc. Min., **1**, 126, 1878).

WHEELERITE *O. Loew*, Am. J. Sc., **7**, 571, 1874.

A resin, yellowish in color, found in the Cretaceous beds of northern New Mexico, filling the fissures of the lignite, or interstratified in thin layers in it. Most abundantly observed in the vicinity of Nacimiento. Two analyses gave Loew:

| | | | |
|---|---|---|---|
| 1. | C 73·07 | H 7·95 | O *undet.* |
| 2. | 72·87 | 7·88 | " |

These agree closely with the formula $n(C_5H_6O)$, where $n$ is probably 5 or 6.

Soluble in ether, less so in carbon disulphide. In concentrated sulphuric acid dissolves producing a dark brown solution, from which it is precipitated by water. In alcohol the principal portion is readily dissolved, while a small part remains insoluble. The hot alcoholic extract of the resin deposits, on cooling, a few yellow flocculi. The solution, on evaporation, gives a yellowish resin very brittle, and becoming strongly electric on friction; it melts at 154°. Named for Lieut. G. M. Wheeler, U. S. Army.

IONITE *S. Purnell*, Am. J. Sc., **16**, 153, 1878. A fossil hydrocarbon found in a more or less impure condition in the lignite of Ione Valley, Amador County, California. Structure firm, earthy. Color brownish yellow. Partially soluble in cold alcohol, largely soluble in ether, completely so in chloroform. A brown tarry oil containing a small quantity of paraffin is separated by dry distillation. Exact chemical nature unknown.

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EUOSMITE. Erdharz, Kampferharz, Euosmit, *C. W. Gumbel*, Jb. Min., 10, 1864.

Amorphous, in masses of a brownish yellow color, or like that of cherry gum, and looking like common pitch. H. = 1·5. G. = 1·2–1·5. Brittle. In thin pieces transparent. Fracture conchoidal. Strongly electric on friction. Has an odor between that of resin and that of camphor. Dissolves easily in cold alcohol or ether, and hot oil of turpentine.

Ratio of C, H, O = 17 : 29 : 1 = Carbon 81·9, hydrogen 11·7, oxygen 6·4 = 100. Afforded 0·84 of ash. The ratio is almost identical with that of leucopetrite. Melts at 77°, and burns with a bright flame and very aromatic odor. Solutions of the alkalies dissolve only a little of it, after long action.

From clefts in brown coal, at Baiershof, near Thumsenreuth, in the Fichtelgebirge, and derived probably from a kind of Conifer, and one resembling the *Cupressinoxylon suæquale* Göppert.

**Bathvillite.** Bathvillite *C. Gr. Williams*, Ch. News, 7, 133, 1863. Torbanite pt.

Amorphous. Dull, and of a fawn-brown color, looking somewhat like wood in the last stage of decay. Opaque. G., after removing air of pores by air-pump, about 1·01. Very friable, but this characteristic may not be essential to the species. Insoluble in benzene. Torbanite has H. = 2·25; G. = 1·18 Heddle; color clove-brown; powder yellowish; tough.

**Comp.**—Ratio for C, H, O, from the analyses, 40 : 68 : 4, or near that of succinite, = Carbon 78·43, hydrogen 11·11, oxygen 10·46 = 100. The ratio 40 : 66 : 4 is less near, giving the percentage: Carbon 78·7, hydrogen 10·5, oxygen 10·8 = 100. Anal.—1, Williams, l. c.; 1*a*, same with ash excluded. 2, Miller; 2*a*, same with ash excluded.

| | | C | H | O | Ash |
|---|---|---|---|---|---|
| 1. | *Bathvillite* | 58·89 | 8·56 | 1·23 | 25·32 = 100 |
| 1*a*. | " | 78·86 | 11·46 | 9·68 | — = 100 |
| 2. | *Torbanite* | 63·10 | 8·91 | 8·21 | 19·78 = 100 |
| 2*a*. | " | 78·67 | 11·11 | 10·22 | — = 100 |

Williams refers here the torbanite anlyzed by Miller. Other analyses of torbanite give less oxygen. The oxygen includes a little nitrogen and sulphur. Williams makes the formula $C_{30}H_{50}O_3$ = Carbon 78·60, hydrogen 10·92, oxygen 10·48, agreeing hardly as well with the analyses as the above.

Does not melt when heated. In a platinum crucible affords a fatty odor, and burns with a dense smoky flame. No action with moderately dilute nitric acid; completely carbonized by concentrated sulphuric acid.

Obs.—Bathvillite occurs in the torbanite or Boghead coal (of the Carboniferous formation), adjoining the lands of Torbane Hill, in the grounds of Bathville, Scotland. It forms lumps which fill cavities in the torbanite. Other cavities are occupied by calcite, pyrite, etc. It may be an altered lump of resin; or else material which has filtrated into the cavity from the surrounding torbanite.

The analysis of Miller shows that some of the torbanite has the same composition. As proof of the absolute purity of the substances analyzed could not be had, the results are open to some doubt, as Williams observes.

Torbanite. Torbanite, although related to cannel coal, has a very nearly uniform composition, according to all analyses thus far made, excepting that of Miller, and this composition is like that of bathvillite, excepting less oxygen. It corresponds very nearly with the formula $C_{40}H_{68}O_{2.25}$ = Carbon 82·19, hydrogen 11·64, oxygen 6·17. The mean of five analyses (see 5th Ed., p. 757) is, Carbon 81·15, hydrogen 11·48, with oxygen about 6·0, nitrogen 1·37 = 100; excluding the nitrogen, C 82·28, H 11·54, O 6·08 = 100. Less than 1½ p. c. of torbanite is soluble in naphtha (Fyfe).

Retinellite. *Part of* Bright Yellow Loam (fr. Bovey) so saturated with petroleum that it burns like sealing-wax, *J. Milles*, Phil. Trans., 51, 536, 1760; Bitumen from Bovey, Retin asphaltum. *Hatchett*, ib., 402, 1804; Retinite. Resin of Retin Asphalt, Retinic Acid, *J. F. W. Johnston*, Phil. Mag., 12, 560, 1838 Retinellite *Dana.*

Resin-like. Light brown. Begins to melt at 121°, is perfectly fluid at 160°. and gives off a resin-like odor at 100°. Soluble in alcohol, still more freely in ether. Ratio for C, H, O = 21 : 28 : 3 = Carbon 76·8, hydrogen 8·6, oxygen 14·6 = 100. Analysis: Johnston, l. c.

C 76·86 H 8·75 O 14·39 = 100

Johnston describes salts of retinic acid with silver, lead, and lime.

The retinasphalt of Hatchett, from the Tertiary coal of Bovey in Devonshire, from which alcohol separates the above species, occurs in roundish masses, having H. = 1–2·5; G. = 1·135 Hatchett; luster slightly resinous in the fracture, often earthy externally; color light yellowish brown, sometimes green, yellow, reddish, or striped; and is subtransparent to opaque; often flexible and elastic when first dug up, though brittle on drying. Johnston, after drying the retinasphalt at 300°, obtained 53·92 p. c. of resin soluble in alcohol, 27·45 of insoluble organic matter, and 13·23 of ash = 100. The insoluble portion has not been investigated.

Xyloretinite. Xyloretin *Forchhammer*, J. pr. Ch., **20**, 459, 1840. Hartin *Schrötter*, Pogg., **59**, 45, 1843. Psathyrit *Glocker*, Syn., 8, 1847.

Massive, but crystallizes from a naphtha solution in needles of the orthorhombic system. G. = 1·115 hartine. Color white. Pulverizes in the fingers. Without taste or smell. Soluble in ether.

Ratio (Rg.) for C, H, O = 42 : 58 : 5 = Carbon 78·51, hydrogen 9·05, oxygen 12·44. $C_{20}H_{34}O_2$, deduced by Schrötter, corresponds better with the analyses. Anal.—1–3, Schrötter, l. c. 4, 5, Forchhammer, l. c.

| | C | H | O | Fusing T. |
|---|---|---|---|---|
| 1. *Hartine* | 78·26 | 10·92 | 10·82 = 100 | 210° |
| 2. " | 78·46 | 11·00 | 10·54 = 100 | |
| 3. " | 78·33 | 10·85 | 10·82 = 100 | |
| 4. *Xyloretinite* | 79·09 | 10·93 | 9·98 = 100 | 165° |
| 5. " | 78·57 | 10·81 | 10·62 = 100 | |

The *hartine* is a white resin separated by ether from a resin obtained from the brown coal of Oberhart. No. 1 is *hartine* as separated in an amorphous condition by means of naphtha; and 2, 3, crystallized from an ether solution. (Besides the hartine, two amorphous brown resins were also obtained from the solution.) *Xyloretinite* was derived by Forchhammer through the action of alcohol on fossil pine-wood from the marshes of Holtegaard in Denmark.

Scleretinite *J. W. Mallet*, Phil. Mag., **4**, 261, 1852.

In small drops or tears, from the size of a pea to that of a hazel-nut. H. = 3. G. = 1·136. Translucent in thin splinters. Color black, but by transmitted light reddish brown; streak cinnamon-brown. Luster between vitreous and resinous, rather brilliant. Brittle; fracture conchoidal. Insoluble in alcohol, ether, alkalies, and dilute acids.

Ratio for C, H, O = 40 : 56 : 4 = Carbon 80·0, hydrogen 8·0, oxygen 9·3 = 100. Anal.—J W. Mallet:

| | C | H | O | Ash |
|---|---|---|---|---|
| 1. | 76·74 | 8·86 | 10·72 | 3·68 = 100 |
| 2. | 77·15 | 9·05 | 10·12 | 3·68 = 100 |

Heated on platinum foil it swells up, burns like pitch, with a disagreeable empyreumatic smell and a smoky flame, leaving a coal rather difficult to burn, and finally a little gray ash.

In a glass tube yields a yellowish brown oily product of a nauseous empyreumatic odor. Even strong nitric acid acts slowly upon it. From the Coal-measures of Wigan, England.

GUYAQUILLITE *J. F. W. Johnston,* Phil. Mag., **13**, 329, 1838.

Amorphous. In large masses or layers. Yields easily to the knife, and may be rubbed to powder. G. = 1·092. Color pale yellow. Luster not resinous, or imperfectly so. Slightly soluble in water, and largely in alcohol, forming a yellow solution which is intensely bitter.

Ratio for C, H, O = 40 : 52 : 6 = Carbon 76·67, hydrogen 8·17, oxygen 15·16 = 100 Johnston. Begins to melt at 69½°, but does not flow easily till near 100°. As it cools becomes viscid, and may be drawn into fine tenacious threads. Soluble in cold sulphuric acid, forming a dark reddish brown solution. A few drops of ammonia put into the alcoholic solution darken the color, and finally change it to a dark brownish red.

Stated to form an extensive deposit near Guyaquil in South America.

MIDDLETONITE *J. F. W. Johnston,* Phil. Mag., **12**, 261, 1838.

In rounded masses, seldom larger than a pea, or in layers a sixteenth of an inch or less in thickness, between layers of coal. Brittle. G. = 1·6. Luster resinous. Color reddish brown by reflected light, and deep red by transmitted; powder light brown. Transparent in small fragments. No taste or smell. Blackens on exposure. Only a trace dissolved by boiling alcohol, ether, or oil of turpentine. Not altered at 210°.

Ratio for C, H, O = 40 : 44 : 2 = Carbon 86·33, hydrogen 7·92, oxygen 5·75 = 100. Johnston obtained: $\frac{8}{3}$ Carbon 86·21, hydrogen 8·03, oxygen 5·76 = 100. On a red cinder burns like resin. Softens and melts in boiling nitric acid, with the emission of red fumes; a brown flocky precipitate falls on cooling. Soluble in cold concentrated sulphuric acid.

Occurs between layers of coal about the middle of the Main coal or Haigh Moor seam, at the Middleton collieries, near Leeds, in thin layers and masses, rarely thicker than $\frac{1}{16}$ in., and little rounded masses seldom larger than a pea; also at Newcastle.

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**Tasmanite.** Resiniferous Shale (fr. Tasmania), Catal. Internat. Exhib., 1862. Tasmanite *A. H. Church,* Phil. Mag., **28**, 465, 1864.

In disks or scales thickly disseminated through a laminated shale; average diameter of scales about 0·03 in. Fracture conchoidal. H. = 2. G. = 1·18. Luster resinous. Color reddish brown. Translucent. Not dissolved at all by alcohol, ether, benzene, turpentine, or carbon disulphide, even when heated.

**Comp., etc.**—No action with hydrochloric acid; slowly oxidized by nitric acid. Readily carbonized by sulphuric acid, with evolution of hydrogen sulphide. Alkalies in solution without action. Burns readily with a smoky flame and offensive odor; fuses partially, yielding oily and solid products having a disagreeable smell. Ratio of C, H, O, S = 40 : 62 : 2 : 1 = Carbon 79·2, hydrogen 10·2, oxygen 5·28, sulphur 5·28 = 100. Anal.—Church, after rejecting 8·14 p. c. of ash:

C 79·34 H 10·41 O 4·93 S 5·32

**Obs.**—From the river Mersey, north side of Tasmania. The rock is called *combustible shale.*

TRINKERITE *G. Tschermak,* J. pr. Ch., **2**, 258, 1870, and Jb. G. Reichs., **20**, 279, 1870.

Compact and amorphous. H. = 1·5–2. G. = 1·025. Luster greasy. Color hyacinth-red to chestnut-brown. Transparent to translucent. Anal.—1, Hlasiwetz, l. c. 2, Niedzwiedzki, Vh. G. Reichs., 132, 1871.

| | | C | H | O | S | Ash |
|---|---|---|---|---|---|---|
| 1. Carpano | | 81·1 | 11·2 | 3·0 | 4·7 | None = 100 |
| 2. Gams | G. = 1·032 | 81·9 | 10·9 | 3·1 | 4·1 | — = 99·0 |

Fuses at 168°–180°, at a higher temperature gives off choking fumes. Insoluble in water, and only slightly in alcohol and ether. Soluble in hot benzene.

Occurs in large compact masses in brown coal at Carpano near Albona in Istria; also found at Gams near Hieflau in Styria. Resembles in composition the tasmanite of Church.

**Dysodile.** (Fr. Melili, Sicily.) *Paulo Boccone,* Recherches et Obs. Nouv., etc., Amsterd., 1674. Dysodile *Cordier,* J. Mines, **23**, 275, 1808. Merda di Diavolo *Ital.* Stinkkohle *Germ.* Houille papyracée, Tourbe papyracée, *Fr.*

In very thin leaves or folia, flexible, slightly elastic. G. = 1·14–1·25. Color yellow or greenish gray. Streak shining.

Very inflammable, burning with a bright flame and an odor like that of asafœtida, leaving an ash in the form of laminæ, consisting largely, as shown by Ehrenberg, of the siliceous shells of infusoria, especially of Naviculæ. Delesse found (Thèse anal. Chim., **50**, 1843) a variety from Glimbach, near Giessen, to afford water and volatile matters 49·1, carbon 5·5, ash, 45·4; of the last, 17·4 were soluble silica, 11·0 iron sesquioxide, and 10·0 clay.

Church, Ch. News, **34**, 155, 1876, has obtained for dysodile from Rotl near Bonn, after deducting ash:

C 69·01 H 10·04 O 16·90 S 2·35 N 1·70 ≐ 100

It is not certain that the sulphur may not be present as pyrite.

Originally from Melili, Sicily, forming a coaly deposit, made up of very thin paper-like leaves, which had evidently been derived from the joint decomposition and alteration of vegetable and animal matter. Reported also from the lignite deposits of Westerwald near Rolt; of Siegberg to the north of the Siebengebirge; of Saint Armand in Auvergne; Glimbach near Giessen; but the real nature of only the first of these substances has been investigated.

**Pyroretinite.** Part of Pyroretin of *A. E. Reuss*, Ber. Ak. Wien, **12**, 551, 1854; *J. Stanek*, ib., p. 554. Pyroretinite *Dana*.

Resin-like. Deposited in powder from a hot alcoholic solution of pyroretin as it cools.

Ratio of C, H, O = 40 : 56 : 4 = Carbon 80·00, hydrogen 9·33, oxygen 10·67 = 100. Analysis. —Stanek, l. c.:

C 80·02 H 9·42 O [10·56] = 100

Approaches, as Stanek states, the beta-resin of the resin of *Pinus abies* (Johnston) = $C_{40}H_{58}O_5$, and also copaivic acid (fr. Copaiba balsam), $C_{40}H_{60}O_4$, and other related compounds, showing that it is probably from coniferous trees.

Pyroretin of Reuss, the resin which affords the above, occurs in the brown coal, between Salesl and Proboscht, near Aussig in Bohemia. It occurs in masses from the size of a nut to that of a man's head, and also in plates an inch thick. It is brittle; of brownish black color; greasy-resinous luster; wood-brown powder; H. = 2·5; G. = 1·05–1·18; and resembles much brown coal. It burns with a reddish yellow flame, and a strong odor like that of burning amber, and leaves a black coal. It melts easily, decomposing and giving off white fumes, and leaves an asphalt-like mass. Reuss states evidence showing that it has probably been formed by the action of the heat of a basaltic dike on a bed of brown coal.

STANEKITE is separated from the pyroretin of Reuss by boiling alcohol, which leaves it behind. Not soluble in any fluid without decomposition, and not at all in a solution of potash. Anal.—Stanek:

$\frac{2}{2}$ C 76·71 H 7·30 O 15·99 = 100

Corresponding to C : H : O = 39 : 44 : 6, or perhaps 40 : 44 : 6. When heated gives off the odor of succinic acid.

REUSSINITE. Resin-like. Color fine reddish brown. Soluble in boiling alcohol and in ether, and not deposited from the alcoholic solution on its cooling. Stanek (l. c.) found for the composition of the resin thus obtained: C 81·09, H 9·47, O 9·44 = 100; corresponding to $C_{40}H_{55}O_{3\cdot5}$; and he regards the substance as a mixture of the above *pyroretinite*, $C_{40}H_{55}O_4$, with another resin (here designated *reussinite*) of the formula $C_{40}H_{55}O_3$.

**Leucopetrite.** Leucopetrin *L. Brückner*, J. pr. Ch., **57**, 1, 1852, in art. entitled Ueber einige eigenthümliche wachshaltige Braunkohlen.

Between a resin and wax in characters. Crystallizable in needles from solution. Color of crystals white. Melting point above 100°; and after fusion brown and partly decomposed, and hence the exact melting point not easily determinable. Soluble in ether; also 1 part in 268 of boiling absolute alcohol; but not at all in alcohol of 80 p. c.

**Comp.**—$C_{50}H_{84}O_3$, Brückner, = Carbon 81·97, hydrogen 11·47, oxygen 6·56 = 100; very nearly $C_{45}H_{67}O_{2\cdot4}$. Not at all acted upon by a hot solution of potash, or cold nitric acid.

**Obs.**—From a layer ½–2 ft. thick, in an earthy *yellowish brown* brown coal, at Gesterwitz, near Weissenfels. The material of the layer is of loam-like aspect, but gives a shining wax-like streak, has G. = 1·297 Wackenroder, and loses 22 p. c. of water at 100°. The dried mass is nearly half sand and other earthy materials. The leucopetrite is associated in the coaly layer, according to Brückner, with other organic compounds, soluble in alcohol of 80 p. c., including two resins, two wax-like substances (p. 1012), and an acid which Brückner calls *Georetinic acid* (Brücknerellite *Dana*). By a distillation of the mass of the brown coal, 28 p. c. of the whole passes over as a butter-like mass, which is related to the paraffins, but, according to Brückner, contains 2 p. c. of oxygen. It afforded : $\frac{2}{2}$ Carbon 84·04, hydrogen 14·10, oxygen [1·86], and he writes the formula $C_{55}H_{110}O$. It dissolves easily in hot absolute alcohol and ether, and very sparingly in alcohol of 80 p. c.; crystals in pearly hexagonal plates from the alcoholic solution; melts at 50°.

Named after the locality, Weissenfels (= white rock), from *λευκός*, *white*, and *πέτρος*, *stone*.

BRÜCKNERELLITE (see above) has the following characters: Crystallizable in white needles from alcoholic solution. Dissolves easily in boiling alcohol; and, if the solution is a concentrated one, crystallizes out more or less completely on cooling. Composition $C_{24}H_{44}O_8$, Brückner, =

Carbon 62·61, hydrogen 9·56, oxygen 27·83 = 100. The lead salt afforded: Carbon 43·36, hydrogen 6·59, lead oxide 34·58, oxygen [15·47] = 100.

ANTHRACOXENITE. Part of Anthracoxen (fr. Brandeisl) *Reuss, T. Laurenz,* Ber. Ak. Wien, **21**, 271, 1856, J. pr. Ch., **69**, 428, 1856. Anthracoxenite *Dana.*

Obtained as a black powder from a resin, by separating the remainder by means of ether, the anthracoxenite being insoluble in ether. Ratio of C, H, O = 40 : 38 : 7½. Anal.—Laurenz:

| | | |
|---|---|---|
| $\frac{2}{2}$ C 75·274 | H 6·187 | O 18·539 |

11 p. c. of ash were separated. Not soluble in menstrua without decomposition.

From a resin-like material, constituting layers 2½ in. thick between layers of coal, in the coal beds of Brandeisl, near Schlan in Bohemia; the mass is amorphous, and has H. = 2·5; G. = 1·181; luster externally weak adamantine; color brownish black, hyacinth-red in thin splinters by transmitted light; streak dull, yellowish brown; fracture small-conchoidal; easily rubbed to a fine powder; fuses easily; burns with a yellow smoking flame, and an odor not disagreeable. This substance was named *anthracoxene* by Reuss. The name is here appropriated to the part insoluble in ether.

The soluble part, which has been named *schlanite,* is a dark or light brown powder. Ratio for C, H, O = 40 : 52 : 3½ = Carbon 81·63, hydrogen 8·85, oxygen 9·52 = 100. Anal.—Laurenz, l. c.: $\frac{2}{2}$ C 81·47, H 8·71, O 9·82 = 100.

**Geomyricite.** Geomyricin *L. Brückner,* J. pr. Ch., **57**, 10, 1852.

Wax-like. Obtained in a pulverulent form from a solution, the grains consisting (as apparent under a microscope) of acicular crystals. Color white. Melting point 80°–83°. After fusion has the aspect of a yellowish brittle wax. No action in a solution of potash. Soluble easily in hot absolute alcohol and ether, but slightly in alcohol of 80 p. c.

**Comp., etc.**—$C_{34}H_{68}O_2$ = Carbon 80·59, hydrogen 13·42, oxygen 5·99 = 100. Anal.—Brückner, l. c.

| | | C | H | O |
|---|---|---|---|---|
| 1. | Melt. T. = 83° | 80·33 | 13·50 | [6·17] |
| 2. | " = 83 | 79·97 | 12·85 | [7·18] |
| 3. | " = 80 | 80·21 | 13·24 | [6·55] |

Burns with a bright flame. Brückner observes that the composition is very near that of the Chinese wax, Palm wax (from the S. A. palm, *Ceroxylon andicola*), Carnauba wax (from the S. A. palm, *Corypha cerifera*), for which Lewy obtained $C_{36}H_{72}O_2$ = Carbon 80·59, hydrogen 13·42, oxygen 5·99 = 100.

**Obs.**—Occurs at the Gesterwitz brown-coal deposit, in a *dark brown* layer, similar in most respects to the *yellowish brown* which afforded the leucopetrite. Its very slight insolubility in alcohol of 80 p. c. enabled Brückner to separate resins and other soluble ingredients present in the mass. L. Lesquereux states (priv. contr.) that the brown-coal beds of the basin in which Gesterwitz lies has afforded the palms *Flabelaria latania* and *Phœnicites Giebelianus,* and perhaps others, though none has yet been reported from the particular bed at Gesterwitz.

**Geocerite.** Geocerain *L. Brückner,* J. pr. Ch., **57**, 14, 1852.

Wax-like. Color white. Not observed to crystallize from its solution in alcohol. Melting point near 80°; after fusion solidifies as a yellowish wax, hard but not very brittle. Soluble in alcohol at 80 p. c. Not acted upon by a hot solution of potash.

**Comp.**—$C_{28}H_{56}O_2$ = Carbon 79·24, hydrogen 13·21, oxygen 7·55 = 100. Anal.—Brückner.

| | | |
|---|---|---|
| C 79·06 | H 13·13 | O [7·81] = 100 |
| 79·16 | 13·01 | [7·83] = 100 |

**Obs.**—From the same *dark-brown* brown coal of Gesterwitz that afforded the geomyricite, and from the same solution. The solution, after yielding the geomyricite, and next, on adding a hot solution of acetate of lead, a precipitate of a salt of lead and "geocerinsäure" (geocerellite *Dana*), finally afforded, on filtering the hot solution, the *geocerite* in the state of a jelly, which on drying became a white foliated mass. Named from *γή, earth,* and *κηρός, wax.*

GEOCERELLITE has the following characters: Color white. Brittle, and easily pulverized. No crystallization observed. Soluble freely in hot alcohol, and deposited from the solution as a jelly on cooling, with nothing crystalline under the microscope. Melting point 82°. Analysis. Brückner (l. c.): $\frac{3}{3}$ Carbon 78·61, hydrogen 12·70, oxygen 18·69 = 100. This corresponds to $C_{28}H_{66}O_4$.

**Bombiccite.** *Bechi, Achiardi,* Min. Toscana, **1**, 358, 1873. *Bombicci,* Mem. Accad. Bologna, **9**, 1869. *Guareschi,* Boll. Com. G., **2**, 70, 1871. Schrauf, Atlas, xxxv, 1873.

Triclinic. H. = 0·5–1. G. = 1·06. Transparent. Colorless. Analysis, Bechi (after deducting impurities), l. c.

| | | |
|---|---|---|
| C 74·56 | H 10·70 | O 14·74 = 100 |

This corresponds to the empirical formula $C_7HO_{13}$. Softens with heat, and fuses at 75°, and at a higher temperature it volatilizes. Insoluble in water, but extremely soluble in carbon disulphide; also soluble in ether and in alcohol.

Found in lignite at Castelnuovo d'Avane, in the upper valley of the Arno, Tuscany.

Achiardi refers to this species a fossil resin, described by Guareschi ~~(l. c.)~~ as found in the upper valley of the Arno. It occurs in irregular whitish-yellow masses, soft. It fuses easily, and burns with a smoky flame. Two analyses gave:

| | | | |
|---|---|---|---|
| 1. | C 72·72 | H 9·41 | O 17·87 = 100 |
| 2. | 76·94 | 9·12 | 13·94 = 100 |

**Hofmannite** *Bechi,* Acc. Linc. Trans., **2**, 135, 1878. Occurs in rhomb-shaped tabular crystals; colorless, tasteless, odorless. G. = 1·0565. Soluble in alcohol (5 pts. in 1000 pts. alcohol at 14°) more readily than in ether. Melts at 71° to a fluid resembling olive oil, burns with a bright flame. Composition $C_{20}H_{36}O$. Analysis gave: C 82·23, H 12·20, O 5·57. Forms a white crystalline efflorescence on lignite in the neighborhood of Siena. Named after Prof. A. W. Hofmann, of Berlin.

**Idrialite.** Quecksilberbranderz pt. Idrialine (fr. Idria) *Dumas,* Ann. Ch. Phys., **50**, 360, 1832. Idrialite *Schrötter,* Baumg. Zs., **3**, 245, **4**, 5.

In the pure state crystalline in structure. Color white. In nature found only impure, being mixed with cinnabar, clay, and some pyrite and gypsum in a brownish-black earthy material, called, from its combustibility and the presence of mercury, *inflammable cinnabar* (*Quecksilberbranderz*).

Dumas separated the idrialite by treatment with oil of turpentine and obtained: C 94·9, H 5·1 = 100, which corresponds to C : H = 3 : 2; cf. Schrötter, l. c.

Insoluble in water, and little so in alcohol or ether. Fuses at 205°. Schrötter found in one specimen of the crude mineral: 77·32 idrialite, 17·85 cinnabar, and 2·75 of other impurities.

Bödecker, Lieb. Ann., **52**, 100, 1844, obtained for the composition of a substance he derived from the crude material: $\frac{4}{4}$ Carbon 91·83, hydrogen 5·30, oxygen 2·87 = 100, corresponding to $C_{42}H_{14}O$. He derived it from the ore by sublimation in an atmosphere of carbon dioxide. Bödecker states that a black material obtained from the condensation-chambers at Idria afforded a substance which has the composition of Dumas's idrialite; and this he calls *Idryl,* supposing it to be the radical of his own idrialite.

Goldschmiedt (Ber. Ak. Wien, **80** (2), 290, 1880) has investigated a pistachio-green mineral resin of Idria occurring in nodules and as an incrustation at the mercury mines, which according to him is the substance which impregnates the hepatic cinnabar, and has been called idrialite. G. = 1·85. Composition, $C_{80}H_{56}O_2$ = Carbon 91·6, hydrogen 5·3, oxygen 3·1 = 100. Anal.: C 91·71, H 5·32, to which the formula $C_{80}H_{54}O_2$ agrees more closely.

Zepharovich (Zs. Kr., **13**, 140, 1887) has found some of the scales to be anistropic and biaxial with 2H = 101° 20′. The extinction on the tabular face is oblique and it hence probably corresponds to the clinopinacoid, the system being monoclinic.

**Aragotite** *Durand,* Proc. Acad. Cal., **4**, p. 218, 1872. A volatile hydrocarbon supposed to be related to idrialite. Occurs at the New Almaden Mine, California, in bright yellow scales, impregnating a crystalline siliceous dolomite; also on cinnabar at the Redington mine. Insoluble in oil of turpentine. alcohol, and ether.

Bertrand found the scales to be optically biaxial, the bisectrix (+) sensibly normal to the tabular face, axial angle large, dispersion $\rho < v$. Bull. Soc. Min., **4**, 87, 1881.

**Posepnyte** *J. von Schröckinger.* Vh. G. Reichs., 128, 1877.

In plates and nodules, sometimes brittle, sometimes hard. Color generally dirty light green. G. = 0·85–0·95. Separated by ether into two parts. Anal.—1, 2, Dietrich: 1, of the portion soluble in ether; 2, the insoluble portion. 3, Melville, quoted by Becker, U. S. G. Surv., Mon., **13**, 361, 1888.

| | | C | H | O |
|---|---|---|---|---|
| 1. | *Sol.* | 71·84 | 9·95 | 18·21 = 100 |
| 2. | *Insol.* | 84·27 | 11·74 | 3·99 = 100 |
| 3. | | 85·60 | 10·71 | 3·22 Ash 0·47 = 100 |

The insoluble portion is regarded as being ozocerite, and for the rest (anal. 1) the formula $C_{22}H_{36}O_4$ is calculated, requiring: C 72·52, H 9·89, O 17·59 = 100. From the Great Western mercury mine, Lake Co., California.

The substance examined by Melville (anal. 3) is regarded as doubtless posepnyte, though the characters differ somewhat from those given above. It is soft, elastic, with G. = 0·985; color reddish brown. On platinum foil, volatilizes partially at a low temperature with a suffocating, aromatic odor; at a high temperature, becomes black, fuses and boils like rubber. In a retort, a brownish yellow liquid distills over considerably below red heat; at a low red heat a dark brown liquid is obtained, leaving a black residue. Partially dissolved in alcohol; ether removes an olive-colored oil, the substance not dissolving.

**Rochlederite.** *Part of* Substanz Bituminose *Rochleder*, Ber. Ak. Wien, **6**, 53, 1851; = Melanchym *Haid.*, Lotos, **1**, 85, 216, **6**, 86, **8**, Heft 3; *Kenng.*, Ueb., 147, 1850, 134, 1853. Rochlederite *Dana.*

Resin-like. Color reddish brown. Transparent or translucent. Melting point 100°. Soluble in alcohol.

**Comp.**—Ratio of C, H, O = 40 : 56 : 6. Analysis.—Rochleder, l. c.

| | | |
|---|---|---|
| C 76·79 | H 9·06 | O 14·15 = 100 |

Burns with a yellow smoking flame, something like amber.

**Obs.**—The part soluble in alcohol of a bituminous substance called melanchyme by Haidinger, and found in masses as large as the head in the brown coal of Zweifelsruth, near Neukirchen in Eger, Bohemia. A similar substance, of somewhat lighter color, occurs at Cehnitz, near Strakonitz, in Bohemia.

The rest of the substance insoluble in alcohol has been called *melanellite.* It is black and gelatinous, as obtained by Rochleder. Separated from rochlederite, or the resinous ingredient of melanchyme, by dissolving the latter out by means of alcohol. The jelly-like mass gave: Carbon 67·14, hydrogen 4·79, oxygen 28·07 = 100. corresponding to the ratio 48 : 40 : 15 or 48 : 40 : 16 = 12 : 10 : 4. Regarded by Rochleder as an acid related to ulmic acid, but, as it was not combined with a base before analysis, there is no proof of its purity.

NATIVE HUMUS ACID. *C. v. John*, Vh. G. Reichs., 64, Feb. 3, 1891. Native humus acid has been observed at the coal-basin at Falkenau, Bohemia. It was found as a black, crumbling coaly mass leaving an ash of 5·25 p. c., and losing 59·25 p. c. water at 100°. Soluble in ammonia and in sodium carbonate, leaving only a slight residue of clay and a trace of organic matter ; hydrochloric acid precipitated the entire organic substance from the solution. Analysis, of material dried at 100°:

| | | | |
|---|---|---|---|
| $\frac{2}{2}$ C 54·98 | H 4·64 | O 39·98 | Ash 0·40 = 100 |

Calculated formula $C_{46}H_{46}O_{25}$. This substance agrees closely with a humus acid obtained by Herz (1861) from the brown coal of southern Bavaria, for which he derived the formula $C_{40}H_{36}O_{14}$.

HIRCITE. Hircine *Piddington*, Arch. Pharm., **74**, 318, Kenng., Ueb., 134, 1853.

Amorphous. Fracture conchoidal. G. = 1·10. Color exteriorly brown, within yellowish brown. Subtranslucent to opaque. Softens in boiling water, and then has the odor of a resin. In cold alcohol a little soluble ; in boiling about one-half, and the solution, which is gold-yellow, affords white flocks on cooling.

In the flame of a candle fuses and burns with a yellowish flame, like a bituminous coal, and leaves a tough coaly globule of a peculiarly strong animal odor (whence the name, from *hircus, a goat*). After complete combustion, leaves an ash. In sulphuric acid soluble, and color of solution blood-red.

**Dopplerite.** Dopplerit *Haid.*, Ber. Ak. Wien, **2**, 287, 1849, **52** (1), 281, 1865.

Amorphous. In elastic or partly jelly-like masses. When fresh, brownish black, with a dull brown streak and greasy subvitreous luster ; and when in thin plates reddish brown by transmitted light.

H. = 0·5. G. = 1·089 Fötterle. After drying, H. = 2–2·5. G. = 1·466, and luster somewhat adamantine. Becomes elastic on drying from exposure to the air. Tasteless. Insoluble in alcohol or ether.

An acid substance, or mixture of different acids, related to humic acid. Ratio for C, H, O, nearly 10 : 12 : 5, from analyses 2, 3. Anal.—1, Schrötter, Ber. Ak. Wien. **2**, 287, 1849. 2, 3, F. Mühlberg, Jb. G. Reichs., **13**, 283, 1865.

| | C | H | O | N | |
|---|---|---|---|---|---|
| 1. Aussee | 51·09 | 5·29 | 42·59 | 1·03 | = 100 |
| 2. " | 55·94 | 5·20 | 38·86 | | = 100 |
| 3. Obbürgen | $\frac{3}{3}$ 56·63 | 5·58 | 37·79 | | = 100 |

From No. 1, 5·86 of ash are excluded ; from No. 2, 5·18; from 3, 5 to 14·2 p. c. All were dried. Schrötter found the loss of water 78·5 p. c.; and Mühlberg, at 110°, for No. 2, 20·04 p. c. for an air-dried specimen ; for 3, 81·8 p. c. for a jelly-like specimen, and 19·7 for an air-dried. In caustic potash soluble, with a residue of earthy matters. The Aussee dopplerite has also been analyzed by Demel (Ber. Ch. Ges., **15**, 2961, 1882), who obtained the composition $C_{12}H_{14}O_6$, and showed that the ash (5·1 p. c.) consisted largely of lime, 72·67 p. c., with $Al_2O_3,Fe_2O_3$ 12·02 p. c. From the alkaline solutions acids gave a precipitate having the composition $C_{24}H_{22}CaO_{12}$ ; this dopplerite is accordingly regarded as a lime salt of a humus acid.

**Obs.**—Found in peat beds, near Aussee in Styria ; and at Bad Gonten in Appenzell, and Obbürgen, near Stansstad in Unterwalden, Switzerland.

Named after Bergrath Doppler (1803–1854), who was the first to bring the substance to notice.

C. W. Gümbel has referred here (Jb. Min., 278, 1858) a substance from a peat bed near Berchtesgaden. It is soft, plastic, elastic, black, of waxy luster, tasteless; on drying in the air it resembles compact coal, is brittle and velvet-black, and has H. = 2·5, G. = 1·439, luster vitreous, with powder brownish black. The air-dried material loses, at 80°, 12 p. c. of water. Unlike dopplerite, it burns with a bright yellow flame, is partially soluble in alcohol, and the alcoholic solution affords a resin (Kenng., Ueb., 142, 1858).

A pitch-black coal-like substance from the above-mentioned peat beds at Kolbenmoor, near Berchtesgaden, related to dopplerite in composition, and in *not burning* with a flame when inserted in fragments in the flame of a candle, has been analyzed by C. Gilbert Wheeler (priv. contr., dated Nuremberg, Jan. 23, 1866). It afforded him: C 50·98, H 5·36, N 3·74, O 36·14, ash 3·78 = 100. It appears to be the same substance that is here partially described by Gümbel. It is found embedded in, and entirely surrounded by, the peat; and specimens show well the transition from peat to the coal-like substance.

Phytocollite *H. C. Lewis*, Am. Phil. Soc. Philad., Dec. 2, 1881. A black gelatinous hydrocarbon, related to dopplerite, described by *T. Cooper* (Eng. Mng. J., Aug. 13, 1881) as found in a stratum of muck below a peat bed at Scranton, Penn. When first found it was jelly-like in consistency, but on exposure to the air it became tougher and elastic, somewhat like india-rubber, and finally when quite dry it was brittle and nearly as hard as coal. Only partially dissolved in hot alcohol, but completely in caustic potash. When dry burns with a yellow flame. Analysis by J. M. Stinson, of material dried at 100°, gave: C 28·99, H 5·17, N 2·46, O 56·98, ash 6·40 = 100; whence the empirical formula $C_{10}H_{22}O_{16}$ = Carbon 30·2, hydrogen 5·5, oxygen 64·3 = 100. Named from *φυτόν* and *κόλλα*, *plant-jelly*.

Dopplerite of *J. C. Deicke*, B. H. Ztg., **17**, 383. (Not Dopplerite according to *Kenng.*, Ueb., 141, 1858.) Grayish, earthy, plastic in the fingers when fresh; becoming dark reddish brown to black on drying. Yields after drying: Combustible substance 83·25, water 12·5, ash 4·25. Burns with a bright flame and intense heat, and differs from dopplerite in this respect, and also in containing much less water. From a peat bed at Finkenbach in the Canton of St. Gall, Switzerland.

## APPENDIX TO HYDROCARBONS.

The substances included here are: 1, Petroleum, passing into the viscid bitumen, maltha or mineral tar; 2, the solid bitumen Asphaltum; 3, Mineral Coal. These are in general more complex substances than those included in the preceding pages and have still less claim to be regarded as definite mineral species (though it may be a matter of convenience in many cases to have the different kinds provided with names). It is hence not unnatural to separate them from the somewhat more definite substances previously described in this chapter, although no line can be drawn between them, and the division must be made somewhat arbitrarily. In fact it may be noted that even some of the substances ordinarily classed as coals, in behavior toward solvents and in composition, approach closely to hydrocarbons already mentioned (cf. torbanite, pp. 1009, 1022.

With petroleum is to be included also another substance of the first economic importance, Natural Gas; the description of native gaseous compounds, however, does not fall within the scope of this work.

**Petroleum.** Naphtha and Petroleum. Νάφθα, *Strabo*, **16**, i. § 15, *Dioscor.*, **1**, 101. Naphtha, Bitumen liquidum candidum, *Plin.*, **2**, 109, **35**, 51. Naphtha flos bituminis *Agric.*, Ort. Caus. Subt., 45, 1544. Liquidum bitumen, nunc vocatur Petroleum, *Agric.*, Nat. Foss., 222, 1546. Erdöl, Bergöl, Steinöl, *Germ.* Mineral Oil. Kerosene. Bitume liquide *Fr.*

Pittasphalt. *Πιττασφάλτος* *Dioscor.*, **1**, 100. Pissasphaltus *Plin.*, **24**, 25, **35**, 51. Maltha *Plin.*, **2**, 108. Bergtheer *Germ.* Bitume visqueux, Bitume glutineux, Poix minerale, Mineral graisse, *Fr.* Petroleum pt. Mineral Tar. Brea *Span.*

Liquids or oils, in the crude state, of disagreeable odor; varying widely in color, from colorless to dark yellow or brown and nearly black, the greenish brown color the most common; also in consistency from thin flowing kinds to those that are thick and viscous; and in specific gravity from 0·6 to 0·9.

Petroleum passes by insensible gradations into *pittasphalt* or *maltha* (viscid bitumen); and the latter as insensibly into *asphalt* or solid bitumen.

**Comp.**—Chemically, petroleum consists for the most part of members of the paraffin series, $C_nH_{2n+2}$, varying from Marsh Gas, $CH_4$, to the solid forms. The olefines, $C_nH_{2n}$, are also present in smaller amount. The above is especially true of the American oils. Those of the Caucasus have a higher density, the volatile constituents are less prominent, they distill at about 150° and contain the benzenes, $C_nH_{2n-6}$, in considerable amount. There are present also members of the series $C_nH_{2n-8}$. The German petroleum is intermediate between the American and the Caucasian. The Canadian petroleum is especially rich in the solid paraffins.

**Obs.**—Petroleum occurs in rocks or deposits of nearly all geological ages, from the Lower Silurian to the present epoch. It is associated most abundantly with argillaceous shales, sands, and sandstones, but is found also permeating limestones, giving them a bituminous odor, and rendering them sometimes a considerable source of oil. From these oleiferous shales, sands, and limestones the oil often exudes, and appears floating on the streams or lakes of the region, or rises in oil springs. It also exists collected in subterranean cavities in certain rocks, whence it issues in jets or fountains whenever an outlet is made by boring. These cavities are situated mostly along the course of gentle anticlinals in the rocks of the region; and it is therefore probable, as has been suggested, that they originated for the most part in the displacements of the strata caused by the slight uplift. The oil which fills the cavities has ordinarily been derived from the subjacent rocks; for the strata in which the cavities exist are frequently barren sandstones. The conditions required for the production of such subterranean accumulations would be therefore a bituminous oil-bearing, or else oil-producing, stratum at a greater or less depth below; cavities to receive the oil; an overlying stratum of close-grained shale or limestone, not allowing of the easy escape of the naphtha vapors.

The two regions which now furnish the chief part of the petroleum are, first in importance, western Pennsylvania, with parts of New York and Ohio, and, second, the Baku region on the Caspian Sea, at the eastern end of the Caucasus. The oil has been known to exist at the latter locality since early times, but only recently has its economic importance been recognized.

In the United States liquid oil occurs in the *Lower Silurian*, in the "Bird's-eye" limestone of Rivière à la Rose (Montmorency), Canada, and of Watertown, N. Y., in drops in fossil coral; and in the Trenton limestone at Pakenham, Canada, the cavities of large Orthocerata sometimes hold several ounces (T. S. Hunt, Am. J. Sc., **35**, 166, 1863); on Grand Manitoulin Id., where a spring affording it rises from the Utica shale, the source possibly the subjacent limestones; at Guilderland, near Albany, from the Hudson River group, as observed in a spring by Beck; quite freely in limestone and shale near Chicago; far more so in Kentucky, in the Cumberland oil region, the wells descend 200 ft. into the Blue Limestone, in which there are bituminous shaly strata overlaid by sheets of thin-bedded compact limestone; these features prevail from Lincoln and Casey Cos., through Adair and Russell, Cumberland and Clinton Cos., Ky., and Overton and Jackson Cos., Tenn.

In the *Upper Silurian* traces have been observed in the Niagara limestone and the Medina red shales; at Gaspé, Canada, in a Lower Helderberg limestone, on Silver Brook, etc.; near Chicago, so abundant in a limestone as to ooze out, and the rock may be made to burn, owing to its presence.

In the *Lower Devonian*, the Corniferous limestone is regarded by Hunt as the source of the oil of Enniskillen, Canada, where there are large areas covered by the half-inspissated bitumen. Hunt states (l. c.) that at Rainham, Canada, on L. Erie, shells of *Pentamerus aratus* are sometimes filled with petroleum; and that in other places in the region embedded corals, *Heliophyllum* and *Favosites*, have, in certain of the layers, their cells full of oil (while in other layers it is absent from the corals), and in quarrying, the oil flows out and collects on the water of the quarry; and at Gaspé, Lower Devonian sandstones afford oil springs and give rise to beds of thickened petroleum, and the chalcedonic geodes of a trap dike, intersecting the sandstone, sometimes contain petroleum. In the *Middle Devonian*, the Black shale, or Genesee slate, is supposed by many geologists to be the principal source of the oil of Pennsylvania, the Kenawha valley, and other parts of eastern Virginia, and of Ohio and Michigan; but J. P. Lesley attributes much of the oil of western Pennsylvania to the Subcarboniferous. Near Fredonia, Chautauqua Co., and at Rockville, Alleghany Co., oil is found in connection with Chemung rocks, or the Upper Devonian (Hall).

A little oil has been observed in connection with Triassic shales at Southbury, Conn. The oil of southern California proceeds from Tertiary shales. On Trinidad, a thick oil, with asphalt, occurs in connection with lignite and other vegetable remains in the shales constituting the upper part of the Tertiary.

The oil spring of Cuba, Alleghany Co., N. Y., called the Seneca Oil Spring, long known, was described by Prof. Silliman in 1833 (Am. J. Sc., **23**, 97) as a dirty pool, about 18 ft. across, covered with a film of oil, which was skimmed off from time to time for medicinal purposes. The so-called "Seneca oil," sold at the time in the shops (and from which he often distilled naphtha for preserving potassium), he observes was not from this spring (around which the Seneca Indians then had a reserve of a square mile), but, as he was told, from Oil Creek, Venango Co., Pa., about 100 m. from Pittsburg. *Seneca Lake* has oil on its surface in some parts, and it is said to have given the name to the oil; but whether this is the true source, or whether it came from its being collected and sold by the Seneca Indians, is not clear. Hildreth in 1833 (ib., **24**, 63), and later in 1836 (ib., **29**, 86, 121, 129), gave an account of the salt wells of the Little Kenawha valley, which then afforded, he says, 50 to 100 gallons a year. He also speaks, in 1833, of a well 475 ft. deep, 30 m. N. of Marietta, Ohio, which, when first opened, discharged at intervals of 2 to 4 days, for 3 to 6 hours each time, throwing out 30 to 60 gallons of oil at each "eruption," but was then yielding only a barrel a week. In 1840 a *spouting* well of oil, at Burksville, Kentucky, was described (ib., **39**, 195); the well was bored for salt, and 200 ft. down a "fountain of pure oil was struck, which was thrown up more than 12 ft. above the surface of the earth," emitting, according to the estimate, 75 gallons a minute; it "continued to flow for several days successively," but then failed; and efforts to bring it into action again, or find another, were not successful. The petroleum of Enniskillen, Canada, was mentioned in 1844 by Mr. Murray, in the Canada Geological Report for 1846; and in 1857 wells were sunk for the collection of it. In 1859, on Oil Creek, Venango Co., Pa., a boring for salt, but 75 feet deep, let out the first *fountain* of oil of that now famous oil region. For many weeks it discharged 1,000 gallons per day. Since that time the development in western Pennsylvania has been wonderfully rapid, and at the present time the production of this oil region amounts to 30,000,000 barrels annually. See further the volumes of the Pennsylvania Geol. Survey, also Min. Res. U. S., 1883 *et seq.*, for description of localities, statements of production; also, Petroleum and Natural Gas in New York State, C. A. Ashburner, Am. Inst. Mng. Eng., read July, 1887.

Noted foreign localities are 3 miles from Ye-nan-gyoung (*Fetid-water-rivulet*), Upper Burma (and exported from Rangoon), where there are about 100 wells, from 180 to 306 feet deep, each lined with horizontal timber, but not now much worked; also Pegu, Arakan, Upper Assam, and several parts of Punjab, Baluchistán, and Afghanistán (cf. Ball., Geol. India, **3**, 124, 1881). Further on the peninsula of Apcheron on the western shore of the Caspian, at Baku, alluded to above, where naphtha exudes from argillaceous and calcareous beds, especially the former, of the Middle Tertiary (Abich), and where it has long been used for burning in lamps and for cooking; near the center of the region the light and pure naphtha oil is obtained, while along its borders the oil is a thicker petroleum, or passes into an asphalt, and solid masses of this asphalt are often seen floating in the Caspian; on the island of Cheleken, near the eastern coast of the Caspian, in Balkan Bay; on the banks of the Kuban, promontory of Taman, east side of the straits between the Azov and Black Sea; near the river Betchora, in the government of Archangel, Russia; near the village of Amiano, in Parma, Italy, whence enough was formerly obtained to light the streets of Genoa; at Zante, one of the Ionian islands (ancient Zacynthus), which has furnished oil for more than 2,000 years, its petroleum spring having been mentioned by Herodotus. Also obtained in some quantity in Galicia; in Brunswick, Hannover, Alsace, etc. Pliny mentions the oil of a spring at Agrigentum, Sicily, and states that it was collected and used for burning in lamps, as a substitute for oil. He distinguishes this oil from naphtha, which he says was too light and inflammable for such a use. Of naphtha, he mentions a locality in "Parthia" (about the sources of the Indus). Oil is found also near the city of Mexico, and on the river Lagun. Also in Venezuela, in New Zealand, Japan, China, etc.

The Baku oil fields at Balakhani, 8 miles north of Baku on the Caspian, have come into prominence especially since 1876, and they now rank as a prominent source of the commercial supply of the world. Some of the wells in the region have given phenomenal outflows (see further Min. Res. U. S., p. 463 *et seq.*, 1886).

The word naphtha is from the Persian *nafata*, signifying to *exude;* and petroleum from πέτρος, rock, and *oleum*, oil (the latter from the Greek *ἔλαιον, oil*), dating only from the middle ages (see Syn., p. 1015.

The name *pittolium* is from *πίττα*, *pitch*, and *oleum*, oil, analogous to *petroleum;* and *pittasphaltum*, from the Greek for *pitch* and *asphalt.*

The word *maltha* is from the Greek *μάλθη*, *soft wax;* it was also used sometimes for a mixture of wax and pitch, employed for making the surface of writing-tablets, and for some kinds of cements. But Pliny (2, 108) describes under this name an inflammable mud flowing from a pool at Samosata in North Syria on the Euphrates, which he says (ib., 109) was similar in nature to naphtha; and this use of the word has led to its later application to viscid bitumens.

*Petroleum in cavities in crystals.* Davy, in his examinations of the fluids in crystals (Phil. Trans., 367, and postscript, 1822), found only water, except in the case of quartz from Dauphiny. The liquid in this case was about as viscid as linseed oil; brownish in color; became solid and opaque at 13°; had a smell resembling naphtha; acted like a fixed oil when heated, the temperature of ebullition being high; and burned with flame, producing a white smoke. The cavity was $\frac{1}{3}$ in. across, but only a sixth of it was occupied by the fluid. Davy made his investigations of the fluids in crystals by having the crystals bored through to the cavity by a lapidary, and was the first to use this method.

Petrolene. Boussingault obtained from the viscid bitumen and asphalt of Bechelbronn an oil which he called *Petrolene,* and announced it as the *liquid* ingredient of all asphalt, the *solid* one being named by him *Asphaltene.* It was separated by heating in an oil bath to a temperature of 300°. None of it passed over at a temperature below 100°. He obtained for its composition, Ann. Ch. Phys., **64**, 141, 1837; **73**, 442, 1840:

| | | | | | | |
|---|---|---|---|---|---|---|
| Carbon | 87·36 | 86·78 | 87·45 | 86·98 | $\frac{3}{3}$ | 88·4 |
| Hydrogen | 11·90 | 12·20 | 12·30 | 12·70 | | 12·5 |

He writes for it the formula $C_{10}H_{16}$, making it of the camphene series $C_nH_{2n-4}$. It boiled at 280°. The vapor density is stated at 9·415, or "double that of oil of turpentine." There can be no doubt that the petrolene was a mixture of oils. See further, 5th Ed., pp. 729, 730.

The Bechelbronn tar and that similar from Lobsann (both in the Dept. du Bas-Rhin, France) are called also *Minéral Graisse* and *Graisse de Strasbourg.*

**Asphaltum.** *Ἄσφαλτος Aristot.*, *Strabo, Diosc.*, etc. Bitumen *Plin.*, **35**, 51. Asphalt, Mineral Pitch. Asphalt, Bergpech, Erdpech, *Germ.* Asphalte, Bitume, *Fr.* [For syn. of Pittasphalt or Mineral Tar (Bergtheer *Germ.*), see p. 1015.]

Asphaltum, or mineral pitch, is a mixture of different hydrocarbons, part of which are oxygenated. Its ordinary characters are as follows:

Amorphous. G. = 1–1·8; sometimes higher from impurities. Luster like that of black pitch. Color brownish black and black. Odor bituminous. Melts ordinarily at 90° to 100°, and burns with a bright flame. Soluble mostly or wholly in oil of turpentine, and partly or wholly in ether; commonly partly in alcohol.

The more solid kinds graduate into the pittasphalts or mineral tar, and through these there is a gradation to petroleum. The fluid kinds change into the solid by the loss of a vaporizable portion on exposure, and also by a process of oxidation, which consists first in a loss of hydrogen, and finally in the oxygenation of a portion of the mass.

**Comp.**—The action of heat, alcohol, ether, naphtha, and oil of turpentine, as well as direct analyses, show that the so called asphaltum from different localities is very various in composition. The following are the classes of ingredients present:

A. Oils vaporizable at about 100°, or below; sparingly present, if at all.

B. Heavy oils, probably of the Pittolium or Petrolene groups (see above); vaporizable between 100° and 250°; constituting sometimes 85 p. c. of the mass.

C. Resins soluble in alcohol.

D. Solid asphalt-like substance or substances, soluble in ether and not in alcohol; black, pitch-like, lustrous in fracture; 15 to 85 p. c.

E. Black or brownish black substance or substances not soluble either in alcohol or ether; similar to D in color and appearance, Kersten; brown and ulmin-like, Völckel; 1 to 75 p. c.

F. nitrogenous substances; often as much as corresponds to 1 or 2 p. c. of nitrogen.

**Obs.**—Asphaltum belongs to rocks of no particular age. The most abundant deposits are superficial. But these are generally, if not always, connected with rock deposits containing some kind of bituminous material or vegetable remains.

Some of the noted localities of asphaltum are the region of the Dead Sea, or Lake Asphaltites, whence the most of the asphaltum of ancient writers; a lake on Trinidad, 1½ m. in circuit, which is hot at the center, but is solid and cold toward the shores, and has its borders over a breadth of ¾ m. covered with the hardened pitch with trees flourishing over it; and about Point La Braye, the masses of pitch look like black rocks among the foliage; at various places in S. America, similar lakes, as at Caxitambo (not Coxitambo), Peru, which is used at Payta, on the coast (under the equator), for pitching boats, etc.; at Berengela, Peru, not far from Arica (S.), where it is put to the same use; in California, near the coast of St. Barbara, an area of some acres; in a large bed, near Avlona in Albania (G. = 1·205). Also in smaller quantities, sometimes disseminated through shale and sandstone rocks, and occasionally limestones, or collected in cavities or seams in these rocks; near Matlock, Derbyshire, in stalactitic masses; Poldice mine in Cornwall; Haughmond Hill in Shropshire; at Bastennes and Dax, Dept. of Landes, constituting 6 p. c. of a sandy deposit; Val de Travers, Neuchâtel, impregnating a bed in the Cretaceous formation, and serving as a cement to the rock, which is used for building; impregnating dolomite on the island of Brazza in Dalmatia; in the Caucasus; in gneiss and mica schist in Sweden.

**Elaterite.** Subterranean Fungus (fr. Derbyshire) *Lister*, Phil. Trans., 1673. Elastic Bitumen. Mineral Caoutchouc. Bitume élastique *Delaméth.*, J. Phys., **31**, 31, 1787. Elastic Bitumen *Hatchett*, Linn. Trans., **4**, 146, 1797. Elastisches Erdpech *Klapr.*, Beitr., **3**, 107, 1802. Elastisches Erdharz *Germ.* Elaterit, Fossiles Erdharz, *Hausm.*, Handb., **1**, 87, 1813.

Masssive, amorphous. G. = 0·905–1·233 Derbyshire. Soft, elastic, sometimes adhering to the fingers (*a*); also moderately soft and elastic; much like india-rubber (*b*); and occasionally hard and brittle (*c*), embedded in the softer kinds. Color brown, usually dark brown. Subtranslucent; sometimes dark orange-red by transmitted light.

Johnston analyzed the three kinds, A, B, C, separately (Phil. Mag., **13**, 22, 1838). He mentions the action of ether only on the B, from which it separated but 18 p. c. of the mass; and the two analyses given are those of the undissolved material. Analyses:

|  | C | H |  |
|---|---|---|---|
| 1. A | 85·47 | 13·28 | = 98·75 |
| 2. B | 84·38 | 12·58 | = 96·96 |
| 3. B | 83·67 | 12·54 | = 96·21 |
| 4. C | 85·96 | 12·34 | = 98·30 |
| 5. C | 86·18 | 12·42 | = 98·60 |

He states that the loss in A and C may be partly or wholly oxygen, and that in the case of C, of the insoluble residue, 3–3·8 p. c. is oxygen. He thus leaves the constitution of elaterite in doubt. It appears to be partly a carbohydrogen near ozocerite, and partly an oxygenated insoluble material.

It is found at Castleton in Derbyshire, in the lead mine of Odin, along with lead ore and calcite, in compact reniform or fungoid masses, and is abundant. Also reported from St. Bernard's Well near Edinburgh; Chapel quarries in Fifeshire; a coal mine at Montrelais, at the depth of 230 feet; and, according to Hausmann (Handbuch, 3, 273), at Neuchâtel, and on the island of Zante. A similar material in external characters has been met with at Woodbury, Ct.

A mineral tar from the Old Red Sandstone at Craig Well, near Dingwall, Ross-shire, is described by W. Morrison (Trans. Ed. G. Soc., 5, 500, 1888, and Min. Mag., 8, 133, 1889). It is black, lustrous, sticky, of the consistence of tar, and occurs associated with albertite. Insoluble in acids, alkalies, alcohol, but soluble in paraffin oil, and partially soluble in ether, leaving an inflammable residue. Melts at about 140°. On dry distillation yields an inflammable oil, a gas and water. A similar tar occurs in the Carboniferous limestone of Derbyshire.

Analyses, Macadam, Min. Mag., 8, 136, 1889: 1, 2, of elaterite; 3, of mineral pitch.

| | C | H | O, etc. | N | S | |
|---|---|---|---|---|---|---|
| 1. Derbyshire | 83·62 | 11·19 | 4·78 | 0·17 | 0·24 | = 100 |
| 2 " | 82·80 | 11·92 | 4·92 | 0·11 | 0·25 | = 100 |
| 3. Dingwall | 81·19 | 13·37 | 4·45 | 0·13 | 0·86 | = 100 |

*Coorongite* is a kind of mineral caoutchouc from the Coorong district, South Australia; analysis gave: C 64·73, C (fixed) 1·00, H 11·63, O 20·38, $H_2O$ 0·47, ash 1·79 = 100. Cf. G. C. Morris, Proc. Acad. Philad., 131, 1877.

SETTLING STONES RESIN. New Mineral Resin fr. Settling Stones, *J. F. W. Johnston*, Edinb. J. Sc., 4, 122, 1831, Phil. Mag., **14**, 88, 1839. Settlingite *Dx.*, Min., 2, 42, 1874. In the form of drops, more or less rounded, or flattened, as if once fluid or soft, and found incrusting the rocky walls of a vein at an old lead mine in Northumberland, known by the name of Settling Stones, resting on and occasionally covered by calcite and pearl spar; the rock is the Mountain limestone (Subcarboniferous). The resin is hard, brittle under the hammer, but difficult to reduce to powder; G. = 1·16–1·54; color from pale yellow to deep red; a pale green opalescence; *does not melt at* 205°. Burns in the flame of a candle. Very slightly acted upon by alcohol. An analysis afforded Johnston:

C 85·133 H 10·853 Ash 3·256 = 99·242

But Johnston adds: "It is therefore doubtful whether this resinoid substance contains oxygen or not. It may be only an impure carbo-hydrogen." It is very slightly acted upon by alcohol. Gives empyreumatic products when fused in a closed tube. It has close relations to elaterite.

BERENGELITE *Johnston*, Phil. Mag., **13**, 329, 1838. Asphaltum-like. Color dark brown, with a tinge of green. Powder yellow. Luster of surface of fracture resinous. Anal.—Johnston: C 72·47, H 9·20, O 18·33 = 100, corresponding to the ratio for C, H, O = 40 : 62 : 8. Forms a solution with cold alcohol, which is bitter to the taste. On evaporation the resin obtained has a clear red color, and remains soft and viscid at the ordinary temperature. Nearly insoluble in caustic potash. Odor resinous, disagreeable; but after fusion for some time at 100°, this odor is succeeded by an agreeable one; on cooling it regains the original odor. It is said to form a lake like that of Trinidad, in the province of St. Juan de Berengela, about 100 m. from Arica, Peru, and is used at Arica for paying boats and vessels.

BIELZITE *G. Benkö* and *K. Jahn*, Zs. Kr., **13**, 68, 1887.

Massive. Fracture subconchoidal. Brittle. H. = 1–2. G. = 1·249. Luster resinous. Color brownish black. Opaque. Analysis: $\frac{2}{2}$ C 79·74, H 6·34 = 86·08. Melts easily and burns with smoky flame; at 175° becomes soft and at 330° swells up and becomes dry, leaving on cooling a black shining coal. Dissolves in considerable part in chloroform and carbon disulphide; much less soluble in alcohol, ether, and benzene. From Zsil-Vajdej, Transylvania. Named after E. A. Bielz.

PIAUZITE. Retinit von Piauze, Piauzit, *Haid.*, Pogg., **62**, 275, 1844. An asphalt-like substance, remarkable for its high melting-point, 315°. It occurs slaty massive; color brownish or greenish black; thin splinters colophonite-brown by transmitted light; streak light brown, amber-brown; H. = 1·5; G. = 1·220; 1·186 Kenngott. After melting, it burns with an aromatic odor and much smoke, leaving 5·96 per cent of ash. Soluble in ether and caustic potash, also largely in absolute alcohol. Heated in a glass tube a yellowish oily fluid is distilled, having an acid reaction.

Obtained from a bed of brown coal at Piauze, near Neustadt in Carniola; on Mt. Chum, near Tüffer in Styria, where thousands of pounds have been obtained. It much resembles a black lamellar coal (cf. Kenngott, Jb. G. Reichs., 7, 91, 1856).

WURTZILITE *W. P. Blake*, Eng. Mng. J., **48**, 542, Dec. 21, 1889; Trans. Am. Inst. Mng. Engineers, Feb. 1890. *Henry Wurtz*, Mng. Eng. J., **49**, 106, 1890.

From the Uinta Mountains, in Wasatch Co., Utah, between Salt Lake and the valley of Green River, not far from the source of uintahite, or "gilsonite" (see p. 1020).

It is a firm, black solid, and breaks with a brilliant conchoidal fracture, and has a general resemblance to jet or some of the cannel coals. Sectile, the shavings having a degree of elasticity, but if bent too far, or suddenly, snap like glass; when slowly pressed and warmed a flake may be bent nearly double. In very thin plates, deep red. The color by reflected light jet-black. H. = 2–3. G. = 1·030. Does not fuse in boiling water, but becomes softer and tougher, and is more plastic. Melts in the flame of a candle, takes fire, and burns with a bright, luminous flame, with little smoke, giving off a strong bituminous odor. Fused in a glass tube it gives off a dense cloud of white and yellow smoke and distills over a thick, brown tarry oil with a strong odor, and leaves a small residue of fixed carbon. Fragments warmed in the hand emit a strong odor like that of some of the crude petroleums, which is rather offensive. It resists the usual solvents of bitumen.

Named *Wurtzilite* after Dr. Henry Wurtz, of New York.

On the relations of uintahite, albertite, grahamite, and asphaltum in general, see W. P. Blake, Trans. Am. Inst. Mng. Eng., read Feb., 1890. Further on the occurrence of various bituminous substances and coals, in Utah and Colorado, with a discussion as to their origin, see Stone, Am. J. Sc., **42**, 148, 1891.

The following are related to asphaltum.

**Albertite** *Robb.* Melan-Asphalt *Wetherill,* Trans. Am. Phil. Soc. Philad., 353, 1852. Differs from ordinary asphaltum in being only partially soluble in oil of turpentine, and in its very imperfect fusion when heated. It has H. = 1–2; G. = 1·097; luster brilliant, pitch-like; color jet-black. Softens a little in boiling water; in the flame of a candle shows incipient fusion. According to imperfect determinations, only a trace soluble in alcohol; 4 p. c. in ether; 30 in oil of turpentine. Wetherill obtained in an ultimate analysis: Carbon 86·04, hydrogen 8·96, oxygen 1·97, nitrogen 2·93, S *tr.*, ash 0·10 = 100.

Occurs filling an irregular fissure in rocks of the Subcarboniferous age (or Lower Carboniferous) in Nova Scotia.

This and the related substances have been usually regarded as inspissated and oxygenated petroleum. Peckham, however, takes a different view, cf. Am. J. Sc., **48**, 362, 1869. For an article on its mode of occurrence, see Hitchcock, Am. J. Sc., **39**, 267, 1865.

An albertite from the Old Red Sandstone at Kiltearn (Strathpeffer), Ross-shire, has been described by W. Morrison, Min. Mag., **6**, 101, 1884; Honeyman, ibid., 7, 77, 1886.

**Cloustonite** *Heddle,* Min. Mag., **3**, 222, 1879. Occurs in patches in blue limestone and in blue flags at Inganess, Orkney. Brittle. H. = 3. Luster brilliant like obsidian. Color jet-black. Soluble in benzene. At a red heat it gave: 47·8 p. c. of illuminating gas, 51·8 carbon, 0·24 ash; 0·1 p. c. volatile below 210°. Named after Dr. Clouston, who in 1839 wrote an account of the geology and mineralogy of Orkney.

**Grahamite** *Wurtz.* Coal or Asphalt *Lesley,* Proc. Am. Phil Soc. Philad., **9**, 183, 1863; Grahamite *Wurtz,* Rep. Min. Format. in W. Virginia, 1865, Am. J. Sc., **42**, 420, 1866. Proc. Am. Assoc., **18**, 124, 1869. See also Wurtz, Gas Light Journal, Oct. 2, 1869; S. F. Peckham, ib., Dec. 2, 1869.

Resembles albertite in its pitch-black, lustrous appearance; H. = 2; G. = 1·145. Soluble mostly in oil of turpentine; partly in ether, naphtha, or benzene; not at all in alcohol; wholly in chloroform and carbon disulphide. No action with alkalies or hot nitric or hydrochloric acid. Melts only imperfectly, and with a decomposition of the surface; but in this state the interior may be drawn into long threads.

Occurs in W. Virginia, about 20 m. in an air line S. of Parkersburg, filling a fissure (shrinkage fissure) in a sandstone of the Carboniferous formation; and supposed to be, like the albertite, an inspissated and oxygenated petroleum. Jenney has manufactured grahamite from petroleum (Am. Chemist, **5**, 359). The material is partly columnar from a fracturing as a result of contraction in the material, the structure being vertical to the sides of the vein. Named after J. Lorimer Graham of New York and Col. Graham of Baltimore.

A similar deposit occurs in Huasteca, Mexico (J. P. Kimball, Am. J. Sc., **12**, 277, 1876). That from the Cristo mine (*cristo-grahamite*) has been analyzed by W. Wallace. G. = 1·156.

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|---|---|---|---|---|
| Volatile matter........ | Illum. gas 61·32 | S 0·46 | $H_2O$ 0·36 | = 62·14 |
| Coke Carbon.......... | 31·63 | 0·37 | Ash 5·86 | = 37·86 |
| | | | | 100·00 |

**Uintahite** or Unitaite *W. P. Blake,* Eng. Mng. J., Dec. 26, 1885. Gilsonite. A variety of asphalt from the Uinta (or Uintah) valley, near Fort Duchesne, Utah. Occurs in masses several inches in diameter, with conchoidal fracture; very brittle. H. = 2–2·5; G. = 1·065–1·070. Color black, brilliant, and lustrous; streak and powder a rich brown. A non-conductor of electricity; electrically excited by friction.

It fuses easily in the flame of a candle and burns with a brilliant flame, much like sealing wax; and like sealing-wax, it will give a clean sharp impression from a seal. Unless the melted mineral is very hot, it does not adhere to cold paper. It has considerable plasticity while warm, and is not sticky, but retains after melting its lustrous black and smooth surface. By distillation a very small quantity of a clear white and dense oil is given off, and a little gas or vapor. It is much more readily dissolved by the heavy oils and fats than by the lighter and more volatile menstrua. Thus it dissolves and incorporates quickly in heavy lubricating petroleum, while the white distillates from petroleum have little or no effect upon it at ordinary temperatures. So also it freely dissolves in oil of turpentine when warmed, but it does not readily dissolve in cold spirits of turpentine. Ether apparently does not attack fragments, but the powder is slowly dissolved. Soluble in ordinary alcohol.

Also called *gilsonite* after Mr. S. H. Gilson of Salt Lake City.

**Mineral Coal.** *'Ανθρακευτὰ δ' ὅσα τῶν τοιούτων γῆς πλέον ἔχει ἢ καπνοῦ* [ = Coal-like substances which have in them more of earth than of smoke or fire] *Aristot.*, *Μετεωρολογ.*, 4, 9. *Εν ῷ* (river Pontus in Thrace) *τινας λίθους οι καίονται* [ = Certain stones which burn] *Aristot*, *Περὶ Θαυμ 'Ακουσμ.*, c. 115. *Οὓς δὲ καλοῦσιν εὐθὺς αιθρακας τῶν θρυπτομένων* (? *ὀρυττομένων*) *διὰ τὴν χρείας εισι γεώδεις*, etc. [ = Those (of minerals) dug for use, which are called simple coals, are earthy, but will kindle and burn like charcoal] (fr. Liguria). *Theophr.*, 16 (in Schneider's edit.), 315 B.C. *Ενιοι δὲ τῶν θραυστῶν ἀνθρακοῦνται τῇ καύσει και διαμένουσι πλείω χρόνον* [ = Some brittle stones become by burning like glowing coals, and remain so a long time] (fr. Bena in Thracia, and the promontory of Erineas). *Theophr.*, 12. *Θρακιας λίθος* *Aristot.* *Γαγγιτης λίθος* *Strabo.* *Γαγατης λίθος*, *Θρακίας λίθος*, *Diosc.*, 5, 145, 146. Thracius lapis, Gemma Sammothracia, *Plin.*, 33, 30, 37, 67. Gagates *Plin.*, 36, 34. Steinkohle *Germ.* Houille, Charbon fossile, *Fr.*

Compact massive, without crystalline structure or cleavage; sometimes breaking with a degree of regularity, but from a jointed rather than a cleavage structure. Sometimes laminated; often faintly and delicately banded, successive layers differing slightly in luster.

Fracture conchoidal to uneven. Brittle; rarely somewhat sectile. H. = 0·5–2·5. G. = 1–1·80. Luster dull to brilliant, and either earthy, resinous, or submetallic. Color black, grayish black, brownish black, and occasionally iridescent; also sometimes dark brown. Opaque. Without taste, except from impurities present. Insoluble in alcohol, ether, naphtha, and benzene, excepting at the most 2 or 3 p. c. (rarely 10?); usually less than 1 p. c. Insoluble in a solution of potash. Infusible to subfusible; but often becoming a soft, pliant, or paste-like mass when heated. On distillation most kinds afford more or less of oily and tarry substances, which are mixtures of hydrocarbons and paraffin.

**Var.**—The variations depend partly (1) on the amount of the volatile ingredients afforded on destructive distillation; or (2) on the nature of these volatile compounds, for ingredients of similar composition may differ widely in volatility, etc.; (3) on structure, luster, and other physical characters.

Coal is in general the result of the gradual change which has taken place in geological history in organic deposits, chiefly vegetable, and its form and composition depend upon the extent to which this change has gone on. Thus it passes from forms which still retain the original structure of the wood (peat, lignite) and through those with less of volatile or bituminous matter to anthracite and further to kinds which approach graphite, like the coal of Rhode Island. (Cf. *schungite*, p. 8.)

1. Anthracite. Anthracit *Karst.*, Tab., 58, 96, 1808. Glanzkohle *Germ.* H. = 2–2·5. G. = 1·32–1·7, Pennsylvania; 1·81, Rhode Island; 1·26–1·36, South Wales. Luster bright, often submetallic, iron-black, and frequently iridescent. Fracture conchoidal. Volatile matter after drying 3–6 p. c. Burns with a feeble flame of a pale color.

The anthracites of Pennsylvania contain ordinarily 85–93 per cent. of carbon; those of South Wales, 88–95; of France, 80–83; of Saxony, 81; of southern Russia, sometimes 94 per cent.

Anthracite graduates through semi-anthracite into bituminous coal, becoming less hard and containing more volatile matter; and an intermediate variety is called *free-burning* anthracite.

*Native Coke.* Carbonite. More compact than artificial coke, and some varieties afford considerable bitumen. From the Edgehill mines, near Richmond, Va., according to Genth, who attributes its origin to the action of a trap eruption on bituminous coal. (Cf. Wurtz, Trans. Am. Inst. Mng. Eng., 3, 457, 1875.)

2. Bituminous Coal. Schwarzkohle *Hausm.*, Handb., 73, 1813. Steinkohle pt. *Germ.* Under the head of Bituminous Coals, a number of kinds are included which differ strikingly in the action of heat, and which therefore are of unlike constitution. They have the common characteristic of burning in the fire with a yellow, smoky flame, and giving out on distillation hydrocarbon oils or tar, and hence the name *bituminous.* The *ordinary* bituminous coals contain from 5–15 p. c. (rarely 16 or 17) of oxygen (ash excluded); while the so-called *brown coal* or *lignite* contains from 20–36 p. c., after the expulsion, at 100°, of 15–36 p. c. of water. The amount of hydrogen in each is from 4–7 p. c. Both have usually a bright, pitchy, greasy luster (whence often called *Pechkohle* in German), a firm compact texture, are rather fragile compared with anthracite, and have G. = 1·14–1·40. The *brown* coals have often a brownish-black color, whence the name, and more oxygen, but in these respects and others they shade into ordinary bituminous coals.

The ordinary bituminous coal of Pennsylvania has G. = 1·26–1·37; of Newcastle, England. 1·27; of Scotland, 1·27–1·32; of France, 1·2–1·33; of Belgium, 1·27–1·3. The most prominent kinds are the following:

(*a*) *Caking* or *Coking Coal.* A bituminous coal which softens and becomes pasty or semi-viscid in the fire. This softening takes place at the temperature of incipient decomposition, and is attended with the escape of bubbles of gas. On increasing the heat, the volatile products which result from the ultimate decomposition of the softened mass are driven off, and a coherent, grayish-black, cellular, or fritted mass (*coke*) is left. Amount of coke left (or part not volatile) varies from 50–85 p. c. A caking coal will lose its caking quality if kept heated for 2 or 3 hours at 300°, and sometimes on mere exposure for a time to the air.

(*b*) *Non-Caking Coal.* Like the preceding in all external characters, and often in ultimate composition; but burning freely without softening or any appearance of incipient fusion.

Percentage of volatile matter same as for caking coal, but the *coke* is not a proper coke, being in powder, or of the form of the original coal.

There are all gradations between caking and non-caking bituminous coals. In external characters the two kinds are alike. They often break into layers; and there is besides a horizontal banding arising from a succession of very thin *non-separable* layers, slightly differing in luster or shade of color. *Cherry coal* or *soft coal* (of England) is a non-caking coal igniting well and burning rapidly, while *splint* or *hard coal* ignites less readily, burns less rapidly, owing to the smaller amount of volatile matter. Coals which do not cake on burning are called *free-burning* coals, while the caking are called *binding* coals.

(*c*) *Cannel Coal* (Parrot Coal). A variety of bituminous coal, and often caking; but differing from the preceding in texture, and to some extent in composition, as shown by its products on distillation It is compact, with little or no luster, and without any appearance of a banded structure: and it breaks with a conchoidal fracture and smooth surface; color dull black or grayish black. On distillation it affords, after drying, 40 to 66 of volatile matter, and the material volatilized includes a large proportion of burning and lubricating oils, much larger than the above kinds of bituminous coal; whence it is extensively used for the manufacture of such oils. It graduates into oil-producing coaly shales, the more compact of which it much resembles. The original *Parrot coal* is a cannel from near Edinburgh, which burns with a crackling noise, whence the name (Percy); and *Horn coal*, a kind from South Wales, which emits when burning something of the odor of burning horn.

*Torbanite.* A variety of cannel coal of a dark brown color, yellowish streak, without luster, having a subconchoidal fracture; H = 2·25; G. = 1·17–1·2. Yields over 60 p. c. of volatile matter, and is used for the production of burning and lubricating oils, paraffin, illuminating gas. Named from the locality at Torbane Hill, near Bathgate in Linlithgowshire, Scotland. Also called *Boghead Cannel* (see pp. 1008, 1009).

(*d*) *Brown Coal* (Braunkohle *Germ*., Pechkohle pt. *Germ*., Lignite). The prominent characteristics of brown coal have already been mentioned. They are non-caking, but afford a large proportion of volatile matter. They are sometimes pitch-black (whence Pechkohle pt. *Germ*.), but often rather dull and brownish black. G. = 1·15–1·3; sometimes higher from impurities. It is occasionally somewhat lamellar in structure.

Brown coal is often called *lignite.* But this term is sometimes restricted to masses of coal which still retain the form of the original wood. *Jet* (Jaïet *Fr*., Gagath *Germ*.) is a black variety of brown coal, compact in texture, and taking a good polish, whence its use in jewelry.

*Earthy Brown Coal* (*Erdige Braunkohle*) is a brown friable material, sometimes forming layers in beds of brown coal. But it is in general not a true coal, a considerable part of it being soluble in ether and benzene, and often even in alcohol; besides affording largely of oils and paraffin on distillation. For a notice of "coal" of this kind see under LEUCOPETRITE, p. 1011. Such a coal is sometimes called *wax coal* and *paraffin coal* (Wachskohle, Paraffinkohle, *Germ*.). See also BATHVILLITE, p. 1008.

*Mineral Charcoal.* Fibrous charcoal-like substance often found covering the surfaces between layers of coal, and observed in coal of all ages. It is soft, and soils the fingers like charcoal. One variety of it is a dry powder.

**Comp.**—Most mineral coal consists mainly of *oxygenated hydrocarbons.* On p. 1008 it is shown that the kind of cannel coal called *torbanite* and the substance *bathvillite* are closely related in composition, as well as insolubility, to succinite; and it is probable that other cannel coals contain this or some related compound; and that oil-producing (not oil-bearing) shales include a similar kind of hydrocarbon. The ordinary bituminous coals often have 10 to 15 p. c. of oxygen, and may be of analogous composition; though differing much in the precise constitution of these hydrocarbons, some containing such as produce a pasty fusion or incipient decomposition when heated (caking), and others such as undergo no semi-fusion (non-caking). The brown coals, in which there are 20 to 35 p. c. of oxygen, must include other kinds of oxygenated hydrocarbons, of the insoluble kinds. But microscopic examinations appear to show that woody fiber is present in it in various stages of alteration.

Besides oxygenated hydrocarbons, there may also be present *simple hydrocarbons* (that is, containing no oxygen). This would seem to follow from the small percentage of oxygen (2–3 p. c.) in the Tyneside cannel, while the hydrogen is as large in amount as in any cannel or bituminous coals. And there are various bituminous coals, low in oxygen, that suggest the same conclusion. At present, however, chemistry knows of no simple hydrocarbons that are insoluble in naphtha and benzene.

The presence of *free carbon* is naturally inferred from the composition of coals like the anthracites, which afford very little volatile matter. But even these coals contain ordinarily 1·5 to 2·5 p. c. of each oxygen and hydrogen; and Berthelot holds that they are hydrocarbon compounds like other coals.

The portion of coal soluble in naphtha or benzene, although small in amount, indicates the presence of other hydrocarbons—simple or oxygenated—oils or resins. Their nature remains to be ascertained. Fyfe obtained by means of naphtha, from the Torbane mineral, 1·2 and 1·4 p. c.; from cannel coal, 2–4 p. c.; and from Newcastle caking, in three experiments, 4·2, 5·8, 9·8 p. c. of soluble material. These results do not accord with the ordinary statements with regard to the insolubility of coal, and the subject needs more extended study.

Coals often contain *resins* disseminated in *visible* points through the mass, which may or may not be of soluble kinds.

*Sulphur* is present in nearly all coals. It is supposed to be usually combined with iron, and when the coal affords a *red ash* on burning, there is reason for believing this true. But Percy mentions a coal from New Zealand which gave a peculiarly white ash, although containing 2 to 3 p. c. of sulphur, a fact showing that it is present not as a sulphide of iron, but as a constituent of an organic compound. The discovery by Church of a resin containing sulphur (see TASMANITE, TRINKERITE, etc., p. 1010) gives reason for inferring that it may exist in this coal in that state, although its presence as a constituent of other organic compounds is quite possible. Sulphur is also present as an organic compound in succinite (Helm, p. 1002).

The presence of *nitrogen*, sometimes 2 p. c., proves the presence of nitrogenous hydrocarbons; but of what nature is unknown.

The impurities present, which constitute the *ash* of the coal, consist of silica or quartz, oxide of iron, clay, and other aluminous silicates, or such ingredients as make up the mud and clay of fine soil or alluvium; also some silica, potash, and soda, derived from the original vegetation. The ash in the purest mineral coal amounts to but 0·25 to 1 p. c.; but in that which passes for the best there are ordinarily 5 to 8 p. c.; and in most that is used for fuel there are 8 to 15 p. c.

Coal occurs in beds, interstratified with shales, sandstones, and conglomerates, and sometimes limestones, forming distinct layers, which vary from a fraction of an inch to 30 feet or more in thickness. In the United States, the anthracites occur east of the Alleghany range, in rocks that have undergone great contortions and fracturings, while the bituminous are found farther west, in rocks that have been less disturbed; and this fact and other observations have led geologists to the view that the anthracites have lost their bitumen by the action of heat. For observations on the geological relations of coal beds, reference may be made to geological treatises.

The *origin* of coal is mainly vegetable, though animal life has contributed somewhat to the result. The beds were once beds of vegetation, analogous, in most respects, in mode of formation to the peat beds of modern times, yet in mode of burial often of a very different character. This vegetable origin is proved not only by the occurrence of the leaves, stems, and logs of plants in the coal, but also by the presence throughout its texture, in many cases, of the forms of the original fibers; also by the direct observation that peat is a transition state between unaltered vegetable débris and brown coal, being sometimes found passing completely into true brown coal. *Peat* differs from true coal in want of homogeneity, it visibly containing vegetable fibers only partially altered; and wherever changed to a fine-textured homogeneous material, even though hardly consolidated, it may be true brown coal

Extensive beds of mineral coal occur in Great Britain; in France, Spain, Belgium; in Netherlands, Prussia, Bavaria, Austria, northern Italy, Silesia, Russia on the south near the Azov, and also in the Altai. It is found in Asia, abundantly in China, in Persia in the Cabul territory, and in the Khorassan or northern Persia, in Hindostan, north of the Gulf of Cutch, in the province of Bengal (the Burdwan coal-field) and Upper Assam, in Borneo, Labuan, Sumatra, several of the Philippines, Formosa, Japan, New South Wales and other parts of Australia, New Zealand, Kerguelen Land; in America, besides the United States, in Chili, at the Straits of Magellan, at Nanaimo on Vancouver's Island, at Melville Island in the Arctic seas, and in the British Provinces of Nova Scotia, New Brunswick, and Newfoundland.

In England, the principal coal fields are the Manchester of Lancashire and Cheshire; the Great Central of South Yorkshire, Nottingham, and Derby; that of South Wales, Glamorganshire, etc.; the Newcastle field of northern England. In Scotland, a range of beds extends across from the Firth of Forth to the Firth of Clyde; whole area 1650 sq. m. In Ireland, the three are the Limerick fields about the mouth of the Shannon, the Kilkenny fields to the eastward, and that of Ulster on the north. Cannel coal occurs in Great Britain at Lesmahago in Lanarkshire, about 20 m. from Glasgow; also near Wigan in Lancashire, and West Wemyss in Fyfe.

Mineral coal occurs in France, in small basins, 88 in number, and covering in all, according to Taylor, $\frac{1}{117}$ of the whole surface. The most important are the basin of the Loire, between the Loire and the Rhone, and that of Valenciennes on the north, adjoining Belgium. In Belgium, it occupies a western and eastern division, the western in the provinces of Namur and Hainault, and the eastern extending over Liege.

In the United States there are several separate coal areas ; of these that of eastern Pennsylvania produces practically all the anthracite of the country, while the others yield bituminous coal. One of these areas, the Appalachian coal field, commences on the north, in Pennsylvania and southeastern Ohio, and sweeping south over western Virginia and eastern Kentucky and Tennessee to the west of the Appalachians, or partly involved in their ridges, it continues to Alabama near Tuscaloosa, where a bed of coal has been opened. It embraces several isolated patches in the eastern half of Pennsylvania. The whole surface in Pennsylvania has been estimated at 15,437 sq. m., or $\frac{1}{3}$ the whole area of the state. A second coal area (the Illinois) lies adjoining the Mississippi, and covers the larger part of Illinois, though much broken into patches, and a small northwest part of Kentucky ; it is continued westward over a portion of Iowa, Missouri, Kansas, Arkansas, and northern Texas west of the Mississippi. The latter area is divided along the Mississippi by a narrow belt of Silurian rock , the whole area is about the same with that of the Appalachian coal field. Another area covers the central portion of Michigan, not far from 5000 sq. m. in area. Besides these, there is a smaller coal region in Rhode Island, which crops out across the north end of the island of Rhode Island, and appears to the northward as far as Mansfield, Massachusetts ; the coal from this region is chiefly a graphitic carbon not useful for ordinary combustion. There is also coal (Triassic) in N. Carolina. There are further extensive coal fields in the Rocky Mountains, chiefly bituminous or semi-bituminous, and of more recent geological time than the Carboniferous; much of it belongs to the Laramie epoch; thus at Carbon, Hallville, Wyoming; Evanston and Coalville in Utah; at many points in Colorado, abundant. Further, in Dakota, Montana, Idaho, Utah; also on the Pacific coast, as at Carbonado near Tacoma, at Bellingham Bay, and other points in Washington; in Oregon, California. There are also said to be useful coal deposits in Alaska.

For a general account of the coal fields in the United States, see Min. Res. U. S., 1886, p. 224 *et seq.* (Ashburner); also the other volumes of Min. Res. U. S.; further the geol. reports of Pennsylvania, Ohio, etc.

Out of the borders of the United States, on the northeast, commences a fifth coal area, that of Nova Scotia and New Brunswick, which covers, in connection with that of Newfoundland, 18,000 sq. m., or $\frac{4}{5}$ the whole area of these provinces.

The mines of western Pennsylvania, commencing with those of the Blossburg basin, Tioga Co., those of the States west, and those of Cumberland or Frostburg, Maryland, Richmond or Chesterfield, Va., and other mines south, are *bituminous.* Those of eastern Pennsylvania constituting several detached areas—one, the *Schuylkill* coal field, on the south, worked principally at Mauch Chunk on the Lehigh, and at Pottsville on the Schuylkill—another, the *Wyoming* coal field, worked at Carbondale, in the Lackawanna region, and near Wyoming, besides others intermediate—those of Rhode Island and Massachusetts, and some patches in Virginia, are *anthracites.* Cannel coal is found near Greensburg, Beaver Co., Pa., in Kenawha Co., Va., at Peytona, etc.; also in Kentucky, Ohio, Illinois, Missouri, and Indiana; but part of the so-called cannel is a coaly shale.

Brown coal comes from coal beds more recent than those of the carboniferous age. But much of this more recent coal is not distinguishable from other bituminous coals. The coal of Richmond, Virginia, is supposed to be of the Liassic or Triassic era. Coal of Cretaceous or Tertiary age occurs on the Pacific coast, and in many places over the eastern slopes of the Rocky Mountains, where a "Lignitic formation" is very widely distributed as noted above.

The coal known to the Greeks and Romans was probably brown coal. The first sentence, in the synonymy, from Aristotle evidently alludes to mineral coal of some kind; and the first of the two cited from Theophrastus (a favorite pupil of Aristotle) refers to a similar substance, and perhaps the same specimens. The locality of the latter, Liguria (or northwestern Italy along the Mediterranean), where, he adds, there also is amber, may be taken with some freedom, as articles brought by vessels trading with Ligurian ports, even though coming from French ports beyond, might be referred to Liguria. Elis, on the way to Olympias, is given as another locality. The sentence ends with the statement that "these coals are used by the smiths," showing that the value of the substance as fuel was well understood at the time (4th century B.C.). Theophrastus says further, that it will continue to burn as long as any one blows it, but on stopping it deadens, but may be made to burn again; and that it burns with a strong disagreeable odor. The second citation from each, Aristotle and Theophrastus, relates to a similar coal. The locality, in Thrace, identifies it with the *Thracian stone* of Dioscorides and Pliny, the locality of which, according to the former (from Aristotle), was at Sintia, on the river Pontus (on the Macedonian border of Thracia, to the west of the present Constantinople) According to Dioscorides and Pliny (quoting further in part from Aristotle's "Wonderful Things heard of"), water would make the Thracian stone to burn, and oil extinguish it; which is either altogether a fable, or a partial truth based on somebody's observation that masses or piles of impure pyritiferous coal will become hot, and sometimes ignited, in consequence of being wet. Aristotle mentions its bituminous odor when burning.

The *Gagates* (whence our word *jet*) occurred, according to Dioscorides and Pliny, at Gagas or Gages, a place in Lycia (Asia Minor). The former describes it as black, smooth, and combustible, to which Pliny adds that it was light, and looked much like wood, and that it emitted a disagreeable odor when rubbed, and burned with the smell of sulphur. It was, in part at least, true lignite. Some of the best known localities of jet are the Yorkshire coast in England, near Whitby (*Whitby Jet*), Aude in France; also Spain, Bohemia, etc.

BYERITE *Mallet*, Am. J. Sc., **9**, 146, 1875. A mineral coal from Middle Park, Colorado. It belongs to the class caking-bituminous, and gave on analysis: 39·95 p. c. volatile matter (gas and tarry oil), 54·03 p. c. fixed residue (coke and ash), and 6·02 p. c. water. G. = 1·323. Color jet-black. Powder brown. Resembles albertite in the large amount of gas and tarry oil yielded by it, but differs in being heavier and in yielding no soluble products with carbon disulphide, ether, etc. Also resembles torbanite, but is heavier, does not crackle in the fire, and melts and intumesces when heated.

HUMINITE. A hydrocarbon from Östmark, in Wermland, Sweden, which, according to Ekman (Öfv. Ak. Stockh., **25**, 138, 1868), has the composition (ash free): C 67·15, O 29·83, H 2·55, N 0·47, S [0·40] = 100. A similar coal from Grythytte, Finberget, Sweden, has, according to Helland (G. För. Förh., **2**, 521, 1875), the composition (ash free): C 67·67, O 28·11, H 3·89, N tr., S 0·33 = 100.

ANTHRAXOLITE *E. J. Chapman.* A black combustible coal-like substance of varying composition, found in Quebec and Ontario.

WOLLONGONGITE *B. Silliman*, Am. J. Sc., **48**, 85, 1869.

This name was given provisionally to a supposed hydrocarbon from Wollongong, New South Wales, l. c., occurring in cubical blocks, without lamination; fracture broad conchoidal. It is shown by Liversidge to be simply a carbonaceous shale or *kerosene-shale.*

# SUPPLEMENT.

This supplementary chapter includes: First, descriptions of certain species, fairly well established, but as yet of unknown composition. Second, a summary of recent additions to mineralogical literature, which have appeared during the eighteen months in which the preceding pages have been passing through the press, but too late to find their proper place. This is intended to make the work as complete as practicable to near the close of 1891. Third, brief accounts of many doubtful species, having little or no claim to recognition. This last portion of the chapter contains for the most part references of recent date. The list might be almost indefinitely extended, but the author does not believe that it would be a real service to mineralogical science to attempt to call to life the many bad or doubtful species, which have been once referred to in the literature, but most of them long since forgotten.

AËRINITE *Lasaulx,* Jb. Min., 352, 1876, 60, 1877. A compact, earthy mineral substance, of a bright blue color, from the Pyrenees. H. = 3–4. G. = 3·018. Shown by Des Cloizeaux to be a heterogeneous mass, consisting of a blue paste, inclosing different minerals, perhaps owing its color to artificial means. See Rg., Zs. G. Ges., **27**, 234, 1876; also Macpherson, Jb. Min., **2**, 98, 1882. Analyses are quoted in App. III, p. 2, 1882.

**Aguilarite** *F. A. Genth,* Am. J. Sc., **41**, 401, 1891.

Isometric. In skeleton dodecahedrons, often elongated in the direction of a cubic or octahedral axis.

No cleavage. Fracture hackly. Sectile. H. = 2·5. G. = 7·586. Luster metallic, brilliant. Color iron black. Opaque.

**Comp.**—Sulpho-selenide of silver, $Ag_2S.Ag_2Se$ = Selenium 14·6, sulphur 5·9, silver 79·5 = 100.

**Anal.**—F. A. Genth, l. c.

Se 14·82 S 5·86 Ag 79·07 = 99·75

Another determination gave Ag 79·13.

**Pyr., etc.**—In the open tube heated slowly, yields metallic silver, a slight sublimate of selenium, silky needles of selenium dioxide and sulphur dioxide, the latter forming a small quantity of silver sulphate.

**Obs.**—From the San Carlos mine at Guanajuato, Mexico; very rare. Named after the superintendent of the mine, Señor Aguilar.

**Alt.**—Aguilarite is altered on the surface; the crystals losing their sharp edges and sometimes becoming penetrated by holes showing metallic silver and a coating of microscopic iron-black crystals, sometimes in hexagonal scales. An analysis of the brittle iron-black alteration-product gave:

| S | Sb | As | Ag | Cu | Fe |
|---|---|---|---|---|---|
| 13·62 | 10·82 | 1·29 | 67·08 | 6·44 | 0·82 = 100·07 |

This corresponds to $5(Ag,Cu)_2S.(Sb,As)_2S_3$, or a cupriferous stephanite.

ALBITE, p. 327. Glinka has given a monograph on Russian albite from the localities Kerebinsk in Govt. Orenburg, Kasbek, Kyshtimsk, Mursinka, and Shishimsk. The albite from Kerebinsk and Kasbek proved to be the purest, and of these the former gave the author:

$$\breve{a} : \bar{b} : \dot{c} = 0{\cdot}6330 : 1 : 0{\cdot}5573; \ \alpha = 94^\circ\ 5',\ \beta = 116^\circ\ 27',\ \gamma = 88^\circ\ 7'.$$

Angle of rhombic section on *b* (010), 27° 30′. [Russ. Bergjournal, 1889.] Jb. Min., 1, 218 ref., 1891.

Münzing has investigated the Pfitschthal pericline and finds that the crystals consist essentially of an oligoclase, rich in soda, upon which albite has been deposited in parallel position, especially in the cavities of the original crystals; this albite follows the same twinning laws. This conclusion, based upon an optical examination, is confirmed by analysis. Jb. Min., **2**, 1, 1891.

Amphibole, p. 385 *et seq.*

The chemical constitution of the amphiboles is discussed by Haefke in an inaug. dissertation (Berlin, 1890). He gives the following analyses, 1–8:

| | G. | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Pierrepont | 3·031 | 55·90 | — | 1·29 | 0·78 | 2·33 | 22·96 | 12·25 | 1·24 | 0·66 | 1·98 | 0·62 | [= 100·01 |
| 2. " | 3·008 | 57·13 | 0·20 | 2·10 | 0·29 | 1·35 | 21·86 | 12·09 | 3·03 | 0·91 | 1·42 | 0·90 | [$Li_2O$ 0·26 = 101·54 |
| 3. " | 2·981 | 55·82 | 0·16 | 3·21 | 0·82 | 0·69 | 22·61 | 12·59 | 1·93 | 0·62 | 1·27 | 1·31 | [= 101·03 |
| 4. Snarum | 3·091 | 53·42 | 0·23 | 3·12 | 2·52 | 7·36 | 18·22 | 10·28 | 3·17 | 0·14 | 1·11 | 1·52 | [= 101·09 |
| 5. Ersby | | 41·20 | 0·43 | 15·40 | 2·49 | 4·67 | 15·15 | 12·26 | 3·44 | 1·98 | 1·31 | 1·86 | [= 100·19 |
| 6. Mte. Somma | 3·313 | 38·84 | — | 13·70 | 6·63 | 10·90 | 11·41 | 11·70 | 3·08 | 2·61 | 1·74 | 0·70 | [= 101·31 |
| 7. Edenville | 3·283 | 41·67 | 0·85 | 11·38 | 1·83 | 16·28 | 10·29 | 11·35 | 3·76 | 0·96 | 2·18 | — | [= 100·55 |
| 8. Etna | | 40·20 | 3·34 | 14·62 | — | 13·77 | 13·49 | 12·10 | 3·02 | 0·70 | — | — | [= 101·24 |

Schneider has also given a series of analyses, 9–14, of basaltic hornblende, showing a considerable degree of constancy in composition, except in the $Fe_2O_3$ and FeO. Zs. Kr., **18**, 579, 1891.

| | G. | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $Na_2O$ | $K_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9. Ortenberg | 3·249 | 40·66 | 4·99 | 14·89 | 10·84 | 0·57 | 12·38 | 12·80 | 1·59 | 1·77 | = 100·49 |
| 10. Bohemia | | 39·75 | 5·40 | 15·00 | 7·86 | 2·89 | 14·16 | 12·97 | 1·92 | 1·61 | = 101·56 |
| 11. Härtlingen | 3·247 | 40·15 | 5·21 | 14·34 | 7·80 | 4·53 | 13·14 | 11·75 | 2·31 | 1·14 | = 100·37 |
| 12. Hoheberg | 3·247 | 40·14 | 4·26 | 14·30 | 7·07 | 6·48[a] | 11·62 | 12·00 | 2·22 | 1·35 | = 99·44 |
| 13. Wolkenburg | | 39·29 | 4·86 | 16·57 | 9·18 | 3·19 | 10·40 | 12·90 | *undet.* | | |
| 14. Laacher See | 3·245 | 39·05 | 4·68 | 15·45 | 6·39 | 7·34[b] | 11·28 | 13·75 | 1·34 | 0·94 | = 100·22 |

[a] Incl. 0·21 MnO. [b] Do., 0·31 MnO.

Lane and Sharpless have described an iron-magnesium amphibole, called by them grünerite, which occurs with the iron ores of L. Superior. It resembles actinolite, but corresponds chemically to the variety cummingtonite (p. 390). Shows polysynthetic twinning ‖ *a*, and also striations ‖ *c*. It is colorless or slightly greenish or brownish; faintly pleochroic. Extinction-angle 20°. Analysis of pure material from the Champion mine, Am. J. Sc., **42**, 505, 1891:

| $SiO_2$ | $Al_2O_2$ | $Fe_2O_3$ | FeO | MgO | Alk. | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 76·32 | 0·56 | 0·99 | 6·96 | 12·47 | *tr.* | 2·80 | = 100·20 |

Nephrite has been extensively mined in the mountains of Nan Chan, China, Martin, C. R., **112**, 1153, 1891. Anals., B. Columbia, see Harrington, Trans. R. Soc. Canada, 61, 1890.

Khrushchov has accomplished the difficult task of obtaining amphibole in artificial crystals by a hydrothermal method. A mixture of the following substances was taken: 3 per cent aqueous solution of colloidal silica; an aqueous solution of alumina, and also of ferric and ferrous hydrate; lime-water; freshly prepared magnesium hydrate suspended in water, and finally some drops of caustic soda and potash. This mixture, forming a rather stiff gelatinous mass, was heated in a sealed glass vessel to 550° for three months, with, however, some interruptions.

At the end of this time the mass had been converted into a greenish brown pulp in which were dark-colored shining prismatic crystals, showing the forms: *b* (010), *m* (110), *r* (011), with $011 \wedge 0\bar{1}1 = 31° 32'$; cleavage not distinct. Pleochroism not strong. Optically −. Extinction-angle 17° 56′. Absorption $\mathfrak{c} = \mathfrak{b} > \mathfrak{a}$. Axial angle $2V = 82°$. An analysis gave:

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $Na_2O$ | $K_2O$ | ign. | |
|---|---|---|---|---|---|---|---|---|---|---|
| G. = 3·245 | 42·35 | 8·11 | 7·91 | 10·11 | 14·33 | 13·21 | 2·18 | 1·87 | 0·91 | = 100·98 |

In addition to these crystals, obviously a kind of hornblende (cf. anals. above and on p. 396), there were obtained at the same time crystals referred to a pyroxene near diopside; also isotropic crystals and grains referred with a question to analcite; quartz crystals; adularia in tabular crystals. Jb. Min., **2**, 86, 1891; C. R., **112**, 677, 1891.

See ASTOCHITE below.

**ANOMALITE** *G. A. Koenig*, Am. Inst. Mng. Eng., Philadelphia meeting, 1876.

A name provisionally given to what appears to be a last stage of alteration of jeffersonite. The form of the original mineral is preserved perfectly, even the strong basal parting. Light, like pumice; color in thin section blood-red. Called *anomalite*, because it does not give B.B. with salt of phosphorus the manganese bead, although containing some 30 per cent of $Mn_2O_3$, on account of the presence of cobalt and nickel, whose combined color is green, and this extinguishes the red of the manganese.

**ANORTHITE**, p. 337. Lévy and Lacroix have determined the principal indices of refraction for crystals from Saint-Clément. Their values, together with the analysis, are:

| | | $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | Extinction on *b* |
|---|---|---|---|---|---|---|
| $\alpha = 1{\cdot}574$ | $\gamma = 1{\cdot}586$ | 46·05 | 35·10 | 18·32 | [0·53] = 100 | − 37° |

The plane $S \perp \mathfrak{c}$ intersects the (real) obtuse angle *cb* and makes the (real) angles $cS = 132°$, $bS = 120°$. C. R., **111**, 846, 1890.

**APATITE**, p. 762. Described as probably occurring in the Thomas slags, with also certain compounds of calcium sulphate and calcium silicate, by Stead and Ridsdale, J. Ch. Soc., **51**, 601, 1887; also Miers, ibid., p. 608. Cf. also Hutchings, Nature, **36**, 460, 1887.

A work on the occurrence of apatite and phosphates in general has been published recently by F. Wyatt (The Phosphates of America, New York, 1891).

**ARAGONITE**, p. 281. Buchrucker has described crystals from Leogang in Salzburg, showing the new form (850, $i\text{-}\frac{8}{5}$). The axial angles obtained are: $2E_r = 30° 38'$ Li, $2E_y = 30° 43\frac{1}{2}'$ Na, $2E_{gr} = 30° 57'$ Tl. Zs. Kr., **19**, 140, 1891.

**ASTOCHITE** *Sjögren*, G. För. Förh., **13**, 604, November, 1891. A new kind of amphibole from Långban in Wermland, Sweden. It forms a rather coarse crystalline, short columnar, aggregate together with rhodonite, and has been locally known as "blue rhodonite." Crystallization monoclinic, cleavage-angle 56° 27′, crystals not observed. Color varying from blue to grayish violet; for the former the extinction-angle (with $\dot{c}$) is 15° 40′, for the latter 17° 15′. Optically negative; axial plane ‖ *b*.

Analyses by R. Mauzelius gave:

| | G. | $SiO_2$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ | F |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. *Blue* | 3·05 | 56·25 | 0·15 | 6·49 | 21·89 | 5·44 | 6·17 | 1·60 | 1·56 | 0·15 = 99·70 |
| 2. *Gr.-violet* | 3·10 | 54·76 | 0·21 | 12·71 | 17·82 | 5·83 | 4·02 | 1·65 | 2·77 | 0·09 = 99·86 |

The above correspond to the composition of a normal metasilicate, consisting of $(Mg,Mn,Ca)SiO_3$ and $(Na,K,H)_2SiO_3$. Named from ἄστοχος, *missing the mark, aiming badly*, in allusion to the fact that it was at first regarded as a pyroxene. It does not seem to be very far from richterite, p. 391.

**AUERLITE**, p. 489. Lemon-yellow crystals from Price's Land, Henderson Co., N. C., have been analyzed by Hidden and Mackintosh, Am. J. Sc., **41**, 438, 1891. The crystals are in part twins, similar to those of rutile, zircon, etc. Analysis:

| | $SiO_2$ | $P_2O_5$ | $ThO_2$ | $Fe_2O_3$ | $H_2O$ |
|---|---|---|---|---|---|
| G. = 4·051–4·075 | 6·84 | 8·58 | [72·16] | 1·78 | 10·64 = 100 |

**BABINGTONITE**, p. 381. Artificial crystals have been measured by Buchrucker, Zs. Kr., **18**, 626, 1891. He calculates the axial ratio:

$$\breve{a} : \bar{b} : \dot{c} = 1{\cdot}08066 : 1 : 0{\cdot}62370;\ \alpha = 77° 33',\ \beta = 108° 34',\ \gamma = 97° 7'$$

**BARITE**, p. 899. On crystals from the Puy-de-Dôme, see Gonnard, Bull. Soc. Min., **14**, 174, 1891.

**BEAUMONTITE** *C. T. Jackson*, Am. J. Sc., **37**, 398, 1839. A supposed "native crenated hydro-silicate of copper" from Chessy, France. Named after Prof. L. Elie de Beaumont.

**Bernardinite** *J. M. Stillman.* Described as a new fossil resin from San Bernardino, Cal., Am. J. Sc., **18**, 57, 1879; later regarded as an exudation from a species of conifer, which had received its particular characters from exposure to the atmosphere (ib., **20**, 93, 1880). It is finally shown by J. Stanley-Brown to be a fungous growth on *Polyporus officinalis*, impregnated by resinous material. Ibid., **42**, 49, 1891.

**Bertrandite**, p. 545. Observed at La Mercerie near the bridge of the Verrière, La Chapelle-sur-Erdre, Lacroix and Baret, Bull. Soc. Min., **14**, 189, 1891.

Also noted in cavities in the beryl of Limoges, Haute Vienne, Michel, Bull. Soc. Min., **14**, 76, 1891.

**Beryl**, p. 405. Investigation of the optical anomalies, by A. N. Karnozhitsky, Vh. Min. Ges., **27**, 1, 1891, and Zs. Kr., **19**, 209, 1891.

Analysis of white crystals occurring at the tin mine of Winslow, Me., gave Hillebrand, U. S. G. Surv., Bull. **55**, 53, 1889:

| | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | BeO | MgO | $K_2O,Cs_2O$ | $Na_2O$ | $Li_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| G. = 2·707 | 65·21 | *tr.* | 18·50 | 0·33 | 13·03 | 0·09 | 0·14 | 0·87 | 0·16 | 1·80[a] | = 100·13 |

[a] After drying at 110°.

**Bindheimite**, p. 862. Analyzed by Tscherne from Litica in Bosnia, where it occurs as an alteration-product of bournonite, Vh. G. Reichs., 211, June 30, 1891:

$Sb_2O_5$ 37·48  PbO 50·12  $Fe_2O_3$ 5·60  $H_2O$ 7·39 = 100·59

**Bismuthinite**, p. 38. A seleniferous variety from Guanajuato, Mexico, in prismatic crystals, has been analyzed by Genth:

G. = 6·306  ⅔ S 14·06  Bi 77·54  Se 8·80 = 100·40

Formula: $4Bi_2S_3.Bi_2Se_3$. Am. J. Sc., **41**, 402, 1891.

**Boléite** *Mallard* and *Cumenge*, C. R., **113**, 519, Oct. 26, 1891.

In cubes, sometimes 2 cm. in diameter; also rarely with *o* (111), *d* (110), and *e* (210). Cleavage: cubic, perfect; octahedral, less easy. H. = 3–3·25. G. = 5·08. Color indigo-blue. Refractive index, *n* = 2·07. Sections of the cubic crystals show in polarized light an isotropic center bordered by doubly refracting bands; the latter are regarded as belonging to three crystals uniaxial and negative.

There are also octahedral crystals, regarded as tetragonal, with the forms *a* (100), *c* (001), *e* (101); the measured angles are:

$$ee' = 74° 16' \quad \text{and} \quad ee'' = {}^*117° 27' \qquad \dot{c} = 1·646$$

G. = 5·0 approx. The crystals are optically uniaxial, negative, and are regarded as corresponding to the pseudo-isometric cubic crystals.

The composition deduced is that tentatively given to percylite on p. 172, viz. $PbCuCl_2(OH)_2$, with the addition of $\frac{1}{3}AgCl$. Anal.:

| | Cl | Pb | Cu | Ag | $H_2O$ | O |
|---|---|---|---|---|---|---|
| 1. *Cubic cryst.* | 19·98 | 48·45 | 13·95 | 8·85 | 4·77 | [4·00] = 100 |
| 2. " " | 19·00 | 49·75 | 14·50 | 8·70 | 4·00 | [4·05] = 100 |
| 3. *Octahedral cryst.* | 19·7 | 50·7 | 15·0 | 9·4 | *undet.* | |

From the copper mines at Boleo, near Santa Rosalia, Lower California. The copper deposits here consist of beds interstratified in the tufas and conglomerates resulting from the destruction of the volcanic rocks of the region. The copper is present as malachite, azurite, melaconite, cuprite, atacamite, also as silicates and rarely as the sulphide. Both the cubic and octahedral crystals of boléite are present in an argillaceous gangue, and immediately associated with anglesite, cerussite, phosgenite, and atacamite.

The authors consider the two minerals, respectively in cubic and in tetragonal pyramidal crystals, as essentially identical, a pseudo-cubic "réseau" belonging to each; from the ordinary mineralogical standpoint, however, it seems more natural to regard them provisionally (until a more complete examination of percylite) as dimorphous forms of the same compound; in that case the name boléite would naturally belong to the tetragonal substance, while the isometric mineral would be united with percylite.

**Bombite** *De Bournon; Dufrénoy*, Min., **4**, 289, 1859. An amorphous, dark blackish gray mineral "from near Bombay"; resembles Lydian stone. Compact with conchoidal fracture. H. = 7. G. = 2·210. B B. fuses easily; insoluble in acids. An analysis by Laugier gave: $SiO_2$ 50·0, $Al_2O_3$ 10·5, $Fe_2O_3$ 25·0, MgO 3·5, CaO 8·5, C 3·0, S 0·3 = 100 8. May be simply a kind of tachylyte.

**Braunite**, p. 232. Crystals from Långban, described by Flink, show the new forms: *o* (304, $\frac{3}{4}$-*i*), *l* (401, 4-*i*), *t* (524, $\frac{5}{4}$-$\frac{5}{2}$), *i* (212, 1-2), *s* (645, $\frac{6}{5}$-$\frac{3}{2}$). The axial ratio obtained is $\dot{c}$ = 0·99218, from 111 ∧ $1\bar{1}1$ = 70° 19′. Anal.:

$Mn_3O_4$ 84·77 $SiO_2$ 9·89 $Fe_2O_3$ 4·23 CaO 0·34 MgO 0·15 = 99·38

Oxygen (determined by Cl set free with hydrochloric acid) 7·35 p. c.; formula $RO.RO_2$. Ak. H. Stockh., Bihang, **16** (2), No. 4, 1, 1891.

**Breithauptite**, p. 72. Sarrabus, Sardinia, analysis by E. Mattirolo, Rend. Accad. Linc., **7** (2), 98, 1891.

G. = 8·42 Sb 65·07 As 0·20 Ni 32·94 Co 0·29 S, Ag, Pb *tr*. = 98·50

**Brewsterlinite.** A new fluid in the cavities of minerals *D. Brewster*, Ed. Phil. J., **9**, 1823; Trans. R. Soc. Edinb., **10**, 1, 407, 1826; Am. J. Sc., **7**, 186, 1824, **12**, 214 (with a plate), 1827; Phil. Mag., **25**, 174, 1863. Brewsterline *Dana*, Min., 559, 1850; Brewstoline, ib., 471, 1854.

A colorless transparent fluid, occurring in cavities of topaz crystals from Brazil, Scotland, and Australia, of chrysoberyl, of quartz crystals from Quebec, amethyst from Siberia, and first described by Sir David Brewster. The cavities are mostly microscopic, but occasionally $\frac{1}{8}$ in. across, or even larger. They are generally arranged in layers, and are sometimes counted by thousands in a single crystal. Index of refraction 1·2106, for the fluid from an amethyst from Siberia; 1·1311 for a kind from a topaz; boiling point in a vacuum from 23°–29°, the fluid filling the cavities with the warmth of the hand or mouth; highly expansible, between 10° and 27° more so than water. Volatilized by heat.

Composition not definitely known. The effect of moisture on the dry grains was regarded as showing that the substance was not one of the hydrocarbon oils, or a resin.

Nordenskiöld has recently investigated this substance (earlier, Sorby, Vogelsang & Geissler, etc.) and concludes that it is a hydrocarbon probably belonging to the naphtha group. Jb. Min., **1**, 242, 1886.

*Cryptolinite* or Cryptoline *Dana*, Min., 559, 1850, is another liquid with a refractive index of 1·2946 occurring with the above

See further on the above, 5th Ed., pp. 761, 762.

**Brookite**, p. 241. Occurs in fine crystals at Ville-ès-Martin, near St. Nazaire, Loire Inférieure. Lacroix, Bull. Soc. Min., **14**, 192, 1891.

**Butyrellite.** Bog Butter *Williamson*, Lieb. Ann., **54**, 125, 1845. Butyrit *Glocker*, Syn., 9, 1847. Butyro-limnodic Acid *Brazier*, Chem. Gaz., 375, 1852. Butyrellite *Dana*, Min., 747, 1868.

A butter-like substance from the peat bogs of Ireland. Supposed to be a native hydrocarbon, but, after a thorough chemical examination, Macadam has proved that it is of *animal* not mineral origin, and is simply butter; all of the ten samples analyzed showed the presence of hairs, microscopically like those of a cow! In one case the same bog which had furnished "bog-butter" also yielded heads of cattle. Min. Mag., **6**, 175, 1885.

**Calcite**, p. 262. Sansoni, in continuation of an earlier memoir, has given a monograph of the forms of calcite observed from various localities in Baden. Zs. Kr., **19**, 321, 1891.

Etching by acids as affected by the concentration of the solvent, Hamberg, G. För. Förh., **12**, 617, 1891.

**Cancrinite**, p. 427. By heating 14 gr. of mica with 7 gr. soda, 14 gr. sodium carbonate, and a certain quantity of water for two days at 500°, Ch. & G. Friedel have obtained a mineral in small hexagonal crystals, resembling hydronosean, p. 1043, with *pp′* = 23° 49′ to 25° 1′, optically negative, $\omega - \epsilon = 0·010$. G. = 2·357. Analyses gave:

| $SiO_2$ | $CO_2$ | $Al_2O_3$ | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|
| 35·77 | 4·42 | 30·59 | 22·05 | 2·34 | 4·14 = 99·49 |

Formula calculated: $3(Na_2O.Al_2O_3.2SiO_2).Na_2O.CO_2 + 2H_2O$, Bull. Soc. Min., **14**, 74, 1891.

**Cassiterite**, p. 234. Crystals from Cornwall described by Solly show the forms: $n$ (661, 6), $p$ (12·12·1, 12), $q$ (18·18·1, 18), $\psi$ (120·120·1, 120), $d$ (432, $2\text{-}\frac{4}{3}$), $\vartheta$ (13·11·2, $\frac{13}{2}\text{-}\frac{13}{11}$). A hemimorphic development in some crystals is noted. He gives also: $\omega_r = 1·9793$, $\epsilon_r = 2·079$. G. = 6·92 Dolcoath, black crystals Min. Mag., **9**, 199, 1891.

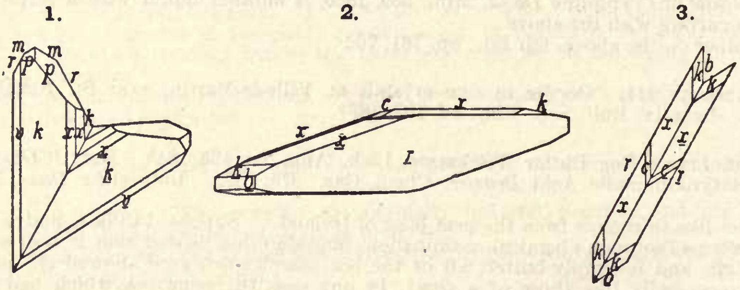
Occurs as a pseudomorph after hematite, also filling cellular crystals, at the Mine del Diablo, Durango, Mexico. Cf. Genth and Rath, Proc. Am. Phil. Soc., **24**, 23, 1887, also Pirsson, Am. J. Sc., **42**, 407, 1891.

Noted in crystals in slag from the bronze melting. Bourgeois, Bull. Soc. Min., **11**, 58, 1888.

The locality of cassiterite in San Bernardino Co., briefly alluded to on p. 235, has recently come into prominence and may prove to be of considerable economic importance. The author is informed (Dec. 10, 1891, priv. contr.) as follows in regard to it: The Temescal tin mines are situated near the northern end of the San Jacinto Estate in San Bernardino Co. The principal vein now being worked has been opened up to a depth of 180 and a length of 300 feet, and varies from a few inches to 8 feet in width. About 40 tons of ore per diem are being crushed and concentrated, yielding 5 p. c. of oxide (cassiterite) which is smelted into pig tin. This vein is evidently a true fissure vein, and shows no sign of weakening. There are also a large number of small veins of a ferruginous mineral similar to that being worked, but which do not appear to contain much tin.

**Celestialite** *J. Lawrence Smith*, C. R., **81**, 1055, 1875. On treating the graphite from the interior of the meteoric iron of Sevier, Tenn., with ether, Smith obtained small quantities of acicular crystals having a peculiar odor, mixed with some small rounded points. These he regards as identical with crystals obtained from the iron of Alais, France (Mar. 15, 1806), by Roscoe (Proc. Lit. Phil. Soc. Manchester, **3**, 57, 1863). Smith has obtained the same crystals from the Alais meteorite. In the closed tube he finds that they fuse at 115°–120°, and at a higher temperature the sulphur is sublimed, and a black residue left behind. He regards these crystals as proof of the presence of a sulpho-hydrocarbon, for which he proposes the name ***celestialite***. Roscoe (l. c.) found that 1·94 p. c. of the meteorite dissolved in ether, and from the solution he obtained crystals melting at 114°, and in two forms: acicular, which he considered as near to könlite (see p. 1002), and rhombic, which he identified as free sulphur.

**Cerussite**, p. 286. Crystals, in part twins with $r$ (130) as tw. pl., are described by G. H. Williams from the Mountain View mine, near Union Bridge, Carroll Co., Md. Johns Hopkins Univ. Circ., No. 87, April 1891. Similar twins, sometimes abnormally developed by extension of the tw. plane $r$ (130), are figured by Pirsson (f. 1–3) from the Red Cloud mine, Yuma Co., Arizona. Am. J. Sc., **42**, 405, 1881.



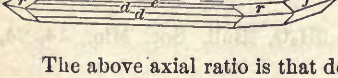
1. 2. 3.

Yuma Co., Arizona, Pirsson.

**Chalcopyrite**, p. 80. Crystals from Cuba, similar to those described by Penfield from the French Creek mines, Pennsylvania (p. 81), have been described by Des Cloizeaux. The crystal figured resembles f. 12, p. 81, and to the forms he assigns the symbols (538, $\frac{5}{8}\text{-}\frac{5}{3}$) for the tetragonal scalenohedron and to the sphenoid (401, $4\text{-}i$); these correspond respectively to $\chi$ and $\phi$ of f. 12.

**Chalcostibite** (Wolfsbergite), p. 113. Crystals from Wolfsberg, studied by Laspeyres, gave the mean axial ratio: $\breve{a} : \bar{b} : \dot{c} = 0·52830 : 1 : 0·62339$, approximating to that of sartorite. The forms present are:

$c$ (001, $O$), $e$ (307, $\frac{3}{7}\text{-}\bar{\imath}$), $d$ (101, $1\text{-}\bar{\imath}$), $g$ (201, $2\text{-}\bar{\imath}$), $f$ (011, $1\text{-}\breve{\imath}$), $q$ (863, $\frac{8}{3}\text{-}\frac{4}{3}$), $p$ (7·14·8, $\frac{7}{4}\text{-}\breve{2}$), $r$ (7·21·27, $\frac{7}{9}\text{-}\breve{3}$).



Angles: 100 ∧ 110 = 27° 50⅚′, 001 ∧ 101 = $cd$ = 49° 43⅙′, 001 ∧ 011 = $cf$ = 31° 56⅓′, $ce$ = 26° 49½′, $cg$ = 67° 2′.

In the above $d$ = 011 ($d$) of p. 113, $g$ = 041 ($h$), etc. The habit is shown in the figure.

The above axial ratio is that deduced by Laspeyres. The results, however, though increasing our knowledge of the crystallization of the species, make little claim to exactness. Thus the calculated value of $cd = 49° 43'$, while he measures 51° 20′; again, $cf = 31° 56'$ calc., and 29° 14′ meas. In view of this the abnormal symbols of the pyramids lose part of their significance; thus $p$ may be 121 instead of 7·14·8, etc. Zs. Kr., **19**, 428, 1891

**Chantonnite.** A supposed black silicate forming veins in certain meteorites, as those of Chantonnay, Charsonville. This is shown by Meunier not to be a definite species, but simply a structure developed by heat. C. R., **52**, 339, 1861, and Météorites, 81, 1884.

**Chloritoid**, p. 640. Lane and Keller have studied the chloritoid occurring with the iron ores of northern Michigan. It occurs in green plates, several centimeters across and up to 4 mm. in thickness, thus at the Champion mine. It is distinctly triclinic as shown in the extinction-angles and the want of symmetry of the lateral cleavages, thus confirming the results of Des Cloizeaux upon sismondine (p. 641). An analysis gave:

| $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 24·29 | 0·28 | 34·00 | 10·55 | 20·51 | *tr.* | 1·29 | 0·61 | 0·97 | 0·35 | 6·75 = 99·60 |

The formula deduced is $8H_2O.7FeO.8Al_2O_3.8SiO_2$. The presence of alkalies is noteworthy; the same authors show that the so-called masonite of Natick, R. I., contains about 2 p. c., chiefly soda. Am. J. Sc., **42**, 499, Dec., 1891, also Zs. Kr., **19**, 383, 1891.

**Chromite**, p. 228. A variety from the Pick and Shovel mine, S. Fork of Chorro Creek, California, has been analyzed by H. Pemberton, Jr., Ch. News, **63**, 241, 1891.

| | $Cr_2O_3$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | MnO | $SiO_2$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 1*a*. | 52·68 | 11·40 | 3·52 | 11·77 | 16·23 | 0·15 | 3·40 | 0·94 = 100·09 |
| 1*b*. | 56·96 | 12·32 | 3·81 | 12·73 | 14·02 | 0·16 | — | — = 100 |

1*b* after deducting 3·26 p. c. serpentine.

On the decomposition of chromite by electric current, see E. F. Smith, Am. Ch. J., **13**, 414, 1891.

**Chrysoberyl**, p. 229. Has been recently found (Foote) in twin crystals at Greenwood, Oxford Co., Maine.

**Chrysolite**, p. 451. Analysis of clear pebbles from Fort Wingate, New Mexico, by Clarke & Schneider, Am. J. Sc., **40**, 305, 1890, gave:

| $SiO_2$ | FeO | NiO | MnO | MgO | $Fe_2O_3$ | $H_2O$ |
|---|---|---|---|---|---|---|
| 41·98 | 5·71 | 0.42 | 0·10 | 51·11 | 0·51 | 0·28 = 100·11 |

It was found that at 383°–412° the mineral was hardly attacked by dry hydrochloric acid, though readily decomposed by the aqueous acid.

On the chrysolite of the Kiowa Co., Kansas, pallasite, see Huntington, Proc Am. Acad., **26**, April 8, 1891.

**Cinnabar**, p. 66. Melville and Lindgren have described crystals from the New Idria mercury mines, California. They are very small, from 0·05 mm. to 0·6 in diameter, and 0·02 to 0·2 mm. in thickness; thin tabular in habit and show the forms $c$ $(0001, O)$, $h$, $(02\bar{2}3, -\frac{2}{3})$, $g$, $(01\bar{1}2, -\frac{1}{2})$; also various tetartohedral forms, chiefly in the zone $c/h$, and having for the most part highly complex symbols. U. S. G. Surv., Bull. **61**, 1, 1890.

**Corundum**, p. 210. Crystals obtained artificially by Fremy (see below) gave the new form $(11\bar{2}3, \frac{2}{3}\text{-}2)$. Dx.. C. R., **106**, 567, 1888.

Friedel has described the production of crystals of corundum and diaspore by the wet way by the action of a solution of soda on amorphous alumina at an elevated temperature. At 450° to 500°, both corundum and diaspore were obtained, at 530° to 535° only corundum, and at 400° only diaspore Bull. Soc. Min., **14**, 8, 1891.

The artificial formation of rubies is described in detail with many colored plates by M. Fremy in *Synthèse du Rubis* (30 pp. 4to, Paris, 1891). In the most successful method the rubies were obtained in an earthen crucible by the reaction at a very high temperature of a mixture of alumina (with more or less potash) upon barium fluoride, with bichromate of potassium as coloring matter. They are well crystallized, clear, of brilliant color.

F. Noetling describes the Namsèka ruby mine in the valley of the Nampai, Mainglôn state, where the rubies have been found in isolated pockets in secondary deposits of river gravel and sand, probably washed down by the Mogôk stream which joins the Nampai near the Namsèka mine. Rec. G. Surv. India, **24**, 119, 1891.

**Coronite.** A name proposed by T. S. Hunt for the common brown magnesian variety of tourmaline, Min. Physiology, pp. 162, 350, 1886; Syst. Min., 299, 1891. The name is taken from the locality, Crown Point, N. Y. A number of other variety names proposed by Dr. Hunt will be found in the same volumes; also a system of dual Latin names, after the method of Natural History, *e.g.*, coronite = "*Turmalinus magneseus.*"

**Corynite**, p. 91. A specimen from a siderite mine near Gosenbach in the Siegen region has been analyzed by Laspeyres:

| | | S | Sb | As | Bi | Ni | Fe | Co |
|---|---|---|---|---|---|---|---|---|
| G. = 6·488 | $\frac{2}{2}$ | 16·22 | 42·93 | 10·28 | 0·68 | 28·91 | 0·40 | 1·13 = 100·56 |

This corresponds to Ni(Sb,As)S. Zs. Kr., **19**, 8, 1891.

**Covellite**, p. 68. On crystals from Leogang, Salzburg, Buchrucker has measured, *cp* = *79° 18′, and *pp′* = 59° 22, yielding *c′* = 4·5833. Zs. Kr., **19**, 135, 1891.

**Craigtonite** *Heddle*, Min. Mag., **5**, 30, 1882. A name given to a blue-black substance forming dendritic stains on red granite, in the quarry of Craigton, Hill of Fare, Aberdeenshire, Scotland. An analysis gave alumina, iron sesquioxide, manganese protoxide, magnesia, and alkalies. It is not a mineral species.

**Cryoconite.** Kryokonit, *Nordenskiöld*, Öfv. Ak. Stockholm, **28**, 293, 1871; **32**, 3, 1874 Geol. Mag., **9**, 355, 1872.
A name given by Nordenskiöld to the powder found by him in Greenland covering the surface of land ice, as also at a distance of thirty miles from the coast. It formed a layer of gray powder, sometimes several millimeters in thickness, and often agglomerated into small round balls of loose consistency. It was supposed to be cosmical in origin, but this is not confirmed by later investigators. Cf. *Lasaulx*, Min. Mitth., **3**, 521, 1881, and Wülfing, Jb Min., Beil.-Bd., **7**, 152, 1890; the latter shows that the cosmical element is comparatively insignificant.

**Cryolite**, p. 166. The methods of twinning are described by Baumhauer, Zs. Kr., **18**, 355, 1890.

**Crystallites.** A name given by Vogelsang to the forms, often observed especially in igneous rocks, which show a regular arrangement of grouping, but have not the properties of crystals, particularly not their regular exterior form. They seem to form an intermediate step between amorphous matter and true crystals. See Vogelsang,—Die Krystalliten, Bonn, 1875. To the crystallites Vogelsang has given a variety of names, according to their form or appearance: ***Globulites*** (Vogelsang, p. 13), ***margarites*** (p. 19), ***longulites*** (p. 21, 112), ***sphärolites*** (p. 131), ***cumulites*** (p. 134), ***globosphärites*** (p. 134), ***belonosphärites*** (p. 135), ***felsosphärites*** (p. 135), ***granosphärites*** (p. 135).

**Cuprocalcite** *Raimondi*, Domeyko, 5th Append., Min. Chili, 1876; Min. Pérou, p. 135, 1878. In small masses and in bands intimately mixed with a ferruginous calcite. H. = 3. G. = 3·90. Color bright vermilion-red. Analysis gave: $Cu_2O$ 50·45, CaO 20·16, $CO_2$ 24·00, $H_2O$ 3·20, $Fe_2O_3$ 0·60, $Al_2O_3$ 0·20, MgO 0·97, $SiO_2$ 0·30 = 99·88. Formula deduced $(Cu_2O)_2.CO_2 + 2CaO.CO_2 + H_2O$. Soluble in hydrochloric acid with effervescence; the solution, formed out of contact with the air, has a strong deoxidizing power, precipitating gold from solutions of gold salts. From the mines of Canza, near the city of Ica, Peru. According to the results of Damour this is only an intimate mixture of calcium carbonate and cuprous oxide ($Cu_2O$), Bull. Soc. Min., **1**, 130, 1878.

**Danalite**, p. 435. Found in El Paso Co., Colorado, at West Cheyenne Cañon. It is thus described by Genth (priv. contr.):
Only part of one crystal, 15 × 17 mm., is thus far known, and one somewhat larger fragment discolored by oxides of iron and manganese. The crystal shows the forms (Penfield): plus tetrahedron *o* (111), minus tetrahedron $o_{,}$ $(1\bar{1}1)$ with narrow planes of the dodecahedron *d* (110) truncating their edges. No cleavage observed; fracture uneven, splintery to subconchoidal. Color in some portions pale rose-red to brownish, owing to slight oxidation; also massive. G. = 2·626–2·661. Associated with quartz and astrophyllite, a crystal of which is implanted in the crystal. The purest material, of a fine pale rose-color, gave on analysis:

| | | $SiO_2$ | ZnO | FeO | MnO | CuO | BeO | S | ign. |
|---|---|---|---|---|---|---|---|---|---|
| G. = 2·661 | $\frac{2}{2}$ | 30·26 | 46·20 | 6·81 | 1·22 | 0·30 | 12·70 | 5·49 | 0 21 = 103·19 less 2·78 (O = S) = 100·41 |

This agrees closely with the empirical formula given on p. 435, $(Be,Zn,Fe,Mn)_7Si_3O_{12}S$; it differs, however, from that analyzed by Cooke in containing much more zinc and but little iron and manganese. A second analysis made upon material somewhat less pure gave nearly identical results.

**Datolite**, p. 502. On crystals from Andreasberg, see Busz, Zs. Kr., **19**, 21, 1891.

Obtained artificially by A. de Gramont, by the action of a solution of sodium borate upon calcium silicate at a high temperature under pressure, in crystalline forms conforming in physical properties and composition to the natural mineral. C. R., **113**, 83, 1891.

**Daubréelite**, p. 79. Obtained artificially by Meunier by treating at a red heat an alloy of iron and chromium with hydrogen sulphide. Analysis gave: S 45·01, Fe 19·99, Cr 35·00 = 100. C. R., **112**, 818, 1891.

**Diamond**, p. 3. Walter (Wied. Ann., **42**, 505, 1891) has observed a characteristic absorption-band between the Fraunhofer lines *G* and *h* in the spectrum given by a diamond prism; this was noted in numerous colorless diamonds, and is ascribed to the presence of some foreign substance at present undetermined. The mean values of the refractive indices for the Fraunhofer lines are:

| A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 2·40245 | 2·40735 | 2·41000 | 2·41734 | 2·42694 | 2·43539 | 2·45141 | 2·46476 |

A few diamonds, up to $\frac{25}{32}$ carat, have been found in the gold gravels of Plum Creek, Rock Elm township, Pearce Co., Wisconsin, Kunz, Am. J. Sc., **41**, 252, 1891.

Reported as occurring in the meteoric iron of Cañon Diable, Arizona. Cf. A. E. Foote, Am. J. Sc., **42**, 413, 1891.

On the history of the Kohinoor, cf. N. Story Maskelyne, Nature, **44**, 555, 1891.

**Diaspore**, p. 246. Observed by Cross forming, with alunite, a rock-mass at Mt. Robinson, Rosita Hills, Colorado (cf. also alunite, p. 974). Crystals, of the ordinary habit, are described by Melville, Am. J. Sc., **41**, 466, 475, 1891.

On the artificial formation, see corundum, p. 1031.

**Dioptase**, p. 463. Basal sections showing abnormal optical characters have been described by Karnozhitsky. Six sectors were noted with quasi-twinning bands, in part biaxial, normal to the prism; a normal uniaxial central portion was not observed. Zs. Kr., **19**, 593, 1891.

**Dipyre**, p. 471. On the transformation of dipyre into feldspar, or "werneritization," see Lacroix, Bull. Soc. Min., **14**, 16, 1891.

**Dolomite**, p. 271. On the true orientation of the forms shown by crystals from the Gebroulaz glacier, described by A. Sella, see Becke, Min. Mitth., **11**, 536, 1890: $\phi = \bar{8}\cdot20\cdot\overline{12}\cdot5$.

**Ekmannite**, p. 662. Investigated optically by Hamberg; uniaxial, positive, the ordinary ray ($\omega$) grass-green, the extraordinary ray ($\epsilon$) nearly colorless. G. För. Förh., **11**, 25, 1889.

**Ellonite** *Heddle*, Min. Mag., **5**, 30, 1882. A pale yellow unctuous powder from the gneiss of Ellon, Aberdeenshire, Scotland. It is an impure hydrous silicate of magnesium.

**Elroquite** *C. U. Shepard*, Min. Contr., 1877. An apple-green to gray, massive substance. Regarded as a hydro-silicate of $Al_2O_3$ and $Fe_2O_3$, mixed with opaline silica and a supposed chromium phosphate, to which "the green color was found to be due." To the chromium phosphate the name PHOSPHOCHROMITE is given. From the island of Elroque, Caribbean Sea.

**Enargite**, p. 147. Occurs in the Cerro Blanco mines, Atacama; angle of cleavage prism 82° 2′. Analysis gave R. de Neufville: G. = 4·51, S 32·21, As 18·16, Cu 47·96, Fe 1·22, Zn 0·57 = 100·12. Zs. Kr., **19**, 75, 1891.

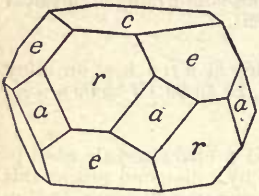
**Erilite** *H. C. Lewis*, Proc. Ac. Nat. Sc. Philad., 292, 1880. Minute acicular crystals, looking like tufts of white wool, observed in a cavity in quartz from Herkimer Co., N. Y.; chemical nature unknown. The cavity also contained a liquid of undetermined character.

**Eucairite**, p. 53. Analyses of a fine granular, perhaps cleavable, variety from the Sierra de Umango, province of La Rioja, Argentine Republic. 1, Fromme, J. pr. Ch., **42**, 57, 1890. 2, 3, Bodländer, quoted by Klochmann, Zs. Kr., **19**, 265, 1891.

|  | Se | Ag | Cu |  |
|---|---|---|---|---|
| 1. | 31·53 | 42·71 | 25·47 = | 99·71 |
| 2. | 32·54* | 43·14 | 26·42 = | 102·10 |
| 3. | 32·32 | 42·20 | 25·41 = | 99·93 |

* A second determination of the material of anal. 3.

**Eudialyte**, p. 409. Crystals from Magnet Cove, Ark., (see fig.), gave Penfield: *ce* = 50° 44′, *cr* = 67° 35′. Am. J. Sc., **41**, 397, 1891.



Magnet Cove, Pfd.

**Falkenhaynite** *R. Scharizer*, Vh. G. Reichs., 433, 1890. Massive, somewhat resembling galena. G. = 4·83 corrected. Color gray-black. Analysis of very impure material, after deducting 13·16 p. c. quartz and 12·77 siderite:

| S | Sb | As | Bi | Cu | Fe | Zn |
|---|---|---|---|---|---|---|
| 26·21 | 23·10 | 4·77 | 0·32 | 39·51 | 4·20 | 1·89 = 100 |

Assuming further that 3·66 p. c. chalcopyrite are admixed, the formula $Cu_3SbS_3$ or $3Cu_2S.Sb_2S_3$ is obtained, or an antimony member of the Bournonite Group, p. 126; it is not far, apparently, from stylotypite, p. 130. The result, however, is not very conclusive, considering the nature of the material. From the Fiedler vein at Joachimsthal; named after Count J. Falkenhayn, Minister of Agriculture.

**Fayalite**, p. 456. Analysis of a massive variety from Cheyenne Mt., Colorado, by Hidden & Mackintosh, Am. J. Sc., **41**, 439, 1891:

G. = 4·35 $SiO_2$ 27·66 FeO 65·79 MnO 4·17 CaO 0·47 = 98·09

Lacroix has noted the occurrence of fayalite in the trachytes of the Capucin, Mont Dore.

**Feldspar Group**, 314 *et seq.* Joly has made the following approximate determinations of the melting points of the various feldspars by the use of the instrument devised by him called the meldometer, Proc. R. Irish Acad., **2**, 38, 1891 (read May 11); and Nature, **33**, 15, 1885:

| | | | |
|---|---|---|---|
| Adularia | 1175° C. | Albite | 1175° C. |
| Sanidine | 1140° | Oligoclase | 1220° |
| Microcline | 1175° | Labradorite | 1230° |

These results do not entirely agree with the experience of some pottery makers, who have found that albite melts to a glass at a temperature at which orthoclase is only partially fused.

The same author gives the following as the (approximate) melting points of the minerals in von Kobell's scale of fusibility:

| | | | | | |
|---|---|---|---|---|---|
| 1. | Stibnite | 525° C. | 4. | Actinolite (green) | 1296° |
| 2. | Natrolite | 965° | 5. | Orthoclase | 1175° |
| 3. | Almandite | 1265° | 6. | Bronzite (Diallage) | 1300° |
| | | | 7. | Quartz | 1430° |

**Ferrite.** A name proposed by Vogelsang (Zs. G. Ges., **24**, p. 529, 1872) for the amorphous hydroxide of iron, which in red or yellow particles plays an important part in many rocks, and whose composition is as yet undetermined.

**Ferrosilicite** *Shepard.* A supposed ferrous silicate present in certain meteorites.

**Fluocerite**, p. 175. Crystals from Österby in Dalarne, Sweden, are found by Weibull to be hexagonal, with *m* ($10\bar{1}0$) and *p* ($11\bar{2}2$) and *mp* = 51° approx., hence $\dot{c}$ = 1·06. G. För. Förh., **12**, 535, 1890.

**Fluorite**, p. 161. On etching-figures, see Becke, Min. Mitth., **11**, 349, 1890.

Becquerel has investigated the phosphorescence of fluorite, C. R., **112**, 557, 1891.

The remarkable adaptivity of fluorite to the construction of lenses (apochromatic) in consequence chiefly of its low refractive and dispersive powers, is developed by Abbe. Thus for the three hydrogen lines $H_\alpha$, $H_\beta$, $H_\gamma$, the differences in the refractive indices are, $n_\beta - n_\alpha = 0·00455$, and $n_\gamma - n_\beta = 0·00255$. Zs. Inst., **10**, 1, 1890; cf. Thompson, Phil. Mag., Feb., 1891.

**Footeite** *G. A. Koenig*, Proc. Acad Philad., 289. 1891.

Monoclinic. In minute prismatic crystals, tabular ‖ *b*, and in part twins, with tw. pl. *a* (100). Forms: *b* (010, *i-ì*), *m* (110, *I*), *d* (*h*0*l*, − *m-ī*), *n* (0*kl*, *m-ì*), *p* (111, − 1), *o* ($\bar{1}$11, 1). Approximate measured angles: *mm‴* = 49°, edge *mm‴*/*pp‴* = 143½°, edge *pp′*/*oo′* = 33°. Color deep blue. Composition deduced, $8Cu(OH)_2.CuCl_2 + 4H_2O$ Approximate analysis on 0·0165 gr.

$CuCl_2$ 13·5 CuO 63·7 $H_2O$ 22·8 = 100

Occurs with paramelaconite and malachite on limonite at the Copper Queen mine, Bisbee, Arizona. Not very far from tallingite, p. 174, but contains only about half as much chlorine. Named after A. E. Foote of Philadelphia.

**Fouquéite** *Lacroix*, Bull. Soc. Min., **12**, 327, 1889.
Monoclinic. In elongated crystals, usually with rounded outlines. Sometimes polysynthetic twins, with *a* (100) as tw. pl. Cleavage oblique to the direction of elongation and making an angle of 90° to 108° with this in sections. Color yellow or white; pleochroism extremely feeble. Optically +. Ax. pl. ∥ cleavage (001). Ax. angle about 90°. Dispersion $\rho < v$. $\gamma - \alpha = 0{\cdot}020$.

Composition like zoisite, from which it differs in form; it appears to be an epidote essentially, containing but little iron (cf. anal. 18, p. 519). Anal.—

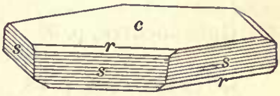
| | G. | $SiO_2$ | $Al_2O_3$ | FeO | CaO | ign. |
|---|---|---|---|---|---|---|
| *White* | 3·24 | 38·6[a] | 32·5 | 1·9 | 23·9 | 2·7 = 99·6 |
| *Yellow* | 3·31 | 38·3 | 31·9 | 4·4 | 23·5 | 2·7 = 100·8 |

[a] Given as 36·6, which makes the total 97·6.

B.B. infusible.

Occurs in anorthite-gneiss at Salem, and less often at Kandy, Ceylon. The rock also contains ordinary epidote (but not immediately associated with fouquéite), scapolite, garnet, amphibole, pyroxene. Named for M. Fouqué.

**Friedelite**, p. 465. Crystals have been described by Lindström (G. För. Förh., **18**, 127, 1891) from the Harstig mine, near Pajsberg, Wermland, Sweden. They occur in six-sided tables with granular galena and greenish gray augite in calcite. Also the same occurrence by Flink (Ak. H. Stockh., Bihang, **16** (2), No. 4, 20, 1891). He measures $cr = 31°\ 33'$, whence $\dot{c} = 0{\cdot}5317$; he also notes the steep rhombohedron *s* $(15\cdot0\cdot\overline{15}\cdot1, 15)$ with faces striated horizontally, $cs = 83°\ 43'$ meas.



Pajsberg, Flink.

Analyses show the presence of 4 p. c. iron protoxide: 1, Lindström; 2, Flink.

| | G. | $SiO_2$ | MnO | FeO | CaO | MgO | Cl | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 1. | | 33·36 | 49·08 | 3·83 | 0·74 | 1·31 | 4·19 | 8·45 $P_2O_5$ *tr.* = 100·96 |
| 2. | 3·058 | 34·66 | 47·70 | — | 0·53 | 2·27 | 3·13 | 8·47 = 99·66 |

**Gadolinite**, p. 509. Nordenskiöld discusses again the molecular weight of the gadolinite-earths present in many rare species, and obtains values ranging from 275·8 in orthite from Sandöna to 247·9 in gadolinite from Gamla, Kårarfvet. Ak. H. Stockh., Bihang **17** (2), No. 1, 1891.

**Gahnite**, p. 223. Oebbeke has analyzed the kreittonite of Silberberg near Bodenmais, as follows (Jb. Min., **1**, 17 ref., 1891).

| $Al_2O_3$ | $Fe_2O_3$ | ZnO | FeO | MnO | MgO |
|---|---|---|---|---|---|
| 48·40 | 7·47 | 27·44 | 14·79 | 2·64 | *tr.* = 100·74 |

**Ganomatite** *Breith.*, Char., 106, 1832. (Gänseköthigerz *Germ.*, Goose-dung Ore, Chenocoprolite *Dana*, Min., 1st Ed., 216, 1837). The material thus named is in part an impure iron-sinter, containing some oxide of cobalt, etc. That of Joachimsthal is a yellowish incrustation, occurring with smaltite. That of Andreasberg is a mixture of oxides of antimony, arsenic, and iron, with a little arsenous oxide (Rg., Min. Ch., 993, 1860).

**Garnet**, p. 437 *et seq* The following are recent analyses:

1. Beautiful rose-pink grossularite in large dodecahedrons from Xalostoc, Distr. Cuautla, State of Morelos, Mexico. Occurs embedded in crystalline limestone with honey-yellow vesuvianite, etc. Described by C. F. de Landero, Am. J. Sc., **41**, 321, 1891, anal. 1 (cf. anal. 8 by Damour, p. 440).
2. From Kedabék in Caucasus, wine-yellow to honey-yellow crystals in trapezohedrons; described by Müller, Jb. Min., **1**, 272, 1891.
3. Cinnamon-garnet from Ottawa Co., Quebec, Canada; described by B. J. Harrington, Can. Rec. Sc., **4**, 93, 1890.
4. Rose-red garnets from Laurentian gneiss of Murray Bay, Quebec, Harrington, l. c.
5. Clear light brownish red spessartite from Amelia Co., Virginia; analyzed by F. W. Clarke, U. S. G. Surv., Bull. **60**, 129, 1890.

6. Melanite from Oberrothweil in the Kaiserstuhl, analyzed by Soltmann, Zs. Kr., **18**, 628, 1891. Cf. anals. 22–31, p. 444.

| | G. | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Xalostoc | 3·516 | 40·64 | — | 21·48 | 1·57 | — | *tr.* | 35·38 | 0·75 | BaO *tr.*, insol. [0·17 = 99·99 |
| 2. Kedabék | $\frac{3}{2}$ | 39·12 | — | 22·73 | 1·77 | — | — | 35·84 | — | ign. 0·15 = 99·61 |
| 3. Ottawa Co., Q. | 3·58 | 36·22 | — | 18·23 | 7·17 | — | 0·63 | 37·39 | *tr.* | ign. 0·70 = 100·34 |
| 4. Murray Bay, Q. | 4·047 | 37·97 | — | 22·44 | 2·39 | 26·12 | 1·18 | 5·27 | 5·43 | = 100·80 |
| 5. Amelia Co., Va. | | 35·35 | — | 20·41 | 2·75 | 1·75 | 38·70 | 0·94 | — | ign. 0·27 = 100·17 |
| 6. Oberrothweil | | 30·48 | 11·01 | 3·13 | 15·49[a] | 3·84 | — | 30·19 | 2·28 | Alk. 1·65, ign. [0·19, $ZrO_2$ 1·28 = 99·54 |

[a] Incl. 0·28 $Mn_2O_3$.

**Grängesite**, p. 654. Cf. Lacroix, Bull. Soc. Min., **10**, 142, 1887.

**Graphite**, p. 7. On the formation by contact-metamorphism, see Beck & Luzi, Jb. Min., **2**, 28, 1891.

**Goethite**, p. 247. Occurs with hematite, pyrolusite, calcite, barite, etc., in the Lower Carboniferous limestone of Clifton, Nova Scotia. An analysis by Shuttleworth (quoted by Harrington, Can. Rec. Sc., **4**, 93, 1890) gave

G. = 4·217 $Fe_2O_3$ 88·92 $Mn_2O_3$ 0·14 $H_2O$ 10·20 $SiO_2$ 0·32 = 99·58

**Greenockite**, p. 69. On artificial crystals, see troilite, p. 1051.

**Guanajuatite**, p. 38. An analysis of an original specimen gave Genth:

G. = 6·977 Se 25·50 S 4·68 Bi 68·86 = 99·04

Formula hence $Bi_2Se_2S$ or $2Bi_2Se_3.Bi_2S_3$ analogous to common tetradymite. Am. J. Sc., **41**, 403, 1891.

**Halite**, p. 154. On the double refraction called out by pressure, see Pockels, Wied. Ann., **39**, 440, 1890.

On indices of refraction, see Dufet, Bull Soc. Min., **14**, 139, 1891.

G. Freda has analyzed some of the chlorides from Vesuvius, like those earlier noted by Scacchi (p. 157) [Gazz. Ch. Ital., 16, 1889], Jb. Min., **2**, 374 ref., 1890. The materials analyzed are as follows: 1, stalactitic salt of the 1884 crater; 2, nodular crusts of 1875 crater; 3, cubic crystals, 1881; 4, thick white stalactites, 1886; 5, white nodular crusts from the Mauro lava of 1887; 6, white crusts from the 1888 Mauro lava.

| | NaCl | KCl | LiCl | $CaCl_2$ | $MgCl_2$ | $CaSO_4$ | |
|---|---|---|---|---|---|---|---|
| 1. | 33·06 | 58·67 | 0·07 | 1·78 | 0·89 | 1·22 | insol. 3·08, $H_2O$ and loss [1·23] = 100 |
| 2. | 32·11 | 66·38 | | | | | = 98·49 |
| 3. | 31·03 | 68·20 | | | | | = 99·23 |
| 4. | 81·93 | 15·41 | | | | | $CaSO_4$ 126 = 98·60 |
| 5. | 54·20 | 43·71 | | | | | = 97·91 |
| 6. | 73·89 | 24·18 | | | | | = 98·07 |

**Hausmannite**, p. 230. Crystals from Jakobsberg show the new forms:

*z* (5·5·11, $\frac{5}{11}$)? *m* (110, *I*) *v* (335, $\frac{3}{5}$) *u* (223, $\frac{2}{3}$) *t* (414, 1-4)

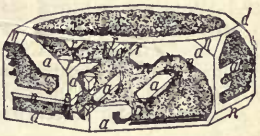
Axial ratio assumed, $\dot{c} = 1·1573$, $001 \wedge 101 = 49° 10'$. G. Flink, Ak. H. Stockh., Bihang, **16** (2), No. 4, 10, 1891.

**Heldburgite** *Luedecke*, Zs. Nat. Halle, **4**, 291, 884, 1879.

Tetragonal. Axis $\dot{c} = 0·7500$. In minute (3 mm. long, $\frac{1}{2}$ to $\frac{1}{3}$ mm. thick) prismatic crystals. Forms: *a* (100, *i-i*), *m* (110, *I*), *p* (111, 1). Angles: $mp = 43° 19'$, $pp'' = *93° 22\frac{1}{2}'$, $pp' = 61° 56'$. It is near zircon in form. In habit resembles guarinite. H. less than that of steel. Luster adamantine. Color yellow. Streak white. Transparent. B. B. infusible. Composition unknown ($TiO_2$ absent). Occurs in the feldspar of the phonolyte of the Heldburg near Coburg.

HEMATITE, p. 213. Crystals altered to or inclosing cassiterite occur at the Mina del Diablo. Durango, Mexico. Cf. Genth & Rath, Proc. Am. Phil. Soc., **24**, 23, 1887, and Pirsson, Am. J. Sc., **42**, 407, 1891. The crystals described by Pirsson (fig. 1) are in part cellular, and are filled with cassiterite. The planes of the hematite brilliant in luster, but are distinct only at the edges; the forms observed are: *c* (0001), *a* (11$\bar{2}$0), *d* (10$\bar{1}$2), *r* (10$\bar{1}$1), *Θ* (20$\bar{2}$1), *η* (01$\bar{1}$1), *s* (02$\bar{2}$1), *n* (22$\bar{4}$3). The cassiterite shows no definite orientation, but forms an intimate crystalline aggregation. Pirsson regards it as a case of simultaneous crystallization in which the form was determined by the hematite.

1.



**Hessenbergite** *Kenng.*, Ber. Ak. München, **2**, 230, 1863. Sideroxen *Hessenberg*, Min. Not., **7**, 4, 1866.

Monoclinic. Axis $\grave{a} : \bar{b} : \acute{c}$ = 1·7514 : 1 : 1·0480 ; $\beta$ = *89° 53′ = 001 ∧ 100 Hessenberg[1]. 100 ∧ 110 = 60° 16½′, 001 ∧ 101 = 30° 52′, 001 ∧ 011 = 46° 20½′.

**Forms:** *c* (001, *O*), *a* (100 $i\text{-}\bar{i}$), *b* (010, $i\text{-}\grave{i}$), *i* (910, $i\text{-}\bar{9}$), *f* (310, $i\text{-}\bar{3}$), *m* (110, *I*), *y* (101, $-1\text{-}\bar{i}$), *p* (501, $-5\text{-}\bar{i}$, *g* ($\bar{5}$04, $\frac{5}{4}\text{-}\bar{i}$), *n* ($\bar{3}$01, $3\text{-}\bar{i}$), *e* (012, $\frac{1}{2}\text{-}\grave{i}$), *o* ($\bar{3}$15, $\frac{3}{5}\text{-}\bar{3}$).

Angles :) *ff‴* = 60° 33′, *mm‴* = *120° 33′, *cy* = *30° 52′, *cp* = 30° 55½′, *cg* = 36° 50′, *cn* = 60° 58′, *ee′* = 55° 18½′, *co* = 22° 35′, *oo′* = 22° 20′.

Twins: tw. pl. *y* (101) common. Crystals tabular ‖ *c*. H. = 7–7·5. Luster adamantine. Colorless, bluish. Transparent.

**Comp.**—A silicate of undetermined constituents. It has been suggested that it may be danburite (Groth), but fails to find correspondence in the forms. Cf. Hintze, Zs. Kr., **7**, 303, 1882.

**Pyr., etc.**—In a closed tube yields no water, and is unchanged. In the platinum forceps whitens, but does not fuse. In borax melts without intumescence. Heated with cobalt solution becomes gray. No action from hydrochloric acid.

**Obs.**—Occurs implanted on crystals of hematite (*Eisenrosen*) at Mt. Fibia, west of the Hospice of St. Gothard.

**Ref.**—Min. Not., **7**, 4. 1866. Cf. also Kenngott, Jb. Min., 232, 1864.

HESSITE, p. 47. An analysis of tabular crystals from Botes, Transylvania, by Loczka, gives the formula $Ag(Au)_2Te$. Anal.: Te 37·77, Ag 61·52, Au 1·01, Fe *tr.* = 100·30. Ber. aus Ungarn, **8**, 103, 1891.

HOWARDITE *Shepard.* A supposed silicate of iron and magnesium, present in certain meteorites.

HYDRONICCITE *C. U. Shepard*, Min. Contr., 1877. A name suggested for a doubtful substance conjectured to be a hydrated oxide of nickel, from Texas, Penn.

HYDROBUCHOLZITE *Thomson.* Thomson obtained (Min., 1, 237, 1836) $SiO_2$ 41·35, $Al_2O_3$ 49·55, $H_2O$ 4·85, gypsum 3·12 = 98·87. Probably from Sardinia.

HYDROSAMARSKITE. *A. E. Nordenskiöld*, Ak. H. Stockh., Bihang, **17** (2), No. 1, 8, 1891. A samarskite from the Nothamnsgrufra, Väddö, containing 10·5 p. c. water and 4 p. c. of "gadolinite-earths" of a molecular weight of 274·1.

HYPOXANTHITE *Rowney*, Ed. N. Phil. J., **2**, 308, 1855; Sienna Earth. A brownish yellow ferruginous clay or ocher, probably only clayey yellow ocher.

ILVAITE, p. 541. Occurs with calcite, tremolite, andradite, forming irregular crystalline masses in a large vein near the head of Barclay Sound, Vancouver Island, B. C. An analysis gave Hoffmann, Am. J. Sc., **42**, 432, 1891:

| | $SiO_2$ | $Fe_2O_3$ | $Al_2O_3$ | FeO | MnO | CaO | MgO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| G. = 3·85 | 29·81 | 18·89 | 0·16 | 32·50 | 2·22 | 13·82 | 0·30 | 1·62 = 99·32 |

IRON, p. 28. J. M. Davison has analyzed the kamacite, tænite, and plessite from the Welland meteoric iron (cf. anals. p. 30). He found the plessite to consist of two parts, A and B, corresponding in composition to the other alloys named, and the same may be true in general. Am. J. Sc., **42**, 64, 1891.

| | Fe | Ni | Co | C |
|---|---|---|---|---|
| 1. *Kamacite* | 93·09 | 6·69 | 0·25 | 0·02 = 100·05 |
| 2. *Plessite* A (*kamacite*) | 92·81 | 6·97 | 0·19 | 0·19 = 100·16 |
| 3. " B (*tænite*) | 72·98 | 25·87 | 0·83 | 0·91 = 100·59 |
| 4. *Tænite* | 74·78 | 24·32 | 0·33 | 0·50 = 99·93 |

Cohen and Weinschenk (Ann. Mus. Wien, **6**, 131, 1891) have investigated chemically a series of meteoric irons. They conclude that the cubic irons have a constant percentage of nickel and cobalt; thus they find Fe 92·90, Ni + Co 7·10 in Coahuila, and Fe 93·82, Ni + Co 6·18 in Braunau, while a series of others lie between these limits. In the Magura and Wichita Co. irons they find large crystals (arranged parallel to an octahedral face) of an iron carbide (*Kohlenstoffeisen*) with 6·4 and 5·1 p. c. carbon and yielding the formulas $(Fe,Ni,Co)_3C$ and $(Fe,Ni.Co)_4C$; the former has been called *cohenite* (p. 31). In the octahedral irons they find two kinds of tænite: A, tin-white, flexible, rich in cobalt and nickel, with small amount of carbon; B, grayish, feebler luster, less flexible to brittle, lower in nickel and carbon and higher in carbon. Analyses:

| A | Fe | Ni | Co | Cu |
|---|---|---|---|---|
| Toluca | 65·17 | 34·29 | 0·40 | 0·14 = 100 |
| Wichita Co. | 65·54 | 32·87 | 1·59 | — = 100 |
| Glorieta Mt. | 63·04 | 35·53 | 1·43 | — = 100 |

| B | Fe | Ni | Co | C |
|---|---|---|---|---|
| Staunton | 73·10 | 23·63 | 2·10 | 1·17 = 100 |

The authors also remark that cohenite, $(Fe,Ni,Co)_3C$, corresponds to the compound, $Fe_3C$, which separates from cast iron in crystals when slowly cooled, between 600° and 700°.

The discovery, mode of occurrence, and distribution of the native nickel-iron alloy, called *awaruite*, on the west coast of the South Island of New Zealand, is minutely discussed by Ulrich in Q. J. G. Soc., **46**, 619, 1890. It is shown to be somewhat widely distributed in a highly basic peridotyte or the serpentine which has resulted from its decomposition.

Found in the Berezovsk mining region near Ekaterinburg, Ural; the special locality is the gold placers of Prikanavny in the valley of the Pyshma which empties into the Tura, a branch of the Tobol. The fragments have a peculiar foliated structure. It is magnetic; G. = 7·59, and contains a minute amount of platinum but no nickel. Associated minerals are quartz, mica, chrysolite, pyroxene, serpentine, chromite, triclinic feldspar, etc. Daubrée and Meunier, C. R., **113**, 172, 1891.

Observed as forming part of a thin coating with oolitic structure on quartzyte on the north shore of St. Joseph Is., Lake Huron, Ontario. Analysis of the coating gave: Metallic grains 58·85, limonite 39·73, siliceous matter 1·42 = 100. The spherical metallic grains varied from a microscopic size up to 0·37 mm. in diameter; an analysis of them yielded:

| Fe | Mn | Ni | Co | Cu | S | P | C | insol. |
|---|---|---|---|---|---|---|---|---|
| 88·00 | 0·51 | 0·10 | 0·21 | 0·09 | 0·12 | 0·96 | ? | 9·76 = 99·75 |

The insoluble portion formed a nucleus of rounded form and coated with a yellowish brown humus-like substance, which disappeared on ignition, leaving the snow-white spherules consisting of 94 p. c. $SiO_2$. G. Ch. Hoffmann, Trans. R. Soc. Canada, 8 (3), 39, 1890.

Hussak has noted the occurrence of undoubted native iron in the gold gravels of the Ribeira in S. Brazil (ref. ottrelite, p. 1043).

**Isopyre** *Haidinger*, Ed. N. Phil. J., 3, 263, 1827.

In compact masses, with cleavage. Fracture flat conchoidal. Brittle. H. = 6–6·5. G. = 2·912. Luster vitreous. Streak light greenish gray. Color grayish black or velvet-black, occasionally spotted red, like heliotrope. Opaque to subtranslucent. Analysis.—Turner, p. 265:

$SiO_2$ 47·09 $Al_2O_3$ 13·91 $Fe_2O_3$ 20·07 CaO 15·43 CuO 1·94 = 98·44

B.B. fuses easily to a magnetic bead, and colors the flame green. A silica skeleton with salt of phosphorus. With the acids decomposed with difficulty and imperfectly.

From St. Just, near Penzance, Cornwall, in a quartzose granite with tourmaline and tin ore, in pieces two inches in diameter. Also in breccia on the Calton Hill, Edinburgh, with limonite. Named from ἴσος, *like*, and πῦρ, *fire*, because the fused bead resembles closely the original mineral.

The above supposed mineral species has been examined by N. Story Maskelyne and W. Flight and proved to be simply impure opal. J. Ch. Soc., **25**, 1049, 1872. The same conclusion has been reached by Fischer.

**Ivaarite.** Iiwaarite, p. 448. Occurs in an Elæolite rock ("Ijolith") at Iiwaara, Finland. The analyses by Thoreld (p. 448) are questioned by Ramsay and Berghell on the ground that the material was probably not homogeneous; they obtained 25·42, 24·93 p. c. $TiO_2$. G. För. Förh., 13. 305, 1891.

JORDANITE, p. 141. Crystals from the Binnenthal are shown by Baumhauer to conform in angle to the monoclinic system. The axial ratio, calculated by him from the angles: 100 ∧ 001 = 89°26½′, 001 ∧ 101 = 28° 6½′, 010 ∧ 250 = 38° 58¼′, is:

$$\grave{a} : \bar{b} : \acute{c} = 0{\cdot}49450 : 1 : 0{\cdot}26552 \qquad \beta = 89°\ 26\tfrac{1}{2}'$$

The planes, which on p. 141 are taken as macropinacoid (*a*), brachypinacoid (*b*), and base (*c*), become, respectively, base (*c*), orthopinacoid (*a*), and clinopinacoid (*b*); further, *κ* (112) = 121, $\bar{1}21$, *m* (110) = 101, $\bar{1}01$, *y* (101) = 011, *p* (011) = 110, etc. A number of new forms are added. Ber. Ak. Berlin, 697, 915, 1891.

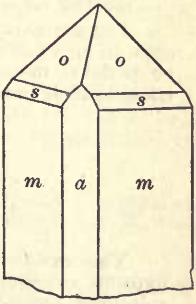
**Kallilite.** *H. Laspeyres*, Zs. Kr., **19**, 12, 1891. Wismuthnickelglanz.
Massive. Luster metallic. Color light bluish gray.
**Comp.**—NiBiS or $NiS_2.NiBi_2$ = Sulphur 10·7, bismuth 69·7, nickel 19·6 = 100. It thus belongs near ullmannite, etc., p. 91. Analysis:

| | S | Sb | Bi | As | Ni | Fe | Co |
|---|---|---|---|---|---|---|---|
| ⅜ | 14·39 | 44·94 | 11·76 | 2·02 | 26·94 | 0·28 | 0·89 = 101·22 |

Occurs at the Friedrich mine near Schönstein, a. d. Sieg. The name refers to the locality.

KAOLINITE, p. 685. Crosby describes a bed of white kaolin of considerable extent in Blandford, Hampden Co., Mass. It has been produced by the decomposition of the feldspar of large veins of pegmatyte and is regarded as representing part of the pre-glacial soil. Tech. Q., 3, 228, 1890.

KARAMSINIT *A. E. Nordenskiöld*, Rg., Min. Ch., 683, 1875. A mineral supposed to be from Finland, containing, according to Thoreld: $SiO_2$ 51·53, $Al_2O_3$ 3·20, $Fe_2O_3$ 5·98, MnO 4·62, CaO 13·05, MgO 6·86, $K_2O$ 10·8, CuO 2·32, $H_2O$ 1·59.



KENTROLITE, p. 544. Found at Långban, Sweden, intimately associated with braunite, also richterite, barite. Crystals prismatic with *a* (100), *m* (110), *o* (111), *s* (221) (cf. fig.). Axial ratio $\breve{a} : \bar{b} : \acute{c}$ = 0·63278 : 1 : 0·89879 from *mm‴* = *64° 39′ and 110 ∧ 111 = *30° 45′. Formula deduced, $\overset{\text{II}}{R}_2SiO_4.\overset{\text{III}}{R}_2SiO_5$, with $\overset{\text{II}}{R}$ = Pb : Mn : Ca = 33 : 5 : 2, and $\overset{\text{III}}{R}$ = Mn : Fe = 3 · 1. Analysis:

| | $SiO_2$ | $Mn_2O_3$ | $Fe_2O_3$ | PbO | MnO | CaO |
|---|---|---|---|---|---|---|
| G. = 6·068 | 17·68 | 16·59 | 5·58 | 55·72 | 3·05 | 0·91 = 99·53 |

Flink finds an error in the axial ratio calculated by vom Rath (0·633 : 1 : 0·784), which, however, has been corrected on p. 544. Ak. H. Stockh., Bihang, **16** (2), No. 4, 1891.

KULIBINITE. Koulibinite. See Koksharov, Min. Russl., **4**, 281; Dx., Min., **1**, 57, 1862. From Transbaikal. Probably simply a kind of pitchstone, Kk., and Dx., Min., **2**, xix, 1874.

KRENNERITE, p. 105. Miers notes on crystals from Nagyág, the new forms: *d* (021, 2-ĭ), *q* (031, 3-ĭ), *s* (041, 4-ĭ), *w* (124, ½-2̆), *t* (121, 2-2̆), *v* (362, 3-2̆). Min. Mag., **9**, 184, 1890.

LÅNGBANITE, p. 543. Sjögren (G. För. Förh., **13**, 256, 1891) distinguishes two types of långbanite from Långban: A, occurring in hexagonal tabular crystals 0·5 to 1 cm. in diameter and some millimeters in thickness, associated with fine granular schefferite. B, small crystals of prismatic habit often embedded in calcite. Analyses 1, 2 (by R. Mauzelius) are of type B; anal. 3, of type A. The formula deduced is $m\text{Sb}_2\text{O}_3.n\text{Fe}_2\text{O}_3.p\overset{\text{II}}{\text{Mn}}(\overset{\text{IV}}{\text{Mn}},\text{Si})\text{O}_3$. The coefficients *m*, *n*, *p* vary, but the relation of MnO : $(Mn,Si)O_2$ is about constant = 1 : 1. Attention is also called to the fact that the axial ratio, $a : \tfrac{5}{6}\acute{c}$ (Flink) = 1 : 1·3694, corresponds closely to that characteristic of the Hematite Group, p. 210 *et seq.* (cf. also pyrophanite, p. 1045). Further, some crystals seem to be hemihedral, i.e. rhombohedral, in habit.

Analyses, 1–3, Mauzelius:

| | G. | $SiO_2$ | $Sb_2O_3$ | $Fe_2O_3$ | $MnO_2$ | MnO | CaO | MgO |
|---|---|---|---|---|---|---|---|---|
| 1. | 4·66 | 12·23 | 11·76 | 14·15 | 26·15 | 31·54 | 2·24 | 1·61 = 99·68 (O 3·50) |
| 2. | 4·73 | 11·32 | 11·61 | 14·31 | 27·12 | 32·30 | 2·04 | 0·86 $H_2O$ 0·32 = 99·88 (O 3·70) |
| 3. | | 8·95 | 12·92 | 4·33 | 35·15 | 36·39 | 1·95 | 0·47 = 100·16 (O 5·03) |

The same subject is discussed by Bäckström (ibid., p. 271), who gives two new analyses and recalculates that of Flink (p. 543). Although differing as regards the state of oxidation of the manganese, he arrives at essentially the same conclusion as that of Sjögren, that the mineral is to be referred to the hematite-ilmenite group. He writes the formula $\overset{m}{R}\overset{n}{R}O_3$, where $m + n = 6$.

Analyses, 4–6, Bäckström:

| | $SiO_2$ | $Sb_2O_3$ | $Mn_2O_3$ | $Fe_2O_3$ | MnO | CaO | MgO | |
|---|---|---|---|---|---|---|---|---|
| 4. | 9·58 | 12·58 | 63·67 | 3·44 | 8·21 | 1·73 | 0·53 | = 99·74 |
| 5. | 8·75 | 15·35 | 61·04 | 4·75 | 5·86 | 2·98 | 0·40 | = 99·13 |
| 6. | 10·88 | 13·89 | 59·43 | 11·46 | 12·87 | — | — | = 108·53 |

**LANTHANITE**, p. 302. On the crystalline form of the analogous didymium carbonate $Di_2(CO_3)_3 + 8H_2O$, which is orthorhombic with *mm‴* = 87° 26′, see Morton, Öfv. Ak. Stockh., **42**, No. 6, 192, 1885.

**Lautarite** *A. Dietze*, Zs. Kr., **19**, 447. Oct. 23, 1891.

Monoclinic. In large prismatic crystals sometimes weighing 20 grams. Prismatic angle of 83° 30′; basal plane rare. Crystals often radiately arranged or in stellate aggregates. G. = 4·59. Colorless to yellowish.

**Comp.**—Calcium iodate, $Ca(IO_3)_2$ = Iodine pentoxide 85·6, lime 14·4 = 100. It thus belongs to a group not before represented among minerals. Analysis gave: I 64·70 and 64·62, CaO 14·95, determined on three portions. Slightly soluble in water, 0·22 gram in 100 grams of water at 20°, or 1·43 grams of iodine to the liter. Aqueous solution colorless. Soluble in hydrochloric acid with evolution of chlorine.

**Obs.**—Occurs in the caliche or sodium nitrate deposits (cf. p. 871) of Atacama, Chili, especially in the "Pampa del Pique III" belonging to the Oficina Lautaro and to neighboring Pampas, all of which belong to the so-called calcium chloride class. The crystals are often embedded in bands of gypsum.

On the form of the hydrous calcium iodate $Ca(IO_3)_2 + 6H_2O$, see Rg., Kr. Ch., 332, 1881.

The same region furnishes crystals in the caliche, as described by Dietze (ibid.), which seem to be a double salt of iodate and chromate of calcium, corresponding to $7Ca(IO_3)_2.8CaCrO_4$; or perhaps more simply $Ca(IO_3)_2.CaCrO_4$, which requires: Iodine pentoxide 61·1, chromium trioxide 18·4, lime 20·5 = 100. Analysis gave:

| $I_2O_5$ | $CrO_3$ | CaO | | I |
|---|---|---|---|---|
| 58·12 | 19·00 | 22·01 | = 99·13 | 44·20 |
| 58·10 | 19·90 | 21·50 | = 99·50 | 44·17 |
| 58·89 | 20·28 | 21·10 | = 100·37 | 44·79 |

The crystals dissolve slowly, more readily on application of heat. On cooling, crystals of the hydrous calcium iodate (cf. above) separate out, while the calcium chromate remains in the solution. On a supposed chromate from the nitrate deposits, see tarapacaite, p. 916. Dietze, however, regards the chromic acid as always present as a double salt united with iodate.

On artificial double salts of iodic and chromic acid, see Berg, C. R., **111**, 42, 1890.

**LEAD SILICATE.** An artificial lead silicate from Bonneterre, St. François Co., Missouri, has been described by E. S. Dana and S. L. Penfield (Am. J. Sc., **30**, 138, 1885), and later by H. A. Wheeler (ibid., **32**, 272, 1886.) It occurs associated with octahedral crystals of magnetite and cleavable galena; form, a hexagonal prism (*m*) with pyramids (*p*, *q*), and basal plane (*c*), *cp* = 50° approx., *cq* = 25°; also in thin tabular crystals with apparently rhombohedral planes. Analyses of crystals: 1, Penfield; 2, Wheeler.

| G. | $SiO_2$ | PbO | FeO | CaO | MgO | $Na_2O$ | |
|---|---|---|---|---|---|---|---|
| 5·92 | 17·17 | 72·39 | 0·51 | 7·48 | 0·56 | 0·35 | = 98·46 |
| | 17·11 | 73·66 | 1·33[a] | 2·35 | 0·22 | 2·22 | NiO 3·06, Cl 0·08 = 100·03 |

[a] $Fe_2O_3$ 0·80, $Al_2O_3$ 0·53

Other analyses are given by Penfield of the massive silicate, and by Wheeler of fine crystals.

**LÅVENITE**, p. 375. Occurs in the phonolytes of the Haute Loire, Lacroix, Bull. Soc. Min., **14**, 15, 1891.

**LEOPARDITE.** A quartzose rock spotted with stains of manganese occurring in North Carolina.

**Leucite**, p. 342. The characters and distribution of the altered leucite (*pseudoleucite*) and leucitic rocks of Magnet Cove, Arkansas, briefly alluded to on pp. 343 and 426, are fully described by J. F. Williams in the Ann. Rep. Geol. Arkansas, 1890, vol. 2, p. 267 *et seq.*
Lacroix has noted the presence of leucite in a basalt of Mont Dore, Puy-de-Dôme. C. R., **113**, 751, Nov. 23, 1891.

**Lithidionite.** Litidionite *E. Scacchi*, Rend. Accad. Napoli, **19**, 175, Dec. 1880.
Blue lapilli, found at Vesuvius in 1873, 7 to 25 mm. in diameter, were found to consist of a white earthy substance, with a glassy blue crust. Of the latter, H. = 5–6, G. = 2·535. The mean of two analyses gave, after being washed: $SiO_2$ 71·57, CuO 6·49, FeO 4·02, $K_2O$ 10·92, $Na_2O$ 6·78 = 99·78. Slightly attacked by HCl; fuses very easily (the white nucleus, consisting of augite, olivine, etc., is infusible). The author, on the ground of the fusibility, regards the substance as a mixture of quartz and the carbonates of potassium and sodium.

**Luzonite**, p. 148. Klockmann has investigated the famatinite of the Sierra de Famatina, Argentine Repub., and also a mineral which he identifies as luzonite from the same locality. He regards both these minerals as isomorphous and unlike enargite in form, while hitherto famatinite and enargite have been considered isomorphous, as given in p. 149. The argument is not conclusive. Anal.—Bodländer, quoted by Klockmann.

G. = 4·390 S 32·40 As 16·94 Sb 3·08 Cu 47·36 = 99·78

**Magnetite**, p. 224. Kemp has given the results of a more minute study of the striated magnetite crystals from Mineville, near Port Henry, Essex Co., N. Y. Zs. Kr., **19**, 183, 1891.
Scheibe mentions on crystals from Magnet Cove and Moriah, Essex Co., N. Y., tw. striations and parting ‖ *o* (111); also tw. lamellæ ‖ *m* (311); further, Moriah, ‖ *e* (210). Zs. G. Ges., **42**, 370, 1890.
A magnetite from Büchig near Hirschberg a. Saale in Oberfranken contains tin according to Sandberger, Jb. Min., **2**, 269, 1890.
Formation in slags and recent eruptive rocks, see Vogt, Arch. Math. Nat., **14**, 25, 1890.

**Mancinite** *Jacquot*, Ann. Mines, **19**, 703, 1841. Described as a zinc silicate from Mancino near Leghorn, but according to Uzielli (Trans. Accad. Linc., **1**, 108, 1877) the mineral is not, as supposed, from the hill Mancino, near Leghorn, nor is it a zinc trisilicate.

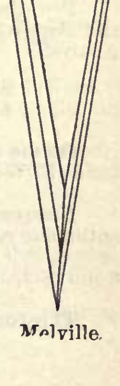
**Manganoferrite** *Vogt*, Arch. Math. Nat., **14**, 35, 1890. Blackish brown skeleton crystals formed in some Martin and Bessemer slags, having the composition $(Fe,Mn)_3O_4$ and resembling hausmannite and magnetite. To which system they belong, tetragonal or isometric, is not determined.

**Marcasite**, p. 94. Trechmann describes marcasite twins (tw. pl. *m*) implanted in parallel position on the faces of pyrite cubes from Bredlar near Brilon, Westphalia. Min. Mag., **9**, 209, 1891.

**Mariposite** *B. Silliman, Jr.*, Cal. Acad. Sc., **3**, 380, 1868. A light apple-green micaceous mineral, occurring in scales associated with pyrite in a gangue of dolomite (ankerite) and quartz; with the ore of the Mariposa region, California.

**Melanophlogite**, p. 194. The nature of this problematical mineral has been further discussed by Streng, Ber. Oberhess. Ges., **27**, 123, 1890, and Jb. Min., **2**, 211, 1891; also Friedel, Bull. Soc. Min., **13**, 356, 1890, and **14**, 74, 1891. Streng argues that the mineral contains silicon disulphide ($SiS_2$), not sulphur trioxide as ordinarily stated, but Friedel pretty conclusively shows that the latter view is correct. He concludes further that the ordinary mineral is pseudo-isometric and tetragonal, optically negative; further, that it does not gain its form by pseudomorphism. There also occur forms which are hexagonal in structure, optically positive, and correspond to tridymite.

**Metacinnabarite**, p. 62. The form of the crystals, from New Almaden, described by Melville and briefly alluded to on p. 63 is given in the accompanying figure. The crystals are minute but brilliantly polished and gave good measurements, but the symbols obtained by him, especially for the hemi-scalenohedrons, are highly complex. The forms observed at the analogous pole are: *c* (0001, 111), *m* $(10\bar{1}0, 100)$, $(0554, 33\bar{2})$, $(1\bar{3}22, 21\bar{1})$; at the antilogous pole: $(50\cdot0\cdot\bar{50}\cdot\bar{1}, 33\cdot\bar{17}\cdot\bar{17})$, $(48\cdot\bar{46}\cdot\bar{2}\cdot\bar{1}, 31\cdot\bar{17}\cdot\bar{15})$, $(41\cdot\bar{38}\cdot\bar{3}\cdot\bar{1}, 26\cdot\bar{15}\cdot\bar{12})$. The specific gravity obtained was only 7·118. The relation of these crystals to those described by Penfield is at present undetermined.
Occurs with cinnabar at Knoxville, Cal., and at the Cerro Gordo mine, 11 miles west of Panoche, Fresno Co. Melville & Lindgren, U. S. G. Surv., Bull. **61**, 22, 1890.



Melville.

Schrauf mentions the occurrence of metacinnabarite at Idria in hemispherical forms with concentric fibrous structure. They are implanted on calcite which coats the calcareous sandstone, forming the gangue rock. G. = 7·66. The amount of sulphur was found to be 14·09 p. c. Anz. Ak. Wien, 156, 1890.

MICROCLINE, p. 322. On the structure of the microcline in pegmatytes from the Argentine Republic, see Sabersky, Jb. Min., Beil., **7**, 359, 1891.

MICROLITES. A name proposed by Vogelsang (Philosoph. Geol., p. 139, 1867) and since used by Zirkel (Mikr. Beschaff. d. Min., pp. 33, 88, 1873) for microscopic crystals, sometimes belonging to known species, sometimes of indeterminate nature, but often observed in igneous rocks. The method of aggregation of these microlites is sometimes very remarkable. Trichite and belonite are names given by Zirkel (l. c.) to analogous forms.

MOLYBDENITE, p. 41. Occurs in spherical forms with concentric structure at Plataro, in Colorado.

MORINITE *A. Lacroix*, Bull. Soc. Min., **14**, 187, 1891. A new species, announced but not fully described, occurring with the amblygonite at Montibras. In monoclinic crystals with *a* (100, *i-ī*), *b* (010, *i-ì*), *c* (001, *O*), *m* (110, *I*). Cleavage: *a* (100). G. = 2·94. Ax. pl. ∥ *b*. Bx inclined 30° in the obtuse angle *ac*. 2E variable, up to 40°.

B.B. the mineral bubbles up and fuses. In the closed tube gives off about 13·5 p. c. of acid water (with fluorine). Gives reactions for phosphoric acid, alumina, and soda.

Morinite is associated with an undetermined hydrated phosphate free from fluorine, crystallizing in tetragonal octahedrons, which are optically positive. Named after M. Morineau.

**Mursinskite** *Koksharov*. Min. Russl., **9**, 341, 1886.

Tetragonal. Axis $\dot{c} = 0·56641$; $001 \wedge 101 = 29° 31\frac{2}{8}'$.

**Forms**: *y* (503, $\frac{5}{3}$-*i*), *x* (201, 2-*i*); *o* (111, 1); *z* (10·5·2, 5-2), *s* (841, 8-2); also two undetermined zirconoids *w*, *v*.

Angles: $cy = 43° 21$, $cx = 48° 34'$, $co = 38° 42'$, $yy' = 58° 5'$, $xx' = 64° 1\frac{1}{2}'$, $oo' = 52° 28'$, $zz' = 35° 6'$, $zz^{vii} = 50° 29'$, $ss' = 36° 9'$, $ss^{vii} = 52° 3$.

H. = 5–6. G 4·149 (on 0·04 gram). Color wine- or honey-yellow. Transparent to semi-transparent.

**Comp**.—Unknown.

**Obs.**—Known only from two specimens discovered about 1854; it occurs as inclusions in topaz. From Alabashka, near Mursinka (Mursinsk) in the Ural.

NATROLITE, p. 600. Gonnard has analyzed several specimens from the Puy-de-Dôme, Bull. Soc. Min., **14**, 165, 1891:

| | $SiO_2$ | $Al_2O_3$ | $Na_2O$ | CaO | $H_2O$ |
|---|---|---|---|---|---|
| Puy-de-Marman | 48·03 | 26·68 | 15·61 | — | 9·62 = 99·94 |
| Tour de Gevillat | 47·88 | 26·12 | 15·63 | 0·45 | 9·80 = 99·88 |

NATRON, p. 301. Described by E. Scacchi as occurring in colorless crystalline grains and prismatic crystals within the lava at the Fosso Grande, Vesuvius. An analysis gave: $CO_2$ 15·91, $Na_2O$ 22·15, $K_2O$ 0·41, $H_2O$ 61·68 = 100·15. Rend. Accad. Napoli, **2**, 488, Dec. 1888, and Zs. Kr., **18**, 100, 1890.

NEPHELITE, p. 423. Continued studies on the nephelite rocks of Brazil are given by Derby, Q. J. G. Soc., **47**, 251, 1891.

Described from the rock called Iiolyte (Ijolith) occurring at Iiwaara, Finland, by Ramsay and Berghell (G. För. Förh., **13**, 308, 1891). Refractive indices: $\omega_y = 1·54515$, $\epsilon_y = 1·54200$. Analysis:

| $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ |
|---|---|---|---|---|
| 43·98 | 34·93 | 0·36 | 16·76 | 3·88 = 99·86 |

On the elæolite rocks of Magnet Cove and other regions in Arkansas, and their minerals, see J. F. Williams, Ann. Rep. G. Ark., vol. **2**, 1891.

NESQUEHONITE, p. 300. Occurs forming white fibrous masses in the galleries of the anthracite mine of la Mure, Isère, France. An analysis by C. Friedel gave:

$\frac{8}{3}$ $CO_2$ 31·88 MgO 28·98 $\frac{8}{3}$ $H_2O$ 39·13 = 99·99

This conforms to $MgCO_3 + 3H_2O$. Bull. Soc. Min., **14**, 60, 1891.

**Newboldite** *Piddington*, J. Asiatic Soc. Bengal, **26**, 1129, 1847. A mineral found by Capt. Newbold in some old lead mines "near Gazoopilly, Kurnool." Probably a ferruginous sphalerite. Cf. Mallet, Min. India, 18, 1887.

**Niccochromite** *C. U. Shepard*, Min. Contr., 1877. A canary-yellow substance, occurring as a coating on zaratite, rarely on chromite, at Texas, Pa. On the ground of a partial blowpipe examination, it is concluded to be a "dichromate of nickel."

**Nickel**, cf. p. 29. The auriferous sands of the stream Elvo near Biella in Piedmont are shown by A. Sella to contain grains of an iron-nickel alloy corresponding nearly to $Ni_3Fe$. They resemble native platinum in appearance, are malleable and strongly magnetic, and have G. = 7·8. An analysis gave:

Ni (with some Co) 75·2 Fe 26·6 = 101·8

Soluble in nitric and dilute hydrochloric acid. C. R., **112**, 171, 1891. See Iron, p. 1037.

**Noselite**, p. 432. A "hydronoseane" has been obtained by Charles & Georges Friedel by heating mica with soda and sodium sulphate. It is in hexagonal crystals (*m*, $10\bar{1}0$) with a pyramid *p*, with $pp' = 24° 22·7'$. Here *p* corresponds to *p* ($10\bar{1}1$) of microsommite and *q* ($10\bar{1}2$) of nephelite. Analyses gave:

| | $SiO_2$ | $SO_3$ | $Al_2O_3$ | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|
| 1. | 35·62 | 7·20 | 29·65 | 23·82 | — | 3·94 | = 100·23 |
| 2. | 34·81 | 7·25 | 29·91 | 23·34 | — | 3·95 | = 99·26 |
| 3. | 34·66 | 7·34 | 31·47 | 18·74 | 5·39 | 2·30 | = 99·90 |
| 4. | 34·20 | 7·98 | 30·78 | 21·53 | 3·08 | 2·34 | = 99·91 |

Bull. Soc. Min., **13**, 238, 1890, **14**, 69, 1891.

**Octahedrite**, p. 239. Occurs in acute pyramidal crystals, resembling those from Tavetsch, with quartz and pyrite on joint-planes at the Arvon slate quarries, Buckingham Co., Va. Cf. G. H. Williams, Am. J. Sc., **42**, 431, 1891. Occurs at Pranal, near Pontgibaud, Puy-de-Dôme, Lacroix, Bull. Soc. Min., **14**, 191, 1891.

**Offrétite** *F. Gonnard*, C. R., **111**, 1002, 1890; Bull. Soc. Min., **14**, 60, 1891.

Hexagonal or rhombohedral. In very minute hexagonal prisms, often rounded and with vertical faces striated; also in hemispherical forms with radiate structure. Cleavage: normal to the base. Fracture uneven. Brittle. G. = 2·13. Luster vitreous. Colorless to white. Double refraction weak. Sections ⊥ $\dot{c}$ show sectors analogous to herschelite.

Calculated formula, $(K_2Ca)_2Al_3Si_{14}O_{39}.17H_2O$. Anal.—Gonnard, l. c.

$SiO_2$ 52·47 $Al_2O_3$ 19·06 CaO 2·43 $K_2O$ 7·72 $H_2O$ 18·90 = 100·58

B.B. turns white and fuses quietly to a white enamel. Decomposed by acids with difficulty.

Occurs in the basalts of Mont Simiouse near Montbrison, France. Named after Professor Offret, of Lyons.

**Oldhamite**, p. 65. Vogt notes a similar compound (also MnS, FeS, etc.) in certain furnace slags. Arch. Math. Nat., **14**, 72, 1890.

**Orpiment**, p. 35. Deposited with realgar by the hot springs of the Norris Geyser basin in the Yellowstone Park, cf. Weed & Pirsson, Am. J. Sc., **42**, 403, 1891.

**Ottrelite**, p. 642. Phyllytes with ottrelite (chloritoid) are described by E. Hussak as occurring with magnetite in São Paulo, Brazil. Bol. Comm. G., S. Paulo, No. 7, 1890.

**Palagonite**. Palagonit *Sartorius v. Waltershausen*, Subm. Vulk. Ausbr. Val di Noto, etc., Gött., 1846; Vulk. Gest., 1853. *Bunsen*, Lieb. Ann., **61**, 265, 1847, Pogg., **83**, 219, 1851. Melanhydrit *A. Krantz*, Vh. Ver. Rheinl., **6**, 154, 1859.

A basaltic tufa consisting chiefly of glass lapilli and the products of their alteration. It formerly passed as a mineral species, but properly belongs to petrography. Cf. Rosenbusch, Mass. Gest., 747, 1887.

**Paramelaconite** *G. A. Koenig*, Proc Acad. Philad., 284, 1891.

Tetragonal. In pyramidal crystals *p* (111, 1), terminated by *c* (001, *O*); the pyramidal faces, *e* (101, 1-*i*), strongly striated horizontally. Measured angle, $ce = 58° 50'$, hence the axis $\dot{c} = 1·6534$.

Cleavage not observed. H. = 5. G. = 5·833. Luster brilliant. Color on the faces purplish black; on the fracture pitch-black.

Composition, probably essentially CuO, but requiring further examination. The analysis is interpreted as CuO 87·66, $Cu_2O$ 11·70, $Fe_2O_3$ 0 64 = 100. Analysis:

CuO 100·58 $Fe_2O_3$ 0·64 = 101·32

B.B. fuses on edges; in the reducing flame is reduced and yields metallic copper. Soluble in acids.

From the Copper Queen mine, Bisbee, Arizona, with footeite, etc.

**Parathorite.** Thorite *Shep.*, Proc. Am. Assoc., **2**, 321, 1850. Parathorite *Shep.*, Min., 287, 1857; *Dana*, *Brush*, Am. J. Sc., **24**, 124, 1857.

Orthorhombic. In minute rectangular and rhombic prisms, with the planes $a$ (100, *i-ĭ*), $b$ (010, *i-ĭ*), $m$ (110, *I*). Angles: $mm''' = 52°$, $bm = 64°$. H. = 5–5·5. Luster subresinous. Color garnet-red to pitch-black; thin edges of black crystals with a ruby translucence, a little like rutile. Translucent to opaque.

In the matrass decrepitates slightly, but does not appear to contain water. B.B. in the platinum forceps glows, fuses with difficulty on the edges, and becomes paler. In borax dissolves to a bead, which is yellow, from iron, while hot, and becomes colorless on cooling. With salt of phosphorus gives in the outer flame a bead, yellow while hot and colorless on cooling. In the inner flame the bead assumes a delicate violet color (due to titanic acid ?), Brush.

Occurs embedded in danburite and orthoclase, and only in very minute crystals, at Danbury, Ct.

Shepard made the crystallization erroneously tetragonal. There are also other discrepancies in his description, which may lead to the supposition that the mineral here described is a different mineral from Shepard's; but the evidence to the contrary is complete.

**Paroligoclase.** Paroligoklas *E. E. Schmid*, Jb. Min., **1**, 78 ref., 1881.

A problematical substance occurring in indistinct prisms, with calcite grains, embedded in the ground-mass of a rock found between Ilmsenberg, Quäriberg, and Silberberg, in the Thüringerwald. It may be an impure scapolite. Cf. App. iii, p. 88; also Rosenbusch, Jb. Min., **1**, 78, 1881.

**Pelagosite** *K. Moser*, Tschermak, Min. Mitth., **1**, 174, 1878.

A substance occurring as a thin, dark-colored incrustation on limestone and dolomite, on the shores of the Mediterranean, as at the Island of Pelagosa (Moser). In some cases looking like varnish, and again resembling lichens. It consists of thin translucent layers, exerting on polarized light the effect of aggregate polarization. An analysis by J. Cloëz on similar material from Cape Ferrat afforded : $CaCO_3$ 91·80, $MgCO_3$ 0·90, $Fe_2O_3$ 0·25, $SiO_2$ 1·22, NaCl 0·49, $H_2O$ 4·56, organic matter 0·71 = 99·93. It is regarded as produced by the action of sea-water on the dolomite.

Des Cloizeaux and Vélain have observed similar coatings on the feldspathic rocks of Corsica, on the coast of Oran, and on basaltic lava on the coast of Réunion Island, Bull. Soc. Geol., **6**, 86, 1878.

**Platinum**, p. 25. Joly has described a method of obtaining crystals, by passing an electrical current through a ribbon of the pure metal upon which some topaz dust has been scattered. After maintaining a current sufficient to heat the strip to redness for half an hour, microscopic crystals are found clinging to the partially decomposed topaz, and after two hours some of these attain a size of 0·1 mm. The prevailing form is the octahedron. Nature, **43**, 541, 1891. On artificial crystals, see also Törnebohm, G. För. Förh., **13**. 81, 1891.

Present in the ores of Boitza, Transylvania, with gold and tellurium; a ton contains 33·6 gr. gold and 2 gr. platinum, Vh. G. Reichs., 96, 1891.

**Pollucite**, p. 343. Described and analyzed from Hebron, Me., by H. L. Wells, Am. J. Sc., **42**, 213, 1891. It was found by Loren B. Merrill chiefly in a single cavity, some 3 × 6 feet and 18 inches deep; it was in fragments in a loose heap mixed with clay, associated with quartz and a cæsium beryl (anal. 10, p. 407). About half a kilogram was found in all. In appearance it is similar to the Elba mineral. G. = 2·986, 2·977. Refractive indices, Penfield:

$n_{r}$ = 1·5215 Li $n_{y}$ = 1·5247 Na $n_{gr}$ = 1·5273 Tl

Analyses, Wells, l. c.

| $SiO_2$ | $Al_2O_3$ | CaO | $Cs_2O$ | $K_2O$ | $Na_2O$ | $Li_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 43·48 | 16·41 | 0·21 | 36·77 | 0·47 | 1·72 | 0·03 | 1·53 | = 100·62 |
| 43·59 | 16·39 | 0·22 | 35·36 | 0·51 | 2·03 | 0·04 | [1·53] | = 99·67 |
| 43·51 | 16 30 | 0·22 | 36·10 | 0·48 | 1·68 | 0·05 | 1·50 | = 99·84 |

The above analyses yield the formula $H_2Cs_4Al_4(SiO_3)_9$ or $H_2O.2Cs_2O.2Al_2O_3.9SiO_2$ = Silica 40·7, alumina 15·4, cæsium oxide 42·5, water 1·4 = 100.

Wells shows by a discussion of the earlier analyses (p. 344, also Plattner) that this composition probably also belongs to the Elba mineral. The unusually large amount of cæsium obtained from this source has enabled Wells and Penfield to make some important researches upon the cæsium trihalides.

POLYBASITE, p. 146. An analysis of polybasite from the Santa Lucia mine, Guanajuato, Mexico, gave Prior:

G. = 6·33 S 15·43 Sb 10·64 As 0·50 Ag 68·39 Cu 5·13 = 100·09

The ratio calculated for S : Sb : Ag(Cu) = 5 : 1 : 7½. Min. Mag., **9**, 13, 1890.

Occurs (Endlich) at the Yankee Boy mine, Ouray Co., Colorado, with pyrargyrite in a quartzose gangue. The crystals are hexagonal in outline and have *mm‴* = 60° approx. Pfd. Am. J. Sc., **40**, 424, 1890. See also p. 1049.

POLYLITE *Thomson*, Min., **1**, 495, 1836, Perhaps a variety of pyroxene (augite). It is described as cleavable massive; G. = 3·231; H. = 6–6·5; color black; opaque. Stated to come from a bed of magnetic iron ore at Hoboken, N. J., where no such bed of ore exists.

PYRITE, p. 84. Crystals from the Roetzgraben near Trofaiach show the new pyritohedron (10·1·0, *i*-10). Höfer, Mitth. Ver. Steiermark, **25**, 230, 1889.

A manganiferous variety, containing 10·9 p. c. Mn, also a little Ag, is reported by Lang (priv. contr.) as occurring at Mineral, Idaho.

PYROLUSITE, p. 243. Manganese nodules from the deep-sea dredgings in the Pacific, also from Loch Fyne; cf. Murray, Proc. R. Soc. Edinb., Jan. 5, 1891. Buchanan shows that the deep ocean nodules approximate in composition to $MnO_2$; those from Loch Fyne are nearly $Mn_2O_3$.

**Pyrophanite** *Hamberg*, G. För. Förh., **12**, 598, 1890.

Rhombohedral; tetartohedral. Axis ć = 1·3692, $0001 \wedge 10\bar{1}1$ = 57° 41⅙′, $10\bar{1}1 \wedge \bar{1}101$ = 94° 5½′ Hamberg.

**Forms:** *c* (0001, *O*), *a* ($11\bar{2}0$, *i*-2), *g* ($10\bar{1}2$, ½) cleavage, *d* ($02\bar{2}1$, —2). Also undetermined vicinal + rhombohedrons, at a maximum, 2½° from *c*.

Angles: *cg* = 38° 19½′, *cd* = *72° 27′, *gg′* = 64° 58′, *dd′* = 111° 19′, *ad* = 34° 20′.

In very thin tabular crystals or scales; basal plane brilliant but with triangular striations parallel to the zone of + rhombohedrons.

Cleavage: *d* ($02\bar{2}1$) perfect; *g* less so. Etching-figures are asymmetric. H. = 5. G. = 4·537. Luster brilliant, vitreous to submetallic. Color deep blood-red; yellowish red in very thin plates. Streak ocher-yellow with a greenish tinge. Not pleochroic. Transparent in thin plates. Indices:

$$\omega_{\mathrm{r}} = 2{\cdot}4408,\ 2{\cdot}4419 \text{ Li} \qquad \omega_{\mathrm{y}} = 2{\cdot}4804,\ 2{\cdot}4816 \text{ Na} \qquad \epsilon_{\mathrm{y}} = 2{\cdot}21$$

**Comp.**—$MnTiO_3$ = Manganese protoxide 46·9, titanium dioxide 53·1 = 100. A little silicon replaces part of the titanium.

**Anal.**—Hamberg, l. c.

$TiO_2$ 50·49 $SiO_2$ 1·58 MnO 46·92 $FeO_3$ 1·16 $Sb_2O_3$ 0·48 = 100·63

**Obs.**—Occurs at the Harstig mine, Pajsberg, Wermland, Sweden; found sparingly, associated with ganophyllite, also garnet and manganophyllite, in cavities later filled with calcite. Named from *πῦρ*, *fire*, and *φανός*, *shining*, in allusion to its red color and brilliant luster.

Hamberg shows that pyrophanite is to be regarded as isomorphous with ilmenite. Further he suggests the following grouping to show the relation to other allied compounds:

| Hematite Group. | Rhombohedral | | Ilmenite Group. | Rhomb., tetartohedral | |
|---|---|---|---|---|---|
| | | ć | | | ć |
| Chromium sesquioxide | $Cr_2O_3$ | 1·368 | Ilmenite | $\overset{II}{Fe}\overset{IV}{Ti}O_3$ | 1·385 |
| Corundum | $Al_2O_3$ | 1·363 | Pyrophanite | $MnTiO_3$ | 1·369 |
| Hematite | $Fe_2O_3$ | 1·366 | Also Catapleiite | | 1·3605 |
| Titanium sesquioxide | $Ti_2O_3$ | 1·316 | $H_2SiO_3.Na_2SiO_3.Zr(OH)_2SiO_3$ | | |

To the second group he would also add the hexagonal calcium metasilicate, $CaSiO_3$, further the artificial compound $KBrO_3$.

PYROXENE, p. 352. Wülfing (Habilitationsschrift, Heidelberg, 1891) has made a careful optical examination of a series of pyroxenes ranging from diopside to hedenbergite, and connected the results with the variation in chemical composition as given by the analyses of Doelter, Flink, and others. The optical constants deduced for a pure diopside $CaMgSi_2O_6$ are as follows:

| | α | β | γ | 2V | ćc |
|---|---|---|---|---|---|
| For Li | 1·6649 | 1·6719 | 1·6941 | 58° 53′ | 37° 55′ |
| Na | 1·6685 | 1·6755 | 1·6980 | 58° 40′ | 37° 50′ |
| Tl | 1·6722 | 1·6791 | 1·7015 | 58° 26′ | 37° 45′ |

For the ægirite from the Langesund-fiord a re-examination of the optical constants was made, with the following results:

| | $\alpha$ | $\beta$ | $\gamma$ | 2V | $\dot{c} \wedge \mathfrak{c}$ |
|---|---|---|---|---|---|
| Eosin | 1·7590 | 1·7929 | 1·8054 | 117° 25′ | 93° 30′ |
| Na | 1·7630 | 1·7990 | 1·8126 | 117° 47′ | 94° 0′ |
| Tl | 1·7714 | 1·8096 | 1·8238 | 118° 16′ | 94° 58′ |

The angles given in the last column correspond to $Bx_r \wedge \dot{c} = +3° 30'$; $Bx_y \wedge \dot{c} = +4° 0'$, $Bx_{gr} \wedge \dot{c} = +4° 58'$.

On the alteration of pyroxene, or a mineral of the pyroxene group, into amphibole in gabbros and related rocks, see Chester, U. S. Surv., Bull. **59**, 1890.

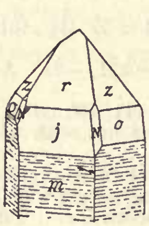
On the relation between the gliding-planes and solution-planes with augite, see Judd, Min. Mag., **9**, 192, 1890.

A chrome diopside from the basalt of Stempel near Marburg, investigated by Bauer (Jb. Min., **2**, 187, 1891), has been analyzed by Friedheim, as follows:

| | $SiO_2$ | $Al_2O_3$ | $Cr_2O_3$ | FeO | CaO | MgO |
|---|---|---|---|---|---|---|
| G. = 3·289 | 52·95 | 5·19 | 2·43 | 2·31 | 19·11 | 18·01 = 100 |

**Quartz**, p. 183. Minute crystals (cf. figs. 1–3), characterized by the presence of the rhombohedron *j* ($30\bar{3}2$) and the trapezohedrons *N* ($21\bar{3}2$) and *L*, ($3\bar{1}\bar{2}2$), are described by Iddings and Penfield from the hollow spherulites of the rhyolyte of Glade Creek, Wyoming. Am. J. Sc., **42**, 39, 1891.

1



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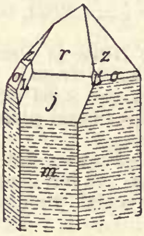

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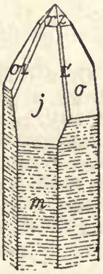


Friedel has described artificial crystals which seem to be twins with ($44\bar{8}9$, $\frac{8}{9}$-$\bar{2}$) as tw. plane, the axes crossing nearly at right angles. Bull. Soc. Min., **11** 29, 1888 (and Zs. Kr., **18**, 333. On crystals from Sarolay, see Cesàro, Mem Soc. G. Belg., **17**, 1890.

Cathrein has described crystals of amethyst from the Zillerthal, Tyrol, showing the new forms. Zs. Kr., **17**, 19, 1889.

$\rho$ ($70\bar{7}5$, $\frac{7}{5}$), ($11\cdot1\cdot\bar{1}\bar{2}\cdot12$, $+$ 1-$\frac{12}{11}$ r), ($1\cdot11\cdot\bar{1}\bar{2}\cdot12$, $-$ 1-$\frac{12}{11}$ l), ($8\cdot1\cdot\bar{9}\cdot10$, $+$ $\frac{9}{10}$-$\frac{9}{8}$ r), ($9\bar{2}\bar{7}8$, $+$ $\frac{9}{8}$-$\frac{9}{7}$ l).

Lacroix notes the occurrence of cristobalite and tridymite associated with quartz in the basalt of Mayen in the Eifel. Bull. Soc. Min., **14**, 185, 1891.

Beaulard discusses the effect of pressure upon sections of quartz crystals in producing biaxial phenomena, etc., C. R., **112**, 1503, 1891.

**Realgar**, p. 33. On the realgar, orpiment, and associated minerals of Casa Testi, M. Amiata, Prov. of Grosseto, Tuscany, see Grattarola, Giorn. Min., **1**, 232, 1890. The new but uncertain form *α* ($\bar{3}13$, 1-$\bar{3}$) is noted.

Occurs with orpiment as a hot-spring deposit in the Norris Geyser Basin in the Yellowstone Park, Weed & Pirsson, Am. J. Sc., **42**, 403, 1891.

**Resanite** *Cleve*, Ak. H. Stockh., **9**, No. 12 (Nov. 1870). Geol. West India Islands, p. 28. Massive, olive-green color, uncrystalline. Analysis.—Fiebelkorn:

$SiO_2$ 35·08, CuO 23·18, $Fe_2O_3$ 9·91, $H_2O$ 23·15 (at 100°); $H_2O$ 8·53 (ignition) = 99·85.

It is easily decomposed by HCl. Found with malachite and chrysocolla, at Puerto Rico (Luquillo), West Indies, and named from Don Pedro Resano.

**Rhodonite**, p. 378. Crystals from Pajsberg, of very varied habit, have been described by Hamberg. They show the new forms *κ* ($2\bar{2}1$, ′2), *ϑ* ($\bar{4}03$, ,$\frac{4}{3}$-ĭ,), *δ* ($\bar{6}23$, ,2-$\breve{3}$). Careful measurements are given and a new axial ratio calculated, corresponding to a new position proposed.

G. För. Förh., **13**, 545, 1891. New analyses (ibid., p. 572): 1, Fräulein Naima Sahlbom; 2–4, Gunnar Paykull.

| | $SiO_2$ | MnO | FeO | CaO | MgO | |
|---|---|---|---|---|---|---|
| 1. | 46·49 | 43·60 | 0·84 | 7·18 | 0·90 | $Al_2O_3$ 0·41 = 99·42 |
| 2. | 46·35 | 45·25 | 0·53 | 6·96 | 0·84 = | 99·93 |
| 3. | 46·53 | 43·20 | 3·03 | 6·50 | 0·72 | $Al_2O_3$ 0·15 = 100·13 |
| 4. | 45·86 | 45·92 | 0·36 | 6·40 | 1·65 = | 100·19 |

**Riebeckite**, p. 400. A secondary amphibole, resembling that described by Cross (p 402), has been noted by Lane in the rocks of the Lake Superior region. Am. J. Sc., **42**, 508, 1891.

On the occurrence in Great Britain, see Teall, Min. Mag., **9**, 219, 1891; and Cole, ibid., p. 222.

**Rowlandite** *W. E. Hidden*, Am. J. Sc., **42**, 430, 1891.

An yttrium silicate occurring in massive form with the gadolinite of Llano Co., Texas (pp. 511, 512). G. = 4·515. Color pale drab-green when pure, transparent in thin splinters. Alters to a waxy brick-red mineral. A partial analysis gave:

$SiO_2$ 25·98 $Y_2O_3$ 61·91[a] FeO 4·69 $UO_3$ 0·40 CaO 0·19 ign., etc., 2·01

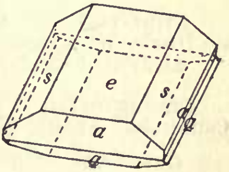
[a] At. wght. 118.

Oxygen ratio of bases to silica = 83·47 : 86·60 or nearly 1 : 1, hence the formula $2Y_2O_3.3SiO_2$. Easily soluble in acids, leaving gelatinous silica.

Named after Prof. Henry A. Rowland of Baltimore.

**Rutile**, p. 237. The peculiar crystals of black rutile from the Black Hills, mentioned on p. 238, have been more fully studied by Headden and Pirsson; the form is shown in the accompanying figure. Am. J. Sc., **41**, 249, 1891. Analyses by Headden: gave :

| $TiO_2$ | $SnO_2$ | FeO | MnO |
|---|---|---|---|
| 90·78 | 1·32 | 8·10 | *tr.* = 100·20 |
| 90·80 | 1·38 | 7·92 | *tr.* = 100·10 |



The paramorphs of rutile after brookite from Magnet Cove, Arkansas (pp. 239, 243), have been minutely described by Bauer (Jb. Min., **1**, 217, 1891). Also the pseudomorphs of rutile after octahedrite ("captivos" Damour) from the gold-washings of Brazil, ibid., p. 232.

**Sanguinite** *H. A. Miers*, Min. Mag., **9**, 182, 1890. Occurs in fine glittering scales usually curved or crumpled; crystallization hexagonal or rhombohedral. Fracture conchoidal. Color black by reflected light, but by transmitted light red like proustite only slightly darker; in very thin scales yellowish red. Streak dark purplish brown. Optically uniaxial. Determined by qualitative trials to be a sulpharsenite of silver, hence near proustite in composition, with which it occurs on argentite from Chañarcillo.

**Sarawakite** *Frenzel*, Min. Mitth., 300, 1877. Occurs in minute crystals, with many planes and rounded angles, "probably tetragonal." Soft. Luster adamantine. Colorless or wine-yellow to greenish yellow. Transparent. Contains antimony, is anhydrous, and, it is suggested, may be an antimony chloride. Found in cavities in the native antimony of Borneo.

**Schuchardtite** *Schrauf*, Zs. Kr., **6**, 386, 1882. A name given by Schrauf to the so-called Chrysopraserde (p. 677), from Gläserndorf, Silesia. Cf. Starkl, ib., **8**, 239, 1883.

**Serpentine**, p. 669. On the serpentine of the Lizard district, Cornwall, see Bonney and McMahon, Q. J. G. Soc., **47**, 464, 1891.

**Shalkite.** Same as piddingtonite, p. 385.

**Siderite**, p. 276. A crystal from Algeria has been described by Cesàro which showed the new form $(41\bar{5}9, \frac{1}{3}^{\frac{5}{3}})$. Ann. Soc. G. Belg., **18**, 1891.

**Snarumite** *Breith.*, B. H. Ztg., **24**, 364, 1865. A mica-like cleavage in one direction, and another transverse imperfect. Occurs massive and in tufts columnar in structure, with H. = 4–5·5, the least on cleavage-surface; G. = 2·826; luster on cleavage-face pearly, elsewhere vitreous ; color mostly reddish white, colorless, grayish white. Comes from the shore of the Snarum-Elf, near Snarum, in Norway. Analysis by Lichtenberger (Jb. Min., 820, 1872) gave :

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ | CaO | $Na_2O$ | $Li_2O$ | ign. |
|---|---|---|---|---|---|---|---|
| 67·42 | 28·21 | 0·42 | 0·18 | 0·24 | 0·93 | 2·15 | 0·23 = 99·78 |

On another snarumite, see p. 384.

**Sordavalite.** Sordawalit *N. Nordenskiöld,* Finl. Min., 86, 1820. A grayish or bluish black glassy substance from Sordavala in Finland. Like tachylyte earlier regarded as a mineral, but shown to be only a local vitreous form of diabase ; a dike of this rock cuts through the hornblende schists, and while crystalline in the mass, becomes more compact toward the margin, and finally at the contact there is a vitreous band one to two inches thick of the so-called sordavalite. Cf. Löwinson-Lessing, Min. Mitth., **9**, 61, 1887, who also gives the literature and history.

**Sphalerite**, p. 59. Cesàro has described crystals showing the hemi-hexoctahedron (861, 8-$\frac{4}{3}$). Mem. Soc. G. Belg., **17**, 1890.

**Spinel**, p. 220. Formation of various kinds of spinel in slags and recent eruptive rocks, see Vogt, Arch. Math. Nat., **14**, 11, 1890.

**Stellarite.** A name given by How to the so-called "stellar coal" or "oil-coal" which occurs with bituminous coal at the Acadia mines, Picton Co., Nova Scotia. It is regarded by Dawson as essentially an earthy bitumen.

**Stephanite**, p. 143. Prior (Min. Mag., **9**, 11, 1890) has given the following analyses :

| | G. | S | Sb | Ag | |
|---|---|---|---|---|---|
| 1. Copiapo | 6·26 | 16·02 | 15·22 | 68·65 | As *tr.* Cu *tr.* = 99·89 |
| 2. Cornwall | 6·24 | 15·95 | 15·86 | 68·21 | Fe *tr.* = 100·02 |

**Stibnite**, p. 36. On the reflection of light from the cleavage (*b*) surface of stibnite crystals, see Drude, Wied. Ann., **34**, 489, 1888.

Analysis of specimens from Hungary, see J. Loczka, Ber. aus Ungarn, 8, 99, 1891.

**Stromeyerite**, p. 56. Occurs at the Silver King mine, Calico distr., San Bernardino Co., California. Analysis, Melville and Lindgren, U. S. G. Surv., Bull. **61**, 27, 1890.

G. = 6·28 S 15·51 Ag 53·96 Cu 28·58 Fe 0·26 gangue 1·55 = 99·86

**Strontianite**, p. 285. Buchrucker (Zs. Kr., **19**, 146, 1891) has described crystals from Leogang, Salzburg, and made the following optical determinations; indices of refraction :

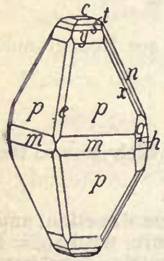
| | $\alpha$ | $\beta$ | $\gamma$ |
|---|---|---|---|
| For Li | 1·514 | 1·515 | 1·659 |
| " Na | 1·515 | 1·516 | 1·667 |
| " Tl | 1·519 | 1·520 | 1·670 |

Also $2E_r = 10° 30'$ Li  $2E_y = 10° 36'$ Na  $2E_{gr} = 10° 54'$ Tl

From 2E and $\beta$, $2V_r = 6° 55\frac{1}{2}'$  $2V_y = 62° 59'$  $2V_{gr} = 7° 10'$

**Sulphur**, p. 8. Crystals from "Bassick in the United States" described by Busz showed the new forms : *g* (337, $\frac{3}{7}$), *f* (335, $\frac{3}{5}$); calculated angles for the axial ratio of p. 8 : $cg = 52° 17'$, $cf = 61° 5'$. Zs. Kr., **17**, 549, 1890.

Crystals with the above noted form *f* (335, $\frac{3}{5}$) have also been described by G. H. Williams from the Mountain View mine, Carroll Co., Md. They occur distributed through the decomposed galena, with anglesite, cerussite. Johns Hopkins Univ. Circ., No. 87, April, 1891.



Yellowstone.

Weed and Pirsson have described the occurrence and form of crystals from the Yellowstone Park, Am. J. Sc., **42**, 401, 1891. They show the forms (cf. fig.), *c* (001), *m* (110), *h* (130), *e* (101), *n* (011), *t* (115), *s* (113), *y* (112), *p* (111), *x* (133), *q* (131). Crystals occurring with stibnite from Allchar, near Rozsdau in Macedonia have been described by Foullon, Vh. G. Reichs., No 17, Dec. 1890.

On the thermic constants, see Schrauf, Zs. Kr., **12**, 321, 1886. On the optical constants at different temperatures, Id., ibid., **18**, 113, 1890.

A new *rhombohedral* variety is described by Friedel, obtained by Engel by agitating with chloroform a solution of sodium hyposulphite treated with concentrated hydrochloric acid. The crystals are prisms terminated by rhombohedral faces, with *rr'* = 40° 50', and optically uniaxial, negative. G. = 2·135. Transparent when first found, but change gradually, with decrease of density into insoluble sulphur. A relation to the rhombohedral form of tellurium is suggested. C. R., **112**, 834, 866, 1891.

The "black sulphur" of Magnus (p. 10) is regarded by Knapp as not properly a modification of sulphur, but as consisting of such a modification adhering to or condensed with a carbonization-product of the oil itself, containing sulphur. J. pr. Ch., **43**, 305, 1891. Also earlier, ibid., **38**, 55, 1888.

**Sychnodymite** *Laspeyres*, Zs. Kr., **19**, 17, 1891.

Isometric. Observed forms: *a* (100, *i-i*), *o* (111, 1), *d* (110, *i*)?, *m* (311, 3-3), *n* (211, 2-2).

In small octahedral crystals, in part with polysynthetic twinning, tw. pl. *o*, analogous to polydymite; also massive. G. = 4·758. Luster metallic. Color steel-gray.

**Comp.**—Essentially $(Co,Cu)_4S_5$, like the nickel sulphide, polydymite; a small part of the cobalt is replaced by nickel.

**Anal.**—1, 2, Laspeyres, l. c.

| | S | Cu | Co | Ni | Fe |
|---|---|---|---|---|---|
| 1. | 40·64 | 18·98 | 35·79 | 3·66 | 0·93 = 100 |
| 2. | 40·33 | 17·23 | 35·64 | 5·74 | 0·82 = 99·76 |

Dissolves in nitric acid, giving a red solution.

**Obs.**—From the Kohlenbach mine, south-east of Eiserfeld in the Siegen district; associated with quartz, siderite, tetrahedrite, etc. It is near carrollite (p. 76), to which, however, the formula $R_3S_4(CuS.Co_2S_3)$ has been assigned.

Named from συχνὺς = πολὺς, as a name corresponding to the related species, polydymite.

SYLVITE, p. 156. On etching-figures, see Linck, Min. Mitth., **12**, 82, 1891. On indices of refraction, see Dufet, Bull. Soc. Min., **14**, 143, 1891. On double refraction developed by pressure, Pockels, Wied. Ann., **39**, 440, 1890.

TACHHYDRITE, p. 178. Artificial rhombohedral crystals have been obtained by A. de Schulten. They have *rr'* = 101° 20', and G. = 1·666. Analysis gave: Cl 40·40, Ca 7·56, Mg 9·25, $H_2O$ 42·44 = 99·65 (author gives Ca 9·56 and sum 99·65). C. R., **111**, 930, 1890.

TACHYLYTE *Breith.*, Kastn. Arch. Nat., **7**, 112, 1826. A glassy substance, pitch-black or velvet-black in color, at one time regarded as a homogeneous mineral, but undoubtedly only a basaltic glass. The original was from Säsebühl, between Dransfeld and Göttingen, but it is not an uncommon occurrence. Named from ταχύς, *quick*, and λυτός, *dissolved*, in allusion to its fusibility.

*Hyalomelan* (*Hausm.*, Handb., 545, 1847) is a similar substance rightly referred by Gmelin to tachylyte from Vogelsberg. Hausmann applied to it the name *hyalomelan*. Here belongs also the *schlackige Augit* of Karsten from Guiliana, Sicily.

TAMMITE. Tamm analyzed a dark steel-colored crystalline powder, locality unknown, very hard. G. = 12·5. He obtained W 88·05, Fe 5·60, Mn 0·15, undetermined 6·20 = 100. The loss he says is not due to oxygen. He calls his unknown substance *ferro-tungstine*, and proposes, in case the character of the mineral is sustained, to give it the name *crookesite*. Mr. Crookes justly says that the name *tammite* should be preferred. Chem. News, **26**, 13, July, 1872. It may be only an artificial alloy.

TELASPYRINE *C. U. Shepard*, Contrib. Min., 1877. Pyrite containing tellurium, from Sunshine Camp, Colorado.

TELLURITE, p. 201. Vrba has described artificial crystals which are in tetragonal pyramids with the forms: *a* (100, *i-i*), *p* (111, 1), *r* (221, 2); *pp'* = 51° 42', hence $\dot{c}$ = 0·5539. Zs. Kr., **19**, 1, 1891.

TELLURIUM, p. 11. Analyses 1, 2, from Facebaya, Transylvania, by J. Loczka, Ber. aus Ungarn, 8, 104, 1891. The material of anal. 1 contained quartz and pyrite.

| | Te | Se | Au | Fe | S | Quartz |
|---|---|---|---|---|---|---|
| 1. | 80·39 | 0 33 | 0 33 | 8·55 | 9·26 | 1·54 = 100·40 |
| 2. G. = 6·083 | 97·92 | *tr.* | 0·15 | 0·53 | — | 1·56 Cu 0·06 = 100·22 |

TENNANTITE, p. 137. Penfield (priv. contr.) has investigated the tennantite and polybasite from the Mollie Gibson mine near Aspen, Colorado. The former occurs massive, of steel-gray color and reddish streak. Analysis gave:

| | S | As | Sb | Cu | Ag | Zn | Fe | Pb |
|---|---|---|---|---|---|---|---|---|
| G. = 4·56 | 25·04 | 17·18 | 0·13 | 13·72 | 13·65 | 6·90 | 0·42 | 0·86 = 99·90 |

The ratio of all the metals to $As_2(Sb)_2$ is 4·00 : 0·99, agreeing closely with the formula $4Cu_2S.As_2S_3$. It is remarkable in the high percentage of silver.

The *polybasite*, or "brittle silver" of the local miners, occurs both indistinctly crystallized and massive; it is associated commonly with a pink barite, also siderite, etc. Analyses gave the following results, after the deduction of 28·18 p. c. impurities from 1, and 12·81 p. c. from 2:

| | S | As | Sb | Ag | Cu | Zn |
|---|---|---|---|---|---|---|
| 1. Massive | 17·73 | 6·29 | 0·18 | 59·73 | 12·91 | 3·16 = 100 |
| 2. Crystallized | 18·13 | 7·01 | 0·30 | 56·90 | 14·85 | 2·81 = 100 |

Both analyses conform to $9Ag_2S.As_2S_3$.

Tennantite and polybasite appear to be rather common minerals in Colorado. Much of the so-called tetrahedrite or "gray copper" is the related arsenical species: thus it is common in the mines near Central City, at the Freeland lode and Crocett mine near Idaho Springs, and at the National Bell mine near Red Mountain. Further, in addition to the localities for polybasite, noted on pp. 146 and 1044, it occurs well crystallized in the mines about Georgetown, in the Marshall Basin near Telluride, and probably at a number of mines in the Red Mountain district.

**Tequezquite.** Corruption of Tequixquitl, a mineral substance formed of mixtures of different salts, especially sodium carbonate and sodium chloride; from Texcoco, Zumpango, in the Valle de Mexico, and elsewhere in Mexico, chiefly as a surface efflorescence. Naturaleza, 3, 239–246, 1875.

**Tetradymite**, p. 39. New analyses: 1, from Norongo, near Captain's Flat, New South Wales, J. C. H. Mingaye, Rec. G. Surv. N. S. W., **1**, 25. 2, Zsupkó, Hungary, J. Loczka, Ber. aus Ungarn, **8**, 102, 1891. 3, Rezbánya, Hungary, Id., ibid., p. 107.

| | G. | Te | S | Bi |
|---|---|---|---|---|
| 1. Norongo | 7·381 | 33·16 | 4·54 | 59·66 Fe 0·42, $SiO_2$ 0·40 = 98·18 |
| 2. Zsupkó | 7·580 | 34·75 | 4·18 | 59·77 Fe *tr.*, insol. 0·16 = 98·86 |
| 3. Rezbánya | 7·022 | 35·69 | 4·00 | 57·42 Fe 0·19, Cu 0·03, insol. 2·04 = 99·37 |

All these analyses correspond to $Bi_2Te_2S$ or $2Bi_2Te_3.Bi_2S_3$, supporting the view of the composition taken on p. 39.

**Thermonatrite**, p. 300. Described by E. Scacchi as occurring as an opaque white cavernous incrustation at the Fosso Grande, Vesuvius. Rend. Accad. Napoli, 2, 488, Dec. 1888.

**Thomsonite**, p. 607. Hahn has described crystals from Mettweiler, near St. Wendel. They are prismatic in habit, with *a*, *b* prominent, and show also the brachydome *x* (0·1·48) and the new pyramid *s* (334). Measured angles: *as* = 57° 26′, *bs* = 58° 37′. Zs. Kr., **19**, 171, 1891.

**Thorite**, p. 488. A kind from Landbö, Norway, has a resin-yellow color, G. = 4·322, and contains 9 p. c. $UO_3$ (11·97 p. c. $H_2O$). Hidden, Am. J. Sc., **41**, 440, 1891.

**Thrombolite.** Thrombolith *Breith.*, J. pr. Ch., **15**, 321, 1838.

An amorphous emerald-green mineral, found with malachite in a fine-grained limestone at Rezbánya, Hungary. According to an imperfect analysis by Plattner it contained chiefly $P_2O_5$, CuO, $H_2O$. Schrauf, however, obtained : CuO 39·44, $Fe_2O_3$ 1·05, $H_2O$ 16·56, $Sb_2O_5$ 6·65, $Sb_2O_3$ 32·52, loss 3·78 = 100. G. = 3·67. Zs. Kr., **4**, 28, 1879. Very probably only a mixture.

**Tiemannite**, p. 63. Occurs with eucairite in the Sierra de Umango, Argentine Republic. Analysis by F. Klockmann, after deducting 11·3 p. c. residue, gave :

Se 29·0 Hg 56·9 Ag 5·3 Cu 8·8 = 100

The silver and copper belong to admixed eucairite. Zs. Kr., **19**, 267, 1891.

**Tourmaline**, p. 551. Memoir (in Russian) on the crystallographic and optical properties by A. N. Karnozhitsky, Vh. Min. Ges., **17**, 209, 1891.

F. Noetling describes the tourmaline mines near Mainglôn, Rec. G. Surv. India, **24**, 125, 1891.

**Trichite, Belonite.** The name *trichite* (from θρίξ, *hair*) is applied by Zirkel (Zs. G. Ges., **19**, 744, 1867) to microscopic *capillary* forms, often curved, bent, or zigzag, sometimes stellately aggregated, opaque and black or reddish brown, of undetermined nature, which he detected in some kinds of glassy or semi-glassy volcanic rocks; and *Belonite* (ib., 738) to microscopic *acicular* crystals (whence the name, from *βελόνη, a needle*), colorless and transparent. The trichite, he states, is not pyroxene or hornblende; the belonite may be a feldspar.

TROILITE, p. 72. Artificial crystals, like wurtzite in form and having the composition FeS, have been obtained by Lorenz, by passing dry hydrogen sulphide over a bundle of iron wires in a tube heated in a combustion-furnace. Wurtzite, in well formed hemimorphic crystals, was obtained in a similar manner, also millerite and further greenockite; the last in forms like the native mineral and also in monoclinic crystals. Ber. Ch. Ges., June, 1891.

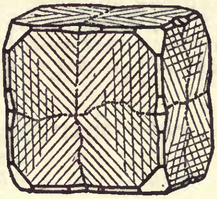
TYREEITE *Heddle*, Min. Mag., **4**, 189, 1881. One and a half hundred-weight of the carnelian marble of Tyree, Scotland, dissolved in sixteen gallons of dilute hydrochloric acid left as a residue, thirty pounds salite, a little scapolite and titanite, and some ounces of a *red mud*. By decantation, 1·91 grams of a powder of deep brick-red color was obtained. Of this mud, sulphuric acid dissolved 0·78 gram, leaving 1·13 insoluble. The last was analyzed and decided to be an impure talc. The soluble portion yielded : $Fe_2O_3$ 38·22, $Al_2O_3$ 8·23, FeO 3·16, MnO 0·39, MgO 29·94, CaO 2·21, $H_2O$ 12·47, $P_2O_5$ 4·71, $SiO_2$ 1·02 = 100·35. To this last obviously heterogeneous substance the new name is provisionally given.

ULLMANNITE, p. 91. Miers describes crystals of ullmannite, from Sarrabus, Sardinia, which, as shown by the striations upon the cubic faces (cf. fig. 1) are twins of tetartohedral and enantiomorphous individuals. The faces of a trigonal trisoctahedron approximating to (27·27·1, 27) occur on the cubic edges. Min. Mag., **9**, 211, 1891.

Crystals from the Landeskrone mine, near Wilnsdorf in the Siegen region, have been described by Laspeyres, which show the forms: *a* (100, *i-i*), *d* (110, *i*), *o* (111, 1); pyritohedrons, *q*(750, $i\text{-}\frac{7}{5}$), $f_,$(130, −*i*-3), $e_,$ (120, − *i*-2), *k* (322, $\frac{3}{2}\text{-}\frac{3}{2}$): diploid, $\rho_,$(261, − 6-3).

The crystals are pyritohedral in habit (cf. fig. 2) and do not show the tetartohedral character noted above, Zs. Kr., **19**, 424, 1891.

1.



2.

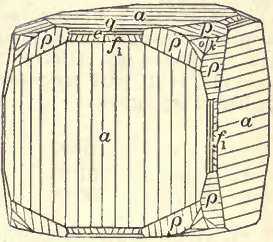


Fig. 1, Sardinia, Miers 2, Siegen, Laspeyres.

**Umangite** *F. Klockmann*, Zs. Kr., **19**, 269, 1891.

Massive; in fine granular to compact masses, no cleavage observed. Fracture uneven to small conchoidal. H. = 3. G. = 5·620. Luster metallic. Color dark cherry-red with a violet tinge on the fresh fracture, soon tarnishing, the color becoming violet-blue. Streak black. Opaque.

**Comp.**—$Cu_3Se_2$ or $CuSe.Cu_2Se$ = Selenium 45·4, copper 54·6 = 100.

**Anal.**—1, 2, F. Klockmann, l. c.: 1, of a relatively pure fragment; 2, of the portion of another sample insoluble in acetic acid reduced to 100.

| | | | |
|---|---|---|---|
| Se 41·44 | Cu 56·03 | Ag 0·49 | $CO_2,H_2O,O$ [2·04] = 100 |
| 45·10 | 54·35 | 0·55 | |

**Obs.**—Occurs with eucairite and tiemannite at the Sierra de Umango, La Rioja, Argentine Republic.

VALAITE *W. Helmhacker*, Jb. G. Reichs, **17**, 210, 1867. Crystallized. Partly in small hexagonal tables, but forms not distinct. Also massive. Fracture uneven. H. below 1·5. Luster shining. Color pitch-black. Streak black. Odor aromatic when rubbed between the fingers Belongs among the resins, but composition undetermined. B.B. swells to more than 10 times its former bulk, and becomes a light, porous mass, which in a higher heat is reduced to a grayish ash. Occurs in thin crusts on dolomite and calcite, or in druses of small crystals, in the Rossitz-Oslawaner Coal formation, Moravia. It is associated with hatchettite (p. 997) and the same bed affords some mineral oil.

VESBINE. A name given by *Scacchi* to the material forming thin yellow crusts on the lava of 1631, Vesuvius, which is supposed to contain a new element called by him *vesbium*. Att. Accad. Napoli, Dec. 13, 1879.

VESTORIEN. Bleu Egyptien. Bleu de Pouzzoles. Egyptian Blue. An artificial enamel used for ornament by the Romans in the early centuries of the Christian era. It is essentially a silicate of copper and calcium, corresponding approximately, according to Fouqué (Bull. Soc. Min., **12**, 36, 1889) to the formula $CaO.CuO.4SiO_2$. G. = 3·04. Analysis, Fouqué:

$SiO_2$ 63·7 CuO 21·3 CaO 14·3 $Fe_2O_3$ 0·6 = 99·9

See further Pisani, Bull. Soc. Min., **3**, 197, 1880, and Michault, ibid., **4**, 31. 1881, who give other analyses, showing a considerable variation in composition, in one case 6·7 p. c. $Na_2O$ and 28·3 p. c. $PbO$.

**Wehrlite**, p. 40. Mingaye has noted the occurrence of a telluride, which he refers to wehrlite, at the Mt. Shamrock gold mine, Queensland. Found in thin folia with brilliant luster and light steel-gray color. G. = 8·05. Proc. R. Soc. N. S. W., **23**, 327, 1890.

**Wehrlite** *von Kobell.* A doubtful mineral substance from Szurraskö, Zemescher Comitat, Hungary, referred to lievrite by Zipser, Jb. Min., 627, 1834. Shown by Fischer to be a mixture.

**Wichtisite.** Wichtyne *Laurent*, Ann. Ch. Phys., **59**, 107, 1835. Wichtisit *Hausmann.* Wihtisit. From Wichtis in Finland, probably the same substance as sordavalite, p. 1048.

**Wollastonite**, p. 371. Grosser has given a series of measurements on crystals from Vesuvius. From the measured angles, 001 ∧ 110 = 86° 16′, 001 ∧ 011 = 43° 51′, 100 ∧ 110 = 46° 20′, he calculates, $\grave{a} : \bar{b} : \grave{c} = 1{\cdot}05235 : 1 : 0{\cdot}96494$; $\beta = 84° 35' 20''$. Zs. Kr., **19**, 604, Dec. 4, 1891.

Among the contact-minerals occurring in connection with the igneous rock of the Potash Sulphur Springs, near Magnet Cove, Arkansas, J. F. Williams has described (Ann. Rep. G. Ark., **2**, 355 *et seq.*, 1891) a calcium silicate near wollastonite, but containing some water, which, however, is in part hygroscopic and in part due to alteration. Analyses by R. N. Brackett (p. 356 *et seq.*) gave:

| | $SiO_2$ | $CaO$ | $FeO$ | $MnO$ | $MgO$ | $Na_2O$ | $K_2O$ | ign. |
|---|---|---|---|---|---|---|---|---|
| 1. *White* | 51·93 | 42·55 | 2·03 | 2·08 | 0·44 | — | — | 1·23 = 100·26 |
| 2. *Pink* | 50·96 | 36·72 | 1·69 | 1·40 | 0·57 | 4·41 | 0·90 | 2·74 = 99·39 |

Both minerals are regarded as altered wollastonite; that of anal. 2 is peculiar in containing sodium and is called *natroxonotlite* since it approximates to the imperfectly known hydrous calcium silicate, xonotlite (p. 569).

**Zincite**, p. 208. Artificial crystals of a pale yellow color, with G. = 5·605, from a furnace at Mostyn, N. Wales, have been described by A. Hutchinson. They are doubly terminated pyramids or quartzoids, showing one form (*y*) only; also a number of pyramids in the same zone, with the basal plane and a pyramid of the other series *r* $(10\bar{1}1)$ Hutchinson, = *d* $(11\bar{2}1)$ of p. 208. Referred to these two positions the forms noted are:

| p. 208 | Hutchinson | p. 208 | Hutchinson |
|---|---|---|---|
| *c* (0001) = | *c* (0001) | *n* $(10\bar{1}2)$ = | *m* $(11\bar{2}3)$ |
| *d* $(11\bar{2}1)$ = | *r* $(10\bar{1}1)$ | *p* $(10\bar{1}1)$ = | *x* $(22\bar{4}3)$ |
| *f* $(10\bar{1}8)$ = | *f* $(1{\cdot}1{\cdot}\bar{2}{\cdot}12)$ | *y* $(20\bar{2}1)$ = | *y* $(44\bar{8}3)$ |
| *s* $(10\bar{1}3)$ = | *k* $(22\bar{4}9)$ | *m* $(10\bar{1}0)$ = | *a* $(11\bar{2}0)$ |

Of the above, *f* is new but uncertain; the author suggests the complex symbol, $4{\cdot}4{\cdot}\bar{8}{\cdot}51$, with which the observed angle ($cf$ = 12° 14′) agrees more closely. Min. Mag., **9**, 5, 1890.

**Zinc**, p. 14. Stated to occur in Transvaal, S. Africa, W. E. Dawson, Min. Mag., **6**, xix, 1885. The reported occurrence in Shasta Co., California, referred to on p. 14 has not been positively substantiated (Durden).

**Zircarbite** *C. U. Shepard*, Contrib. Min., 1877. A massive, compact, or cellular, yellowish brown, opaque mineral. H. = 2–2·5. B.B. infusible. Chemical nature unknown. With cyrtolite, at the granite quarries of Rockport, Mass.

**Adelite** *H. Sjögren*, G. För. Förh., **13**, 781, 1891. A basic arsenate of calcium and magnesium from Nordmark and Långban, Sweden. In masses of a gray color. H. = 5. G. = 3·76. Calculated formula: $H_2O.2CaO.2MgO.As_2O_5$. A relation to the olivenite or wagnerite group is suggested.

**Svabite** *H. Sjögren*, G. För. Förh., **13**. 789, 1891. In hexagonal prisms with the forms: *c* (0001, *O*), *m* $(10\bar{1}0$, *I*), *x* $(10\bar{1}1$, 1), *v* $(11\bar{2}1$, 2-2); measured angles $xx'$ = 36° 10′, $mx$ = *50° 29′, ∴ $\grave{c} = 0{\cdot}7143$. H. = 5. G. = 3·52. Luster vitreous to greasy. Colorless. Also in fibrous crystalline aggregates. Calculated formula: $H_2O.10CaO.3As_2O_5$; a relation to the apatite group is suggested. From the Harstig mine at Pajsberg, Sweden, associated with schefferite.

# CATALOGUE OF AMERICAN LOCALITIES OF MINERALS.

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THE following catalogue of American Localities of Minerals is supplementary to the Descriptions of Species. It is intended to give fuller information than was possible in the preceding pages of the occurrence of individual species and their association. It is essentially an historical list, and does not claim to state what minerals may be found at a given place at the present time. Many localities once prolific are now exhausted, and many others will yield specimens only after much time and money have been spent in opening them. Notwithstanding these limitations, however, the catalogue will prove of great aid to the mineralogical collector in selecting his routes and arranging the plan of his journeys.

Except in the case of very rare species, only important localities, which have afforded cabinet specimens, are in general included; and the *names of those minerals obtained in good specimens are distinguished by italics.* When the name is not italicized, the occurrence is not regarded as especially noteworthy. When the specimens procured have been remarkably good, an exclamation-mark (!) is added.

Localities for coal and oil are not given, and, for the most part, only general statements are made in regard to the occurrence of the peculiarly economic minerals, such as ores of iron, marble, etc. For detailed information in regard to these points, the reader should turn to the series of volumes on the *Mineral Resources of the United States,* published since 1882, under the auspices of the U. S. Geological Survey. The volume for 1887 (pp. 688–812) gives a summary for each state and territory of the localities of useful minerals, both those which are now mined and those which are not. In regard to the occurrence of marble and building stones in general, reference may be made to a recent work by George P. Merrill, *Stones for Building and Decoration,* New York, 1891.

This Catalogue has been carefully revised since it last appeared in print, and in this revision the author has been ably assisted by many gentlemen, whose contributions have done much to give it greater accuracy and completeness. Those who have taken chief part in the revision are as follows:

For Arizona and the south-western territories, also notes on Colorado, Mr. George L. English of New York City; California, Mr. Henry S. Durden of San Francisco; Colorado, also northern New York, Prof. S. L. Penfield of New Haven; Idaho and Montana, Mr. W. H. Melville of Washington; Maine, Prof. F. C. Robinson of Bowdoin College; Delaware, Mr. Fred. J. Hilbiber of Wilmington; Maryland, Prof. G. H. Williams of Baltimore; Michigan, Prof. A. C. Lane of Houghton; Minnesota, Prof. C. W. Hall of Minneapolis; Missouri, Mr. Walter P. Jenney of the U. S. Geol. Survey, and Prof. H. A. Wheeler of St. Louis; North Carolina (also notes on Pennsylvania), Dr. F. A. Genth of Philadelphia; Pennsylvania, Dr. F. A. Genth, Dr. T. D. Rand, and Col. Joseph Willcox of Philadelphia; Texas, also S. Carolina, and notes on N. Carolina, Mr. W. E. Hidden of Newark; Virginia, Profs. W. G. Brown and H. D. Campbell of Lexington, also Profs. F. P. Dunnington and W. M. Fontaine of the University of Virginia; Wisconsin, Prof. Wm. H. Hobbs of Madison; Canada, Mr. G. Ch. Hoffmann of Ottawa.

Also general notes from several of the gentlemen above named, and from Prof. F. W. Clarke of Washington, Mr. George F. Kunz of New York City, and minor notes from others.

## INDEX OF STATES AND TERRITORIES.

## MAINE.

*General Notes for the New England States.*—The most interesting localities of Maine, as of the other New England States, are those of the veins of albitic granite, often worked economically for their feldspar, mica, quartz, and frequently affording fine specimens of many rare minerals, chiefly as accessory original constituents of the veins, in part also secondary. Among these species may be mentioned, the lithium minerals, lepidolite, red and green tourmaline, amblygonite, spodumene, petalite, triphylite (and lithiophilite); also beryllium minerals, beryl, chrysoberyl, and rarely herderite, phenacite, beryllonite ; further, columbite, cassiterite, uraninite, and many others.

In Maine, localities of this class are chiefly in the western part of the state in Oxford Co.; they also occur in New Hampshire, as at Acworth ; in Massachusetts, as conspicuously at Chesterfield and Goshen ; in Connecticut, as at Haddam, Middletown, Portland, Glastonbury, also at Branchville and vicinity, and elsewhere. Further, similar occurrences are found in Pennsylvania, Virginia, and North and South Carolina. The crystalline schists of New England often afford garnet, tourmaline, andalusite, staurolite, sillimanite, cyanite; also occasionally monazite, corundum, iolite, etc. In Massachusetts and Connecticut there are some interesting localities of zeolites and associated species (datolite, prehnite, etc.) connected with the dikes of "trap" rock.

In New England, mining for gold, silver, also tin (Maine, New Hampshire), has been attempted at various points on a small scale, but with no success ; copper, however, is obtained in economic quantities (e.g., Vermont), while the iron mines of western Massachusetts and Connecticut have been long productive. Other useful minerals sometimes obtained in paying quantities (besides the feldspar, etc., noted above) are steatite, graphite, marble, etc.

**Albany.**—*Beryl! green and black tourmaline, garnet, feldspar, rose quartz,* rutile.

**Andover.**—See RUMFORD.

**Auburn,** w. part, near Minot line.—*Lepidolite, amblygonite,* cassiterite, colorless, *green,* blue, etc., *tourmaline! apatite, herderite,* triplite, cookeite, allanite, garnet, molybdenite, beryl, albite, orthoclase, quartz, biotite, damourite.

**Bath.**—Vesuvianite, *garnet,* magnetite, graphite.

**Bethel.**—*Cinnamon garnet,* calcite, titanite, beryl, pyroxene, amphibole, epidote, graphite, talc, pyrite, arsenopyrite, magnetite.

**Bingham.**—*Massive pyrite,* galena, sphalerite, andalusite.

**Blue Hill Bay.**—*Arsenical iron, molybdenite! galena, apatite! fluorite!* black tourmaline (Long Cove), black oxide of manganese (Osgood's farm), *rhodonite,* bog manganese, wolframite.

At the Blue Hill copper mines, chalcocite, chalcopyrite, cuprite, bornite, tetrahedrite, arsenopyrite, pyrite.

**Bowdoin.**—*Rose quartz.*

**Bowdoinham.**—*Beryl,* molybdenite.

**Brunswick.**—*Green mica, garnet! black tourmaline!* molybdenite, epidote, *calcite, muscovite, feldspar, beryl,* titanite, columbite, pyrite, rutile.

**Buckfield.**—*Garnet* (estates of Waterman and Lowe), *muscovite! tourmaline!* magnetite.

**Byard's Point.**—Arsenopyrite.

**Camdage Farm.**—(Near the tide mills), molybdenite, wolframite.

**Camden.**—Chiastolite, *galena,* epidote, black tourmaline, pyrite, talc, magnetite.

**Canton.**—*Chrysoberyl,* feldspar, mica (mined).

**Carmel** (Penobscot Co.).—Stibnite, tetrahedrite, pyrite, chiastolite.

**Corinna.**—*Pyrite, arsenopyrite.*

**Deer Isle.**—*Serpentine, verd-antique,* asbestus, diallage, magnetite, talc (mined), barite.

**Dexter.**—Galena, pyrite, sphalerite, chalcopyrite, green talc.

**Dixfield.**—Native copperas, graphite.

**East Woodstock.**—Muscovite, garnet.

**Farmington.**—(Norton's Ledge), *pyrite,* graphite, garnet, staurolite.

**Franklin Plantation.**—Beryl.

**Freeport.**—*Rose quartz, garnet,* feldspar, scapolite, graphite, *muscovite,* amphibole, green mica.

**Fryeburg.**—*Garnet,* beryl.

**West Gardiner,** along the Litchfield border. See LITCHFIELD.

**Georgetown.**—(Parker's Island), *beryl!* black tourmaline, graphite.

**Gorham.**—Andalusite.

**Greenwood.**—Graphite, black manganese, *beryl! chrysoberyl, arsenopyrite,* cassiterite, *mica, rose quartz, garnet,* corundum, albite, zircon, molybdenite, magnetite, melanterite.

**Hebron,** 7 m. s. of Mt. Mica in Paris.—*Lepidolite, amblygonite* (*hebronite*), *rubellite!* indicolite, *green tourmaline,* damourite (as altered tourmaline), *mica, beryl, apatite, albite, pollucite, childrenite,* herderite, *cookeite, cassiterite,* arsenopyrite, vesuvianite.

**Katahdin.**—Mines of limonite, hematite.

**Linnæus.**—Hematite, limonite, *pyrite,* bog-iron.

**Litchfield.**—*Sodalite, cancrinite, elæolite, zircon, hydronephelite,* albite, spodumene, muscovite, pyrrhotite (from boulders), biotite.

**Lovell.**—Beryl.

**Lubec Lead Mines.**—*Galena, chalcopyrite,* sphalerite, bornite.

**Machiasport.**—*Jasper,* epidote, laumontite.

**Madawaska Settlements.**—*Vivianite.*

**Minot.**—*Beryl, smoky quartz,* vesuvianite.

**Monmouth.**—Actinolite, apatite, *elæolite, zircon,* staurolite, plumose mica, beryl, rutile.

**Mt. Abraham.**—*Andalusite,* staurolite.

**Norway.**—*Chrysoberyl!* molybdenite, *beryl, rose quartz, orthoclase,* green tourmaline, *albite, lepidolite,* cinnamon garnet, triphylite (lithiophilite), cookeite, cassiterite, amblygonite.

**Orr's Island.**—*Steatite,* garnet, andalusite.

**Oxford.**—*Garnet, beryl,* apatite, wad, zircon, *muscovite, orthoclase.*

**Paris,** on Mt. Mica.—*Green! red! black* and *blue tourmaline! mica! lepidolite!* feldspar, *albite, quartz crystals! rose quartz, cassiterite, amblygonite, apatite,* columbite, zircon, brookite, beryl, smoky quartz, spodumene, *cookeite,* löllingite, triphylite. See HEBRON.

**Parsonsfield.**—*Vesuvianite! yellow garnet, pargasite, adularia,* labradorite (cryst.), *scapolite,* galena, sphalerite, chalcopyrite.

**Peru.**—*Crystallized pyrite,* columbite, beryl, *spodumene,* triphylite (cryst.), *chrysoberyl, petalite, amblygonite.*

**Phippsburg.**—*Yellow garnet! manganesian garnet, vesuvianite, pargasite, axinite, laumontite!* chabazite, an ore of cerium ?

**Poland.**—Vesuvianite, smoky quartz, cinnamon garnet.

**Portland.**—*Prehnite,* actinolite, garnet, epidote, amethyst, calcite.

**Pownal.**—*Black tourmaline, feldspar,* scapolite, pyrite, actinolite, apatite, rose quartz.

**Raymond.**—*Magnetite, scapolite, pyroxene, lepidolite, tremolite,* amphibole, epidote, orthoclase, *yellow garnet,* pyrite, *vesuvianite.*

**Rockland.**—Hematite, tremolite, *quartz,* wad, *talc,* calcite.

**Rumford.**—On n. slope of Black Mtn., *tourmaline* (red), *lepidolite, spodumene,* cookeite, *yellow garnet, vesuvianite, pyroxene,* apatite, scapolite, cassiterite, amblygonite, muscovite, albite, graphite.

**Sanford** (York Co.).—*Vesuvianite!* albite, calcite, molybdenite, epidote, black tourmaline, labradorite.

**Searsmont.**—*Andalusite,* tourmaline.

**South Berwick.**—Chiastolite.

**Standish.**—*Columbite! tourmaline,* andalusite, pyrrhotite.

**Stoneham.**—*Columbite, chrysoberyl, herderite, topaz, beryllonite,* cassiterite, *bertrandite,* phenacite, hamlinite, *mica* (curved), triplite, beryl, fluorite.

**Stowe.**—*Chrysoberyl,* sillimanite.

**Streaked Mountain.**—*Beryl! black tourmaline, mica, garnet.*

**Sullivan.**—At the Sullivan mining district (also in Franklin and Hancock), galena, argentite, silver, cerargyrite, pyrargyrite, chalcopyrite, pyrite, stephanite, sphalerite, also gold, native bismuth.

**Thomaston.**—*Calcite, tremolite, hornblende,* titanite, arsenical iron (Owl's Head), black manganese (Dodge's Mountain), *thomsonite, talc,* sphalerite, pyrite, galena.

**Topsham.**—*Quartz, allanite, chrysoberyl, garnet, orthoclase,* muscovite, albite, *black tourmaline,* amphibole, apatite, zircon, beryl, galena, sphalerite, pyrite, gahnite, magnetite, bismuthinite, chalcopyrite, arsenopyrite, tungstite? molybdenite, columbite.

**Union.**—Magnetite, bog-iron ore.

**Wales.**—Axinite in boulder, alum, copperas.

**Warren.**—Calcite, dolomite.

**Waterville.**—*Crystallized pyrite.*

**West Gardiner.**—Iolite, blue sodalite.

**Whiting.**—Chalcopyrite, molybdenite.

**Windham** (near the bridge).—*Staurolite, spodumene, garnet,* beryl, amethyst, *cyanite* tourmaline.

**Winslow.**—Cassiterite in thin veins on slate, white beryl.

**Winthrop.**—*Staurolite,* pyrite, amphibole, garnet, beryl, copperas.

**Woodstock.**—*Graphite,* hematite, prehnite, epidote, calcite.

**York.**—*Beryl,* vivianite, oxide of manganese.

## NEW HAMPSHIRE.

**Acworth.**—*Beryl! mica! tourmaline, orthoclase, albite, rose quartz, columbite!* cyanite, autunite, biotite, garnet, cyanite.

**Alexandria.**—*Muscovite.*

**Alstead.**—*Mica! albite, black tourmaline, molybdenite,* andalusite, staurolite.

**Amherst.**—*Vesuvianite, yellow garnet,* pargasite, amethyst, pyroxene, magnetite.

**Antrim.**—Graphite.

**Bartlett.**—*Magnetite, hematite,* quartz crystals, danalite, limonite, *smoky quartz.*

**Bath.**—Galena, chalcopyrite, alum.

**Bedford.**—Tremolite, epidote, graphite, mica, tourmaline, alum, quartz, graphite.

**Bellows Falls.**—Cyanite, staurolite, prehnite, calcite.

**Benton.**—*Epidote,* beryl, magnetite.

**Berlin.**—*Chalcopyrite,* pyrite, magnetite, amphibole.

**Bristol.**—*Graphite,* galena.

**Campton.**—*Beryl!*

**Canaan.**—Gold in quartz veins and alluvium, *garnet.*

**Charlestown.**—*Staurolite, andalusite,* prehnite, cyanite.

**Chatham.**—Green fluorite.

**Concord.**—Sillimanite.

**Cornish.**—*Rutile in quartz!* (rare), *staurolite,* stibnite.

**Croydon.**—*Iolite!* chalcopyrite pyrite, *pyrrhotite, sphalerite.*

**East Wakefield.**—Beryl.

**Enfield.**—Gold, galena, staurolite, green quartz, ripidolite.

**Francestown.**—*Soapstone, arsenopyrite,* quartz crystals.

**Franconia.**—Arsenopyrite, chalcopyrite.

**Gardner Mtn.**—*Chalcopyrite, pyrite, galena,* azurite, malachite.

**Gilmanton.**—Tremolite, epidote, muscovite, tourmaline, limonite, quartz crystals.

**Goshen.**—*Graphite,* black tourmaline.

**Grafton.**—*Muscovite* (quarried at Glass Hill, 2 m. S. of Orange Summit), *albite!* blue, green, and yellow *beryls!* (1 m. S. of O. Summit), *tourmaline, garnet, triphylite, apatite,* fluorite, columbite, molybdenite, rhodonite.

**Grantham.**—*Gray staurolite!*

**Groton.**—Arsenopyrite, *beryl, muscovite* crystals, orthoclase, columbite.

**Hanover.**—*Garnet, black tourmaline, quartz, cyanite,* epidote, anorthite, cyanite, zoisite.

**Haverhill.**—*Garnet! arsenopyrite, native arsenic,* galena, sphalerite, pyrite, chalcopyrite, magnetite, marcasite, steatite.

**Hebron.**—*Beryl,* andalusite, graphite.

**Hinsdale.**—*Rhodonite,* molybdenite, indicolite, black tourmaline.

**Jackson.**—Drusy quartz, cassiterite, *arsenopyrite,* native arsenic, *fluorite,* apatite, *magnetite, molybdenite,* wolframite, chalcopyrite, bornite.

**Jaffrey** (Monadnock Mt.).—*Cyanite,* limonite.

**Keene.**—*Graphite,* soapstone, milky quartz, rose quartz.

**Landaff.**—*Molybdenite,* magnetite, pyrrhotite.

**Lebanon.**—Limonite, arsenopyrite, galena, magnetite, pyrite.

**Lisbon.**—*Staurolite, garnet, magnetite, amphibole, epidote, zoisite,* hematite, arsenopyrite, galena, gold, ankerite. Franconia iron-mine, amphibole, *epidote, zoisite, hematite, magnetite, garnet, arsenopyrite* (danaite), *molybdenite,* prehnite, cyanite.

**Littleton**—Ankerite, gold, bornite, chalcopyrite, malachite, ilmenite, chlorite.

**Lyman.**—Gold, *arsenopyrite, ankerite,* dolomite, galena, pyrite, pyrrhotite.

**Lyme.**—*Cyanite* (N. W. part), *black tourmaline,* rutile, pyrite, chalcopyrite (East part), stibnite, *molybdenite,* cassiterite, staurolite.

**Madison.**—*Galena,* sphalerite, chalcopyrite, limonite.

**Marlow.**—Tourmaline.

**Merrimack.**—*Rutile!* (in gneiss nodules in granite vein).

**Middletown.**—*Rutile,* arsenopyrite.

**Milan.**—*Chalcopyrite, galena,* sphalerite.

**Millsfield.**—Beryl, garnet.

**Monadnock Mountain.**—Andalusite, amphibole, garnet, graphite, tourmaline, orthoclase, sillimanite.

**Nashua.**—Muscovite.

**New London.**—Beryl, *molybdenite, muscovite.*

**Newport.**—*Molybdenite,* staurolite.

**North Chatham** (Bald Face Mt.).—Phenacite, topaz.

**Orange.**—*Blue beryl!* Orange Summit, chrysoberyl, *muscovite* (W. side of mountain), *albite,* tourmaline, apatite, galena, limonite.

**Orford.**—*Brown tourmaline* (obtained with difficulty), *steatite, rutile, cyanite,* ilmenite, garnet, graphite, molybdenite, pyrrhotite, *melaconite,* chalcopyrite, chalcocite, malachite, galena, *ripidolite.*

**Piermont.**—*Micaceous hematite,* barite, mica, apatite.

**Plymouth.**—Columbite, beryl.

**Richmond.**—*Iolite,* rutile, steatite, pyrite, anthophyllite, talc.

**Rye.**—*Chiastolite* (at Boar's Head, in boulders).

**Saddleback Mt.**—Black tourmaline, garnet, spinel.

**Shelburne.**—*Galena, black sphalerite, chalcopyrite, pyrite,* pyrolusite.

**Springfield.**—Beryl (eight inches in diameter), *manganesian garnet! black tourmaline!* in mica schist, *albite, mica,* rose quartz.

**Sullivan.**—*Tourmaline* (black) in quartz, beryl.

**Surry.**—Amethyst, galena, tourmaline, cyanite.

**Sutton.**—*Graphite, beryl.*

**Unity** (estate of James Neal).—Chalcopyrite, *pyrite, chlorophyllite,* green mica, actinolite, garnet, magnetite, tourmaline.

**Wakefield.**—Orthoclase, mica, columbite; in East Wakefield, *beryl.*

**Walpole.**—Chiastolite, staurolite, mica, graphite.

**Ware.**—Graphite.

**Warren.**—*Chalcopyrite,* sphalerite, *epidote,* quartz, *pyrite, tremolite, galena, rutile, talc,* molybdenite, *cinnamon-stone! pyroxene,* amphibole, *beryl, cyanite,* tourmaline (massive).

**Waterville.**—Labradorite, chrysolite, amethyst.

**Westmoreland** (south part).—*Molybdenite! apatite! blue feldspar, bog manganese* (north village), quartz, amethyst, *fluorite,* chalcopyrite, molybdite.

**White Mts.** (Notch near the "Crawford House").—Green *fluorite,* quartz crystals, black tourmaline, andalusite, amethyst, amazon-stone; also andalusite abundant in the gneiss of Mt. Washington.

**Whitefield.**—*Molybdenite.*

**Winchester.**—Pyrolusite, *rhodonite,* rhodochrosite, *magnetite,* pyrite, *spodumene, tourmaline.*

## VERMONT.

**Athens.**—*Steatite, ankerite,* actinolite, garnet.

**Baltimore.**—*Serpentine, pyrite!*

**Barnet.**—Graphite.

**Belvidere.**—Steatite, chlorite.

**Bennington.**—*Pyrolusite, limonite.*

**Berkshire.**—*Epidote,* hematite, magnetite.

**Bethel.**—*Actinolite!* talc, chlorite, octahedral iron, *rutile, ankerite in steatite.*

**Brandon.**—Pyrolusite, psilomelane, limonite, lignite, kaolinite, statuary marble; **graphite,** chalcopyrite, galena.

**Brattleborough.**—Black tourmaline in quartz, mica, zoisite, rutile, actinolite, scapolite, spodumene, roofing slate.

**Bridgewater.**—*Talc, dolomite, magnetite,* steatite, chlorite, gold, native copper, sphalerite, galena, blue spinel, chalcopyrite.

**Bristol.**—*Rutile,* limonite, manganese ores, magnetite.

**Brookfield.**—Arsenopyrite, *pyrite.*

**Cabot.**—Garnet, staurolite, amphibole, *albite.*

**Cavendish.**—Garnet, *serpentine, talc, steatite, tourmaline, asbestus, tremolite.*

**Chester.**—*Asbestus,* feldspar, chlorite, *quartz.*

**Chittenden.**—Psilomelane, pyrolusite, limonite, *hematite* and *magnetite,* galena, **iolite.**

**Colchester.**—Limonite, iron-sand, jasper, alum.

**Corinth.**—Chalcopyrite (has been mined), pyrrhotite, pyrite, rutile.

**Coventry.**—Rhodonite.

**Craftsbury.**—Mica in concretions, calcite, rutile.

**Cuttingsville.**—Chalcopyrite, pyrite.

**Derby.**—Mica (*adamsite*).

**Ely.**—*Chalcopyrite,* pyrite (copper mines recently reopened).

**Fair Haven.**—*Roofing slate,* pyrite.

**Farmington.**—*Andalusite.*

**Fletcher.**—Pyrite, magnetite, acicular tourmaline.

**Grafton.**—The Grafton *steatite* quarry is in Athens; *quartz*, actinolite.

**Guilford.**—Scapolite, rutile.

**Hartford.**—Calcite, *pyrite! cyanite*, quartz, tourmaline.

**Irasburgh.**—Rhodonite, *psilomelane*.

**Jay.**—*Chromite, serpentine*, amianthus, dolomite.

**Lowell.**—Amianthus, serpentine, cerolite, talc, chlorite.

**Manchester.**—Limonite.

**Marlboro'.**—*Rhomb spar, steatite, garnet, magnetite*, chlorite.

**Middlesex.**—Rutile! (exhausted).

**Monktown.**—*Pyrolusite*, limonite, feldspar.

**Moretown.**—*Smoky quartz! steatite*, talc, wad, rutile, serpentine.

**Mount Holly.**—*Asbestus*, chlorite.

**New Fane.**—*Glassy* and *asbestiform actinolite, steatite, green quartz* (called chrysoprase at the locality), chalcedony, drusy quartz, *garnet, chromic and titanic iron, ankerite*, serpentine, rutile.

**Norwich.**—*Actinolite, feldspar, brown spar* in talc, *cyanite*, zoisite, chalcopyrite, pyrite.

**Pittsford.**—Limonite, manganese ores, *statuary marble!*

**Plymouth.**—Siderite, magnetite, hematite, *gold*, galena, also limonite, kaolin.

**Putney.**—Fluorite, *limonite, rutile* and *zoisite* in boulders, staurolite.

**Reading.**—*Glassy actinolite* in talc.

**Readsboro'.**—*Glassy actinolite, steatite*, hematite.

**Rochester.**—Rutile, hematite cryst., *magnetite* in chlorite slate.

**Rockingham** (Bellows Falls).—Cyanite, indicolite, feldspar, tourmaline, fluorite, calcite, prehnite, staurolite.

**Roxbury.**—*Dolomite, talc*, serpentine, asbestus, quartz.

**Rutland.**—*Magnesite, white marble*, hematite, serpentine.

**Sharon.**—*Quartz crystals*, cyanite.

**Shoreham.**—*Pyrite*, black marble, calcite.

**Strafford.**—Magnetite and *chalcopyrite* (has been worked), native copper, amphibole copperas.

**Thetford.**—Sphalerite, *galena, cyanite*, chrysolite in basalt, pyrrhotite, *feldspar, roofing slate*, steatite, garnet.

**Townshend.**—*Actinolite*, black mica, *talc*, steatite, feldspar.

**Troy.**—*Magnetite*, talc, serpentine, amianthus, *steatite*, ilmenite, chlorite; one mile south-east of village of South Troy, on the farm of Mr. Pierce, east side of Missisco, chromite, zaratite.

**Vershire.**—*Pyrite, chalcopyrite*, native copper, malachite, tourmaline, arsenopyrite, quartz.

**Wardsboro'.**—*Zoisite*, tourmaline, *tremolite*, hematite.

**Warren.**—Actinolite, magnetite, wad, serpentine.

**Waterbury.**—Arsenopyrite, chalcopyrite, *rutile, quartz*, serpentine.

**Waterville.**—*Steatite*, actinolite, talc.

**Weathersfield.**—*Steatite*, hematite, *pyrite*, tremolite.

**Westfield.**—*Steatite*, chromite, serpentine.

**Westminster.**—Zoisite in boulders.

**Windham.**—*Glassy actinolite, steatite, garnet*, serpentine.

**Woodstock.**—*Quartz crystals*, garnet, zoisite.

## MASSACHUSETTS.

**Athol.**—*Allanite, epidote!* babingtonite? mica.

**Auburn.**—*Masonite* (chloritoid).

**Barre.**—*Rutile! mica, pyrite, beryl, feldspar, garnet.*

**Great Barrington.**—Tremolite.

**Bedford.**—*Garnet.*

**Belcherton.**—Allanite.

**Bernardston.**—Magnetite at loc. of crinoidal limestone.

**Beverly.**—Columbite, *green feldspar*, cassiterite.

**Blandford.**—*Serpentine, anthophyllite, actinolite! chromite*, cyanite, rose quartz in boulders.

**Bolton.**—*Scapolite! petalite*, titanite, *pyroxene, nuttalite, diopside, boltonite*, apatite, magnesite, ankerite, *allanite, yttrocerite*, spinel.

**Boxborough.**—*Scapolite*, spinel, *garnet*, augite, actinolite, apatite.

**Brimfield** (road leading to Warren).—*Iolite*, andalusite, adularia, molybdenite, mica, garnet.

**Brookfield.**—Limonite, garnet.

**Carlisle.**—*Tourmaline, garnet! scapolite*, actinolite.

**Chelmsford.**—*Scapolite* (chelmsfordite), *chondrodite, blue spinel, amianthus!* rose quartz.

**Chester.**—Amphibole, *scapolite, zoisite, spodumene, indicolite*, garnet, apatite, magnetite, chromite, stilbite, heulandite, analcite, and chabazite.

At the Emery Mine, Chester Factories.—*Corundum, margarite, diaspore*, epidote, corundophilite, chloritoid, tourmaline, *ilmenite*, rutile, biotite, *cyanite*, amesite.

**Chesterfield.**—*Blue, green, and red tourmaline, cleavelandite* (albite), lepidolite, *smoky quartz, microlite, spodumene, cyanite*, apatite, *beryl, garnet, quartz crystals, staurolite*, cassiterite, *columbite*, zoisite, autunite, brookite (eumanite), scheelite, anthophyllite, bornite.

**Conway.**—Pyrolusite, fluorite, zoisite, *rutile!* native alum, galena.

**Cummington.**—*Rhodonite!* cummingtonite (amphibole), marcasite, *garnet.*

**Deerfield.**—Chabazite, heulandite, stilbite, datolite, prehnite, natrolite, analcite, calcite, fluorite, diabantite, saponite, amethyst, carnelian, chalcedony, *agate,* pyrite, malachite.

**Fitchburg** (Pearl Hill).—*Beryl, staurolite!* garnets, molybdenite, tourmaline.

**Foxborough.**—*Pyrite, anthracite.*

**Framingham.**—Garnet.

**Franklin.**—Amethyst.

**Gloucester.**—*Danalite.*

**Goshen.**—*Mica, albite, spodumene! blue and green tourmaline, beryl, zoisite,* smoky quartz, columbite, tin ore, galena, beryl (goshenite), cymatolite (mixture of albite and muscovite).

**Greenfield** (in sandstone quarry, ½ m. E. of village).—Allophane.

**Hatfield.**—Barite, galena, sphalerite, chalcopyrite, quartz crystals.

**Hawley.**—*Micaceous hematite,* massive pyrite, magnetite, zoisite.

**Heath.**—*Pyrite, zoisite.*

**Hinsdale.**—Limonite, apatite, zoisite.

**Hubbardston.**—*Massive pyrite.*

**Huntington** (name changed from Norwich).—*Apatite! black tourmaline, beryl, spodumene! triphylite* (altered), sphalerite, quartz crystals, cassiterite.

**Lancaster.**—*Cyanite, chiastolite!* apatite, staurolite, pinite, andalusite.

**Lee.**—*Tremolite,* titanite; chondrodite in cryst. limestone in East Lee.

**Leverett.**—Barite, galena, sphalerite, chalcopyrite.

**Leyden.**—*Zoisite, rutile.*

**Malden.**—Galena.

**Marblehead.**—In zircon-syenyte, sodalite, elæolite.

**Martha's Vineyard.**—Limonite, amber, radiated pyrite.

**Mendon.**—*Mica!* chlorite.

**Middlefield.**—*Glassy actinolite,* ankerite, *steatite, serpentine, feldspar,* drusy quartz, apatite, zoisite, nacrite, chalcedony, *talc!* deweylite.

**Milbury.**—*Vermiculite,* graphite.

**Mt. Washington.**—Garnet, staurolite, albite, ottrelite, ottrelite and ilmenite growths.

**New Braintree.**—*Black tourmaline.*

**New Marlboro'.**—*Apatite,* tourmaline, garnet (with granophyre structure), muscovite crystals, bi-pyramidal quartz (in pegmatyte of Tobey Hill); chalcopyrite, *pyrrhotite, hornblende,* magnetite (at Cleaveland "Gold mine"); diopside, tremolite, *quartz crystals* (in limestone).

**Newbury.**—*Serpentine,* chrysotile, *epidote,* vesuvianite, siderite.

**Newburyport.**—*Serpentine, nemalite,* autunite.—Argentiferous galena, tetrahedrite, chalcopyrite, pyrargyrite, siderite, etc.

**Northfield.**—*Columbite,* fibrolite, cyanite.

**Norwich.**—See HUNTINGTON.

**Oxford.**—Arsenopyrite, pyrite.

**Palmer** (Three Rivers).—*Feldspar,* prehnite, calcite.

**Pelham.**—*Asbestus,* serpentine, *quartz crystals,* beryl, *molybdenite, green hornstone,* epidote, amethyst, corundum, vermiculite.

**Plainfield.**—*Cummingtonite, pyrolusite, rhodonite.*

**Richmond.**—Limonite, *gibbsite! allophane.*

**Rockport** (near the extremity of C. Ann).—*Danalite, cryophyllite, annite, cyrtolite* (altered zircon), amazon-stone, fergusonite, *green* and *white orthoclase.*

**Rowe.**—Epidote, talc; at Davis mine, *pyrite,* chalcopyrite, *gahnite,* zoisite.

**Russell.**—*Garnet! mica,* serpentine, beryl, galena, chalcopyrite.

**Salem.**—Cancrinite, sodalite, elæolite, zircon.

**Sheffield.**—*Asbestus,* pyrite, native alum, pyrolusite; *rutile* in limestone, garnet, staurolite, albite in schist.

**Shelburne.**—Rutile.

**Shutesbury** (east of Locke's Pond).—*Molybdenite.*

**Somerville.**—*Prehnite, laumontite,* stilbite, chabazite, quartz crystals, melanolite, babingtonite, calcite, epidote.

**South Royalston.**—*Beryl!* (now obtained with great difficulty), *mica! feldspar!* allanite. Four miles beyond old loc., on farm of Solomon Heywood, *mica! beryl! feldspar!* ilmenite.

**Southampton.**—Galena, cerussite, anglesite, *wulfenite,* fluorite, bornite, barite, pyrite, chalcopyrite, sphalerite, phosgenite, pyromorphite, stolzite, chrysocolla.

**Sterling.**—*Spodumene, chiastolite,* siderite, arsenopyrite, sphalerite, galena, chalcopyrite, pyrite, sterlingite (damourite).

**Stoneham.**—*Nephrite.*

**Sturbridge.**—*Graphite,* garnet, apatite, bog-ore.

**Swampscot.**—*Orthite,* feldspar.

**Taunton** (one mile south).—Paracolumbite (ilmenite).

**Turner's Falls** (Conn. River).—Chalcopyrite, prehnite, chlorite, siderite, malachite, diabantite.

**Tyringham** and on borders of **Otis.**—*Pyroxene, scapolite,* chondrodite, titanite, amphibole, *spherostilbite.*

**Warwick.**—*Massive garnet, radiated black tourmaline, magnetite,* beryl, epidote.

**Washington.**—*Graphite.*

**Westfield.**—*Schiller spar* (diallage), *serpentine, steatite,* cyanite, scapolite, actinolite.

**Westford.**—*Andalusite!*

**West Hampton.**—Galena, *argentine, pseudomorphous quartz.*

**West Stockbridge.**—*Limonite,* fibrous pyrolusite, *siderite.*

**Williamsburg.**—*Zoisite,* pseudomorphous quartz, apatite, rose and smoky quartz, galena, pyrolusite, chalcopyrite.

**Windsor.**—*Zoisite,* actinolite, *rutile!*

**Worcester.**—Arsenopyrite, vesuvianite, pyroxene, garnet, amianthus, smoky quartz, graphite, calcite, bucholzite, siderite, galena.

**Worthington.**—*Cyanite.*

**Zoar.**—Bitter spar, *talc.*

## RHODE ISLAND.

**Bristol.**—*Amethyst.*

**Burrillville.**—Amethyst.

**Cranston.**—Actinolite in talc, graphite, cyanite, mica, melanterite, hematite.

**Cumberland.**—*Manganese, epidote, actinolite,* garnet, titaniferous iron, magnetite, hematite, chalcopyrite, bornite, malachite, azurite, calcite, apatite, feldspar, zoisite, mica, quartz crystals, ilvaite. Beacon Pole Hill, crocidolite.

At Sneech Pond, chalcopyrite, ilvaite, wad, molybdenite, magnetite, epidote, chlorite.

**Diamond Hill.**—Quartz crystals, hematite.

**Foster.**—*Cyanite,* hematite.

**Gloucester.**—*Magnetite* in chlorite slate, feldspar.

**Johnston.**—Talc, ankerite, calcite, garnet, epidote, pyrite, hematite, magnetite, chalcopyrite, malachite, azurite.

**Lincoln.**—Galena.

**Natick.**—See WARWICK.

**Newport.**—*Serpentine,* quartz crystals.

**Portsmouth.**—*Anthracite,* graphite, asbestus, pyrite, chalcopyrite.

**Smithfield.**—*Dolomite, calcite, bitter spar, siderite, nacrite,* serpentine (bowenite), tremolite, asbestus, quartz, magnetite in chlorite schist, *talc!* octahedrite, feldspar, beryl.

**Valley Falls.**—Graphite, pyrite, hematite.

**Warwick** (Natick village).—*Masonite* (chloritoid), garnet, graphite, bog-ore.

**Westerly.**—Ilmenite.

**Woonsocket.**—Cyanite.

## CONNECTICUT.

**Berlin.**—Barite, datolite, sphalerite, quartz crystals.

**Bethel.**—Tourmaline.

**Bolton.**—Staurolite, chalcopyrite.

**Branchville.**—In a vein of albitic granite, *garnet, albite, microcline,* amblygonite, *spodumene! cymatolite, margarodite* (curved), eosphorite, triploidite, triplite, reddingite, dickinsonite, *lithiophilite,* natrophilite, hureaulite, *rhodochrosite,* fairfieldite, *apatite,* microlite, *columbite,* pyrite, tourmaline, staurolite, *uraninite, torbernite, autunite,* vivianite, eucryptite, chabazite, stilbite, heulandite, native bismuth, muscovite, biotite, beryl, montmorillonite.

**Branford** (Stony Creek).—Biotite, apatite.

**Bristol.**—*Chalcocite, chalcopyrite,* barite, *bornite, allophane,* pyromorphite, *calcite,* malachite, galena, quartz.

**Brookfield.**—Galena, calamine, sphalerite, spodumene, pyrrhotite, chalcopyrite.

**Canaan.**—Calcite (Canaan Lime Company's quarry), phlogopite, green tremolite (Maltby's quarry); *diopside,* in part changed to tremolite, fibrolite, garnet, hornblende (Canaan Mt.).

**Chatham.**—Arsenopyrite, smaltite, cloanthite (chathamite), scorodite, niccolite, *beryl,* erythrite.

**Cheshire.**—*Barite!* chalcocite, bornite, malachite, kaolin, natrolite, prehnite, chabazite, datolite, cuprite.

**Chester.**—*Sillimanite!* zircon, epidote.

**Cornwall.**—*Graphite,* pyroxene, actinolite, titanite, scapolite.

**Danbury.**—*Danburite* with *oligoclase* (formerly), brown tourmaline, orthoclase, pyroxene, parathorite.

**Derby.**—Arsenopyrite.

**Farmington.**—Prehnite, chabazite, agate, native copper, *diabantite.*

**Glastonbury** (at Hale's quarry).—*Columbite,* muscovite, orthoclase, albite, *uraninite.*

**Granby** (Simsbury mines).—Bornite, chalcocite, chalcopyrite, malachite.

**Guilford.**—In gneiss, iolite; N. Guilford, rutile (boulder).

**Haddam.**[*]—*Chrysoberyl! beryl, epidote, tourmaline,* orthoclase, *garnet, iolite! chlorophyllite!*

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[*] The pegmatyte veins of Haddam have their continuation in similar veins in Middletown, Portland, and Glastonbury, to the north; in some cases doubt exists as to the exact locality.

*oligoclase, automolite, magnetite, adularia*, apatite, *columbite!* zircon (calyptolite), *mica*, pyrite, marcasite, *molybdenite*, allanite, bismuth ocher, bismutite, cassiterite.

**Hadlyme.**—Chabazite and stilbite in gneiss.

**Hartford.**—*Datolite* (Rocky Hill quarry).

**Kent.**—Limonite.

**Litchfield.**—*Cyanite* with corundum, apatite, and andalusite, ilmenite (washingtonite), chalcopyrite, diaspore, niccoliferous pyrrhotite, margarodite, staurolite, apatite.

**Lyme.**—Garnet, sunstone, microcline.

**Meriden.**—*Datolite* (greenish), diabantite.

**Middlefield Falls.**—Datolite, chlorite, etc., in amygdaloid.

**Middletown.**—At the feldspar quarries, *mica, albite, feldspar, columbite! prehnite, garnet*, samarskite, biotite, monazite, vesuvianite, *beryl*, topaz, uranite, apatite, uraninite, *lepidolite* with green and red tourmaline; at lead-mine formerly *galena, chalcopyrite*, sphalerite, quartz, *calcite*, fluorite, pyrite sometimes capillary.

**Milford.**—Salite, pyroxene, asbestus, verd-antique marble.

**Monroe.**—See TRUMBULL

**New Britain.**—Prehnite calcite, datolite, diabantite, agate, barite; copper minerals in small quantities.

**New Haven.**—Serpentine, salite; also with the trap rocks, prehnite, laumontite, and the zeolites, stilbite, apophyllite, very sparingly; as a contact-mineral, garnet.

**New Milford.**—*Beryl* (golden yellow and green), tourmaline, mica, feldspar.

**Newtown.**—*Cyanite, diaspore, rutile*, damourite, tourmaline.

**Norfolk.**—Biotite crystals, *pseudomorphs of a colorless mica, quartz and fibrolite after plagioclase* (at Norfolk granite quarry, the latter in blocks).

**Norwich.**—In gneiss, *sillimanite, monazite! iolite*, corundum, feldspar.

**Portland.**—At feldspar quarries, orthoclase, *albite, muscovite, biotite, beryl*, tourmaline, bismuthinite, bismutosphærite, columbite, apatite; at Pelton's feldspar quarry, monazite.

**Plymouth.**—Galena, *heulandite, fluorite, chlorophyllite!* garnet, rutile.

**Roaring Brook** (Cheshire).—*Datolite!* calcite, prehnite, saponite.

**Roxbury.**—*Siderite*, sphalerite, *pyrite! galena*, quartz, chalcopyrite, arsenopyrite, limonite.

**Salisbury.**—*Limonite, pyrolusite*, manganite, triplite, *turgite*, scovillite, staurolite.

**Seymour.**—Arsenopyrite, pyrite, native bismuth.

**Simsbury.**—Chalcocite, green malachite.

**Southbury.**—Rose quartz, laumontite, prehnite, calcite, barite, staurolite, garnet.

**Southington.**—Barite, datolite, asteriated quartz crystals, diabantite.

**Stafford.**—Massive pyrite, alum, copperas.

**Tariffville.**—*Datolite!*

**Trumbull** and **Monroe.**—*Chlorophane, topaz, beryl*, diaspore, pyrrhotite, pyrite, scheelite, *wolframite* (pseudomorph after scheelite), native bismuth, tungstite, siderite, arsenopyrite, argentiferous galena, sphalerite, scapolite, *tourmaline, garnet*, albite, augite, graphic tellurium (?), *margarodite.*

**Washington.**—*Tripolite, ilmenite!* (washingtonite), rhodochrosite, natrolite, *andalusite* (New Preston), cyanite.

**Watertown** (near the Naugatuck).—White salite, monazite.

**West Farms.**—Asbestus.

**Willimantic.**—In gneiss, *topaz, monazite, ripidolite, sillimanite*, bismuthinite, bismutosphærite, beryl, orthoclase, uraninite.

**Winchester.**—Magnetite.

## NEW YORK.

Of economic minerals, halite is obtained as rock salt, also from salt wells, extensively in the western counties from Cayuga Lake west to L. Erie (see p. 155); further gypsum in the same region. Hematite at Antwerp, Jefferson Co.; limonite in the south-eastern part of the state east of the Hudson river, chiefly in Dutchess and Columbia counties; also siderite in Columbia Co. Magnetite is largely mined in Essex Co., and occurs widely in the adjacent counties of the Adirondack region; also mined in the Highlands, in Orange, Westchester, and Putnam counties. The magnetite mines sometimes furnish beautiful specimens of rare minerals, e.g., allanite at Moriah, chondrodite, etc., at Brewster.

The most interesting localities for minerals are those of the Archæan in St. Lawrence Co., also Franklin, Jefferson, Lewis, etc., counties. Here are obtained, at many points, fine pyroxene, amphibole, albite and other feldspars, phlogopite, tourmaline, apatite, titanite, zircon, etc.; they most commonly occur in crystalline limestone where it joins the schists. Other important localities, also in the Archæan, are those of Orange Co. (Warwick, Monroe), in the south-eastern part of the state, where in the crystalline limestone, chondrodite, spinel, etc., occur abundantly.

The limestone of the western part of the state affords (e.g., Lockport) calcite, dolomite, celestite, anhydrite, etc.

**ALBANY CO.—Bethlehem.**—Calcite, stalactite, calcareous sinter, snowy gypsum.

**Coeymans Landing.**—Gypsum, epsomite, *quartz* crystals at Crystal Hill, 3 m. S. of Albany.

**Watervliet.**—*Quartz crystals*, yellow drusy quartz.

**CAYUGA CO.—Auburn.**—Celestite, calcite, fluorite, epsomite.
**Springport.**—At Thompson's plaster beds, *sulphur ! selenite.*
**Union Springs.**—*Selenite,* gypsum.

**CLINTON CO.—Arnold Iron Mine.**—*Magnetite,* epidote, molybdenite.
**Finch Ore Bed.**—*Calcite, green* and purple fluorite.
**Plattsburg.**—Nugget of platinum in drift.

**COLUMBIA CO.—Ancram.**—Lead-mine, galena, sphalerite, wulfenite, chalcopyrite.
**Canaan.**—Chalcocite. chalcopyrite.
**Catskill Station.**—Siderite in large beds.
**Copake.**—Limonite (large ore beds), graphite.
**Hudson.**—*Selenite!* epsomite, brown spar, *wad, siderite.*
**Linlithgo.**—Siderite beds.
**New Lebanon.**—Nitrogen springs.

**DUTCHESS CO.—Amenia.**—Dolomite, *limonite, turgite, siderite.*
**Dover.**—Dolomite. tremolite, *garnet* (Foss Ore Bed), *limonite,* staurolite.
**Fishkill.**—Dolomite; near Peckville, talc, asbestus, *graphite,* amphibole, augite, *actinolite, limonite.*
**North East.**—Chalcocite, chalcopyrite, galena, sphalerite.
**Union Vale.**—At the Clove mine, *gibbsite, limonite.*

**ESSEX CO.—Alexandria.**—Kirby's graphite mine, *graphite, pyroxene, scapolite,* titanite.
**Crown Point.**—*Apatite* (eupyrchroite of Emmons), *brown tourmaline!* in the apatite, chlorite, quartz crystals, calcite, pyrite; S. of J. C. Hammond's house, *garnet, scapolite,* chalcopyrite, *aventurine feldspar,* zircon, magnetite (Peru), epidote, mica.
**Keene.**—Scapolite.
**Lewis.**—Wollastonite, *colophonite,* garnet, *labradorite,* amphibole, actinolite; 10 m. S. of Keeseville, arsenopyrite.
**Long Pond.**—Apatite, *garnet, pyoxene,* vesuvianite, *coccolite! scapolite,* magnetite, *blue calcite.*
**McIntyre.**—*Labradorite,* garnet, *magnetite.*
**Moriah,** at Sandford Ore Bed.—*Magnetite,* apatite, *allanite!* lanthanite, actinolite, and feldspar; at Fisher Ore Bed, *magnetite,* feldspar, quartz; at Hall Ore Bed, or "New Ore Bed," *magnetite, zircon;* on Mill brook, *calcite,* pyroxene, amphibole, albite; in the town of Moriah, magnetite, *black mica;* Barton Hill Ore Bed, *albite.*
**Newcomb.**—*Labradorite,* feldspar, magnetite. hypersthene, *tourmaline.*
**Port Henry.**—*Brown tourmaline,* black tourmaline enclosing orthoclase, *mica, rose quartz, serpentine, green* and *black pyroxene,* amphibole, *cryst. pyrite.* graphite, wollastonite, pyrrhotite, *adularia, phlogopite!;* at Mineville, *magnetite* in large quantities, also in fine crystals; in Champlain iron region, uranothorite.
**Roger's Rock.**—*Graphite, wollastonite, garnet, feldspar,* adularia, *pyroxene,* titanite, coccolite.
**Schroon.**—*Calcite.* pyroxene, *chondrodite.*
**Ticonderoga.**—*Graphite! pyroxene, salite,* titanite, black tourmaline, cacoxenite? (Mt. Defiance).
**Westport.**—Labradorite, prehnite, magnetite.
**Willsboro'.**—*Wollastonite, colophonite,* garnet, *green coccolite,* amphibole.

**JEFFERSON CO.—Adams.**—Fluorite, calc tufa, barite.
**Alexandria.**—On S. E. bank of Muscolonge Lake, fluorite (exhausted), *phlogopite,* chalcopyrite, apatite; on High Island, in the St. Lawrence River, feldspar, *tourmaline,* amphibole, *orthoclase,* celestite.
**Antwerp.**—Sterling iron-mine hematite, *chalcodite,* siderite, calcite, ankerite, *millerite! red hematite,* crystallized quartz, *yellow aragonite,* niccoliferous pyrite, *quartz crystals,* pyrite; at Oxbow, *calcite!* porous coralloidal barite; near Vrooman's lake, *calcite!* vesuvianite, *phlogopite! pyroxene,* titanite, fluorite, pyrite, chalcopyrite; also *feldspar, bog-iron ore,* scapolite (farm of Eggleson), *serpentine,* tourmaline (yellow, rare).
**Brownsville.**—Celestite, calcite (4 m. from Watertown).
**Natural Bridge.**—*Gieseckite! steatite* pseudomorphous after pyroxene, apatite, phlogopite, orthoclase.
**New Connecticut.**—Titanite, *brown phlogopite.*
**Omar.**—*Beryl, feldspar,* hematite.
**Philadelphia.**—*Garnets* on Indian River, in the village; hematite.
**Pillar Point.**—*Massive barite* (exhausted).
**Theresa.**—*Fluorite, calcite,* hematite, amphibole, *quartz crystals,* serpentine (associated with hematite), celestite, strontianite.
**Watertown.**—*Tremolite, agaric mineral,* calc tufa, celestite.
**Wilna.**—One mile N. of Natural Bridge, *calcite.*

**GREENE CO.—Diamond Hill.**—Quartz crystals.

**HERKIMER CO.—Fairfield.**—*Quartz crystals*, fetid barite.
**Little Falls.**—*Quartz crystals!* barite, calcite, *smoky quartz;* 1 m. S. of Little Falls, calcite, brown spar, feldspar.
**Middleville.**—*Quartz crystals! calcite*, dolomite.
**Newport.**—*Quartz crystals.*
**Salisbury.**—*Quartz crystals!* sphalerite, galena, pyrite, chalcopyrite.
**Stark.**—Fibrous celestite, *gypsum.*

**LEWIS CO.—Bonaparte Lake.**—Wollastonite.
**Diana** (localities mostly near junction of crystalline and sedimentary rocks, and 2 m. from Natural Bridge).—*Scapolite!* wollastonite, *green coccolite, feldspar, tremolite, pyroxene!* titanite, mica, *quartz crystals*, pyrite, pyrrhotite, *blue calcite*, serpentine, *rensselaerite*, zircon, graphite, chlorite, hematite, bog-ore, *apatite.*
**Greig.**—*Magnetite*, pyrite.
**Lowville.**—*Calcite*, fluorite, pyrite, galena, sphalerite, calc tufa.
**Martinsburgh.**—Wad, galena, etc. (formerly), *calcite.*

**MONROE CO.—Rochester.**—*Dolomite*, calcite, snowy gypsum, fluorite, celestite, galena, sphalerite, barite, hornstone.

**MONTGOMERY CO.—Palatine.**—*Quartz crystals*, drusy quartz, anthracite, hornstone, agate, garnet.
**Root.**—*Drusy quartz*, sphalerite, barite, stalactite, galena, pyrite.

**NEW YORK CO.—Kingsbridge.**—*Tremolite, pyroxene, mica, tourmaline*, pyrite.
**New York.**—*Serpentine, amianthus*, actinolite, *pyroxene*, hydrous anthophyllite, garnet, staurolite, molybdenite, graphite, *chlorite*, beryl, jasper, *necronite*, feldspar, xenotime, wollastonite, dumortierite. In the excavations for the 4th Avenue tunnel, 1875, *harmotome*, stilbite, chabazite, heulandite, etc.

**NIAGARA CO.—Lewiston.**—*Epsomite.*
**Lockport.**—*Celestite, calcite, selenite, anhydrite, fluorite, dolomite*, sphalerite.
**Niagara Falls.**—*Calcite*, fluorite, sphalerite, *dolomite.*

**ONEIDA CO.—Boonville.**—*Calcite, wollastonite, coccolite.*
**Clinton.**—Sphalerite, *lenticular* hematite in the Clinton group, strontianite, celestite, the former covering the latter.

**ONONDAGA CO.—Camillus.**—*Selenite* and *fibrous gypsum.*
**Syracuse.**—*Serpentine*, celestite, selenite, barite.

**ORANGE CO.—Cornwall.**—*Zircon, chondrodite*, amphibole, *spinel, feldspar, epidote*, hudsonite, ilmenite, *serpentine*, coccolite.
**Deer Park.**—*Cryst. pyrite*, galena.
**Monroe.**—*Mica! titanite! garnet*, colophonite, *epidote, chondrodite, allanite*, bucholzite, brown spar, *spinel*, amphibole, talc, ilmenite, *pyrrhotite*, pyrite, chromite, *graphite*, rastolyte, moronolite; Wilks and O'Neill Mine, aragonite, *magnetite*, dimagnetite (pseud.?), jenkinsite, *asbestus*, serpentine, *mica, hortonolite;* TWO PONDS, *pyroxene! chondrodite*, amphibole, *scapolite! zircon*, titanite, apatite; GREENWOOD FURNACE, *chondrodite, pyroxene! mica*, amphibole, *spinel, scapolite, biotite!* ilmenite, anomite.
**Forest of Dean.**—*Pyroxene, spinel*, zircon, scapolite, amphibole.
**Town of Warwick, Warwick Village.**—*Spinel! zircon, serpentine! brown spar, pyroxene!* amphibole, *pseudomorphous steatite, feldspar!* (Rock Hill), ilmenite, *clintonite*, tourmaline (R. H.), *rutile*, titanite, molybdenite, arsenopyrite, marcasite, pyrite, yellow iron sinter, quartz, jasper, mica, coccolite.
**Amity.**—*Spinel! garnet, scapolite*, amphibole, *vesuvianite, epidote! seybertite*, leuchtenbergite, *magnetite, tourmaline*, warwickite, *apatite, chondrodite, talc! pyroxene!* phlogopite, rutile, ilmenite, *zircon, corundum, feldspar*, fluorite, titanite, calcite, serpentine, schiller spar (?), silvery mica, graphite.
**Edenville.**—*Apatite, chondrodite! hair-brown amphibole!* tremolite, *spinel, tourmaline, warwickite, pyroxene*, titanite, *mica, feldspar*, arsenopyrite, orpiment, *rutile*, ilmenite, scorodite, chalcopyrite, *leucopyrite* (or löllingite), allanite.
**West Point.**—*Feldspar, mica*, scapolite, *titanite, amphibole*, allanite.

**PUTNAM CO.—Brewster,** Tilly Foster Iron Mine.—*Chondrodite! magnetite, dolomite, serpentine pseudomorphs, brucite, enstatite*, clinochlore, biotite, actinolite, *pyrrhotite*, fluorite, albite, epidote, *titanite!* garnet, *apatite*, datolite, stilbite, prehnite, *apophyllite.*

**Anthony's Nose**, at top.—Pyrite, pyrrhotite, pyroxene, amphibole, magnetite.

**Carmel** (Brown's quarry).—Anthophyllite, arsenopyrite, epidote.

**Cold Spring.**—Titanite, epidote.

**Patterson.**—*White pyroxene! calcite, asbestus, tremolite*, dolomite, massive pyrite.

**Phillipstown.**—*Tremolite, amianthus, serpentine*, titanite, *diopside, green coccolite*, amphibole, *scapolite*, stilbite, mica, laumontite, gurhofite, calcite, magnetite, chromite.

**Phillips** Ore Bed.—Hyalite, *actinolite, massive pyrite.*

**RICHMOND CO.—Rossville.**—Lignite, *cryst. pyrite.*

**Quarantine.**—*Asbestus, amianthus*, aragonite, *dolomite, gurhofite*, brucite, serpentine, *talc*, magnesite.

**ROCKLAND CO.—Caldwell.**—*Calcite.*

**Ladentown.**—Zircon, malachite, cuprite.

**Piermont.**—Datolite, stilbite, apophyllite, pectolite, prehnite, thomsonite, calcite, chabazite.

**ST. LAWRENCE CO.—Canton.**—*Massive pyrite, calcite*, brown tourmaline, titanite, *serpentine*, talc, *rensselaerite*, pyroxene, hematite, chalcopyrite.

**DeKalb.**—On Sprague Downing's farm and Calvin Mitchel's adjoining, *diopside!* cryst. with hornblende; datolite rare. On Andrew Murty's farm, white or colorless *tourmaline!* with pure white *phlogopite, tremolite, pyroxene*, serpentine, apatite, and pyrite. Near Osborn's lake, at Abner Crosse's, calcite crystals, barite, *fluorite, brown tourmaline*, tremolite and phlogopite. On Francis McIntyre's farm, *barite!*

**Edwards.**—At Freemansburgh, extensive talc mines, fibrous, pseud. after enstatite (agalite) pink tremolite (hexagonite), enstatite. Transparent white phlogopite at the Anthony Mine. *Brown* and *silvery mica!* scapolite, apatite, *quartz crystals*, actinolite, *tremolite!* hematite, serpentine, magnetite.

**Fine.**—On Lorenzo Guinup's farm, in a granite vein, large *pyroxene* cryst. (prisms over a foot in diameter, looking like basaltic columns), *titanite* cryst. as large as a dinner-plate, *fluorite*, fine sage-green *zircons*, calcite. On Fida Scott's farm, large *oligoclase* cryst., *pyroxene, fluorite, calcite, zircon*, pyrite, apatite, titanite.

**Fowler.**—*Quartz* (dihexahedral) with *hematite* and barite, *sphalerite*, galena, tremolite; foliated white *talc* at Wm. Woodcock's mine, near the village of Little York. Also galena, tremolite, chalcedony, bog-ore, satin spar (assoc. with serpentine), pyrite, chalcopyrite, actinolite, *rensselaerite* (near Somerville).

**Gouverneur.**—At Richville, on the Reese farm, fine brown *tourmaline!* with *tremolite! pyroxene, apatite*, pyrite, *titanite* and *phlogopite*. Near David Downing's farm, *fluorite* in twin cubes (etched). Also *calcite! serpentine!* amphibole, *scapolite! orthoclase, tourmaline!* vesuvianite (1 m. S. of G.), pyroxene, diopside, apatite, *rensselaerite*, serpentine, titanite, fluorite, barite (farm of Judge Dodge), black *mica*, phlogopite, *tremolite!* asbestus, hematite, graphite, vesuvianite (near Somerville in serpentine), *spinel*, houghite, scapolite, *phlogopite*, dolomite; $\frac{3}{4}$ m. W. of Somerville, *chondrodite*, spinel.

**Hammond.**—*Apatite! zircon!* (farm of Mr. Hardy), *orthoclase* (loxocase), *pargasite*, barite, pyrite, purple fluorite, *tremolite, phlogopite.*

**Hermon.**—*Quartz crystals*, hematite, siderite, pargasite, pyroxene, serpentine, tourmaline, bog-iron ore.

**Macomb.**—On John McNiel's and Perry Washburn's farms, brown and black *tourmaline! pyroxene, amphibole, albite* (peristerite), *graphite*, apatite, *phlogopite*, scapolite. On Milton Truax's farm, large amphibole (six-sided prisms) in calcite. Veins of galena on many farms formerly extensively worked. On Vilas Ingram's farm, *brown tourmaline! graphite* and feldspar. Also sphalerite, mica, titanite, *fluorite!*

**Mineral Point**, Morristown.—Fluorite, sphalerite, galena, *phlogopite* (Pope's Mills), barite.

**Ogdensburgh.**—Labradorite.

**Pierrepont.**—On Ryland Crary's farm, *black tourmaline!* black *phlogopite, pyroxene* (often changed to uralite), quartz in calcite. On Allen W. Wells' farm, large light green amphibole with pyroxene and oligoclase. On Reuben Vaughn's farm, dark green amphibole. On T. Fitzgerald's farm, large scapolite crystals, albite (peristerite), pyroxene.

**Pitcairn.**—*Feldspar, pyroxene, zircon! titanite*, satin spar, associated with serpentine.

**Pope's Mills.**—See Mineral Point.

**Potsdam.**—*Amphibole;* eight miles from Potsdam, on road to Pierrepont, *feldspar, tourmaline, black mica*, amphibole.

**Rossie.**—On James Martin's farm, *scapolite, pyroxene, titanite, tourmaline*, black *phlogopite*. Near Grasse Lake, on Abner Anables farm, *pyroxene! scapolite, graphite!* in splendid crystals, with *titanite*, and feldspar; tremolite in short prismatic crystals.

Also (Iron Mines).—*Barite*, hematite, coralloidal aragonite (near Somerville), *quartz, pyrite, dolomite;* ROSSIE Lead Mine, *calcite, galena, pyrite, celestite*, chalcopyrite, hematite, cerussite, anglesite, *octahedral fluorite, black phlogopite;* elsewhere in ROSSIE, *calcite*, barite, quartz crystals, chondrodite (near Yellow Lake), *feldspar! pargasite! apatite, pyroxene*, amphibole, titanite, zircon, *mica*, fluorite, serpentine, automolite, pearl spar, graphite.

**Russell.**—On Sam. Moore's farm, light green *pyroxene!* (uralite on the exterior), *amphi-*

*bole! feldspar, scapolite, phlogopite.* On Chas. Buskurk's farm, *danburite!* datolite (rare), scapolite, pyroxene, black tourmaline, albite, quartz, calcite, pyrite, black phlogopite, amphibole.

**SARATOGA CO.—Greenfield.**—*Chrysoberyl! garnet! tourmaline! mica, feldspar,* apatite, graphite, aragonite (in iron mines).

**SCHOHARIE CO.—Ball's Cave,** and others.—Calcite, stalactites.
**Carlisle.**—*Fibrous barite, cryst. and fibrous calcite.*
**Schoharie.**—Fibrous celestite, *strontianite! cryst. pyrite!*

**SULLIVAN CO.—Wurtzboro'.**—*Galena,* sphalerite, *pyrite, chalcopyrite.*

**ULSTER CO.—Ellenville.**—*Galena,* sphalerite, *chalcopyrite! quartz! brookite,* pyrite.

**WARREN CO.—Caldwell.**— *Massive feldspar.*
**Chester.**—*Pyrite,* tourmaline, rutile, chalcopyrite.
**Diamond Isle** (Lake George).—*Calcite, quartz crystals.*
**Johnsburgh.**—*Fluorite! zircon! graphite, serpentine, pyrite.*

**WASHINGTON CO.—Fort Ann.**—*Graphite,* serpentine.
**Granville.**—*Lamellar pyroxene,* massive feldspar, epidote.

**WAYNE CO.—Wolcott.**—Barite.

**WESTCHESTER CO.—Anthony's Nose.**—*Apatite,* pyrite, *calcite!* in large tabular crystals, grouped, and sometimes incrusted with drusy quartz.
**Cruger's.**—White pyroxene, amphibole, magnetite (with greenish spinel), staurolite, sillimanite, corundum, hercynite.
**Davenport's Neck.**—*Serpentine,* garnet, titanite.
**Eastchester.**—Sphalerite, pyrite, chalcopyrite, dolomite.
**Hastings.**—*Tremolite, white pyroxene.*
**New Rochelle.**—*Serpentine,* quartz, *mica,* tremolite, garnet, magnesite, chromite.
**Peekskill.**—Amphibole, staurolite, graphite.
**Rye.**—*Serpentine, chlorite, black tourmaline,* tremolite.
**Sing Sing.**—*Pyroxene, tremolite, pyrite,* beryl; azurite, green malachite, cerussite, pyromorphite, anglesite, vauquelinite, galena, native silver, chalcopyrite, wulfenite, vanadinite. At openings for the aqueduct, *rutile, harmotome,* heulandite, pectolite, stilbite, etc., in gneiss.
**West Farms.**—Apatite, tremolite, garnet, stilbite, heulandite, chabazite, epidote, titanite.
**Yonkers.**—*Tremolite,* apatite, calcite, analcite, *pyrite,* tourmaline.
**Yorktown.**—*Fibrolite, monazite,* magnetite.

**WYOMING CO.—Wyoming.**—Rock salt (and at many other localities, see above).

## NEW JERSEY.*

The most important mineral locality of the State is that of the zinc mines of Franklin Furnace and two miles from there at Sterling Hill (near Ogdensburgh) in Sussex Co., where zincite, franklinite, willemite, calamine are the chief ores, but many rare species, chiefly containing zinc and manganese, have been found. Magnetite is also mined in the northern counties (Sparta, Vernon), where the association is similar to that of the adjoining Orange Co. in New York. Green sand marls are mined along a belt 90 miles long from Sandy Hook to Delaware Bay. Zeolites and associated minerals of secondary origin have been obtained in fine specimens from the R. R. tunnels passing through the trap rock at Bergen, Weehawken.

**Andover Iron Mine** (Sussex Co.).—Willemite, brown garnet, limonite, malachite, azurite, sphalerite, calamine, chalcopyrite, pyrolusite, orthoclase, *calcite, fluorite,* phlogopite, talc, *amphibole,* flos ferri, blue asbestus.
**Allentown** (Monmouth Co.).—*Vivianite, dufrenite.*
**Beemersville.**—Elæolite, sodalite, titanite, ægirite, fluorite, pyrite, in elæolite-syenite.
**Bellville.**—Copper mines.
**Bergen.**—*Calcite! datolite! pectolite! analcite, apophyllite! gmelinite, prehnite!* titanite, *stilbite, natrolite,* heulandite, laumontite, *chabazite,* thomsonite, mesolite, pyrite, pseudomorphous steatite after apophyllite, diabantite, amphibole, *sphalerite,* chalcedony, copper, *dolomite,* epistilbite, fire-opal, hydrophane, *milky quartz.*

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* See the Catalogue of Minerals found in New Jersey, by F. A. Canfield, published in vol. 2, Part 1, of the final Report of the State Geologist, 1889.

**Brunswick.**—*Native copper, malachite, mountain leather.*

**Bryam.**—Chondrodite, *spinel*, at Roseville, *epidote, zircon.*

**Bush Mine** and **Cannon Mine** (Passaic Co.).—Epidote.

**Cantwell's Bridge** (Newcastle Co.).—Vivianite.

**Chester.**—Melanterite.

**Danville** (Jemmy Jump Ridge).—*Graphite,* chondrodite, augite.

**Flemington.**—*Copper mines.*

**Frankfort.**—*Serpentine.*

**E. Belleville** (Hudson Co.).—Azurite, chalcopyrite, chrysocolla, native copper, malachite.

**Franklin Furnace** and **Sterling Hill** near Ogdensburgh (Sussex Co.).—*Spinel! garnet! rhodonite* (fowlerite)! *franklinite! zincite! gahnite!* amphibole, *tremolite, chondrodite, white scapolite, black tourmaline, epidote, mica,* actinolite, augite, salite, coccolite, asbestus. *jeffersonite* (augite), polyadelphite, *calamine,* graphite, fluorite, beryl, galena, serpentine, honey-colored titanite, *axinite,* barite, quartz, chalcedony, amethyst, zircon, molybdenite, vivianite, *tephroite, rhodochrosite,* aragonite, *sussexite,* chalcophanite, rœpperite, vanuxemite, hetærolite, pyrochroite, rammelsbergite, bementite, chloanthite, niccolite, apatite, smaltite, allanite, desaulesite. Also *algerite* in gran. limestone; *green tourmaline!* phlogopite.

**Franklin** and **Warwick Mt.**—*Pyrite.*

**Gove Mine** (Morris Co.).—*Vivianite.* clear crystals on magnetite.

**Griggstown** and **Greenbrook.**—Copper mines.

**Hamburg** (Sussex Co.)—One mile north, *spinel! tourmaline, phlogopite, amphibole, limonite,* hematite.

**Harrisonville** (Gloucester Co.).—*Amber.*

**Hibernia** (Morris Co.).—Enstatite, fluorite, molybdenite, *pyrite, quartz* (cap crystals), siderite.

**Hoboken.**—Serpentine (marmolite), *brucite, nemalite* (fibrous brucite), aragonite, dolomite, agate, cerolite, chromite, hydromagnesite, jasper, selenite.

**Howell's Mill** (Sussex Co.).—Vesuvianite, titanite, tourmaline, rutile.

**Hurdstown.**—*Apatite,* pyrrhotite, magnetite, pyrite.

**Imlaystown.**—Vivianite.

**Lockwood.**—*Graphite, chondrodite, talc, augite, quartz, green spinel,* phlogopite.

**Montville** (Morris Co.).—*Serpentine, chrysotile,* gurhofite (dolomite), marmolite, pyroxene.

**Mullica Hill** (Gloucester Co.).—*Vivianite* lining belemnites and other fossils, beraunite.

**Newton.**—*Spinel,* blue, pink, and white, corundum, *mica,* vesuvianite, amphibole, *tourmaline, scapolite,* rutile, *pyrite, talc, calcite,* phlogopite, wernerite, galena, barite, *pseudomorphous steatite.*

**N. Brunswick.**—Azurite, barite, bornite, chalcopyrite, native copper.

**Paterson.**—At Hoxie's quarry, *prehnite, datolite, apophyllite,* laumontite, stilbite, chabazite, heulandite, natrolite, analcite, pectolite, quartz, calcite, malachite, etc., also quartz pseud. after pectolite, stilbite, datolite and apophyllite.

**Phillipsburg.**—Anthophyllite, apatite, augite, beryl, pyroxene, serpentine, tremolite.

**Pluckamin Copper Mines** (Somerset Co.).—*Prehnite!* zoisite, epidote.

**Red Bank.**—Vivianite.

**Roseville** (Sussex Co.).—*Epidote, amphibole.*

**Sparta.**—Augite, *chondrodite, corundum,* franklinite, phlogopite, *rutile, spinel* of varied colors, talc.

**Stanhope.**—At the Hude mine, molybdenite, molybdite, magnetite, selenite, copper.

**Sterling Hill.**—See FRANKLIN FURNACE.

**Vernon.**—Serpentine, spinel, hydrotalcite, dipyre, chondrodite, corundum, salite.

**Weehawken.**—At the R. R. tunnel, *natrolite, apophyllite,* stilbite, heulandite, pectolite, laumontite, allophane, anthraconite, hyalite, aragonite, *pyrite,* wad.

## PENNSYLVANIA.*

Besides the great production of coal and oil, Pennsylvania affords magnetite in considerable quantity, as in the South Mountain belt, at Durham, Northampton Co.; Jones's mine near Morgantown, Berks Co.; Cornwall iron mountain, Lebanon Co.; near Knauertown and the Warwick mines, Chester Co. Hematite, limonite, and siderite are also mined at many points; further, galena in Chester, Montgomery, Bucks, and Blair counties; copper ores (chalcopyrite, etc.), at Jones's mine, near Morgantown, Berks Co.; Cornwall, Lebanon Co.; Fritz Island near Reading; near Knauertown, Chester Co. Further, nickel ores are mined (millerite, niccoliferous pyrrhotite) at the Gap nickel mine, Lancaster Co.; also chromite at the Wood's mine and Texas mine, Lancaster Co., and elsewhere.

ADAMS CO.—Near **Gettysburg.**—Epidote, fibrous and massive, cuprite, native copper.

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* See also the Preliminary Reports on the Mineralogy of Pennsylvania by Dr. F. A. Genth, 1875, 1876; also the Mineralogy of Pennsylvania by John Eyerman, 48 pp., 1889.

**BEDFORD CO.—Bridgeport.**—Barite.

**BERKS CO.**—At Jones's mine, 1 m. E. of Morgantown, *malachite*, native copper, *chrysocolla, magnetite*, allophane, pyrite, chalcopyrite, aurichalcite, cuprite, melaconite, byssolite, aragonite, apatite, talc. 2 m. N. E. from Jones's mine, graphite, titanite. At Steele's mine, *magnetite*, micaceous iron, coccolite, brown garnet.

**Reading.**—*Smoky quartz* crystals, *zircon*, stilbite, iron-ore. Near Pricetown, zircon, allanite, epidote.

Zion's Church, molybdenite. Near Kutztown, in the Crystal Cave, stalactites of aragonite, quartz.

Fritz's Island, *apophyllite*, thomsonite, *chabazite*, gismondite ?, datolite, brucite, grossularite, marcasite, xanthite, calcite, azurite, *malachite*, magnetite, chalcopyrite, stibnite, prochlorite, precious serpentine.

**Buckingham Township.**—Crystallized quartz. Near New Hope, vesuvianite, epidote, barite.

**Southampton.**—Near Feasterville, in G. Vanarsdale's quarry, *graphite*, pyroxene, salite, coccolite, *titanite*, green mica, calcite, *wollastonite*, glassy feldspar sometimes opalescent (microcline ?), phlogopite, *blue quartz*, garnet, zircon, pyrite, pyrrhotite, moroxite, scapolite.

**New Britain.**—Dolomite, galena, sphalerite, malachite.

**BLAIR CO.—Bell's Mills** near Frankstown.—*Celestite* (fibrous), *quartz crystals*.

**CARBON CO.—Summit Hill.**—In coal mines, *kaolinite*.

**CHESTER CO.—Avondale.**—Asbestus, tremolite, *garnet!* opal, *beryl* (yellow), tourmaline, mountain leather.

**Birmingham Township.**—Amethyst, serpentine.

**East Bradford.**—Near Buffington's bridge, on the Brandywine, green, blue, and gray cyanite, gray crystals loose in the soil. Farms of Dr. Elwyn, Mrs. Foulke, Wm. Gibbons, and Saml. Entrikin, *amethyst*. At Strode's mill, oligoclase, drusy quartz, collyrite ?

Osborne's Hill, *wad, manganesian garnet* (massive), titanite. Caleb Cope's lime quarry, *fetid dolomite*, necronite, blue cyanite, *talc*. Near the Black Horse Inn, *indurated talc*, rutile. Amos Davis's farm, allanite! Near the paper mill on the Brandywine, *zircon*, ilmenite, blue quartz.

**West Bradford.**—Near village of Marshalton, *green cyanite*.

At Chester County Poorhouse limestone quarry, *chesterlite!* on dolomite, *rutile!* in acicular crystals, *damourite!* radiated on dolomite, *quartz crystals*.

**Charlestown.**—*Pyromorphite, cerussite, galena*, quartz, amethyst.

**North Coventry.**—Allanite, near Pughtown, black garnets.

**French Creek Mines** (St. Peters).—See WARWICK.

**East Goshen.**—Serpentine, *asbestus*, magnetite.

**Elk.**—Ilmenite with muscovite, chromite.

**West Goshen.**—On the Barrens, 1 m. N. of West Chester, serpentine, indurated talc, *deweylite*, aragonite, *staurolite*, asbestus, *zoisite* on hornblende at West Chester water-works (not accessible at present).

**New Garden.**—At Nivin's limestone quarry, *brown and yellow tourmaline, necronite, aragonite, sillimanite, kaolinite*, tremolite.

**Kennett.**—Actinolite, tremolite. On Wm. Cloud's farm, *sunstone!* At Pearce's old mill, *sunstone*.

**East Marlborough.**—On farm of Bailey & Brother, 1 m. S. of Unionville, *yellow* and white *tourmaline, chesterlite*, white pyroxene. Near Marlborough meeting-house, serpentine, *zircon* loose in the soil at Pusey's sawmill.

**West Marlborough.**—Near Logan's quarry, asbestiform *tremolite*, black tourmaline, cyanite, yellow tourmaline, rutile. Near Doe Run village, *tremolite*. In R. Baily's limestone quarry, 2½ m. S. W. of Unionville, *fibrous tremolite, cyanite*.

**Newlin.**—1½ m. N. E. of Unionville, *corundum!* often in loose crystals with a coating of a soda-margarite (Genth), *diaspore!* spinel (black), picrolite, black *tourmaline* with flat pyramidal terminations in albite, unionite (zoisite), *euphyllite, feldspar, beryl!* in one crystal weighing 51 lbs., pyrite, chloritoid, diallage, *oligoclase;* ilmenite, *clinochlore*, albite, *orthoclase*, halloysite, margarite, garnet, *beryl*. On J. Lesley's farm, *corundum*, a single mass weighing over 100 tons, *diaspore!* "lesleyite." In Edwards's limestone quarry, rutile. C. Passmore's farm, amethyst.

**East Nottingham.**—*Asbestus, chromite* in crystals, hallite.

**West Nottingham.**—At Scott's chrome-mine, *chromite, foliated talc*, marmolite, serpentine, *rhodochrome*. Near Moro Phillips's chrome-mine, *asbestus*. At the magnesia quarry, *deweylite*, marmolite, magnesite, albite, serpentine, chromite, meerschaum. Near Fremont P. O., corundum.

**West Pikeland.**—In iron-mines near Chester Springs, *turgite*, limonite (stalactitic and in geodes), göthite.

**Pennsbury.**—On John Craig's farm, brown garnets, *mica*. On J. Dilworth's, near Fairville, *muscovite!* in Fairville, *sunstone*. Near Brinton's Ford, *chondrodite, titanite, augite*. At Swain's quarry, orthoclase, muscovite containing magnetite.

**Pocopson.**—Farms of J. Entrikin and J. B. Darlington, *amethyst*.

**Sadsbury.**—*Rutile!* crystals loose for 7 m. along the valley, near the village of Parkesburg. Near Sadsbury village, *amethyst*.

**Schuylkill.**—In railroad tunnel at PHŒNIXVILLE, *dolomite!* quartz crystals, *calcite*. At the WHEATLEY, BROOKDALE, and CHESTER COUNTY LEAD MINES (now abandoned, and good specimens not obtainable), 1½ m. S. of Phœnixville, *pyromorphite! cerussite! galena, anglesite!* quartz crystals, chalcopyrite, barite, *fluorite* (white), *wulfenite! calamine, sphalerite! mimetite!* descloizite, göthite, chrysocolla, native copper, malachite, *azurite*, limonite, *calcite*, ankerite, *sulphur*, pyrite, melaconite, pseudomalachite, gersdorffite, chalcocite ?, covellite.

**Willistown.**—*Magnetite, chromite.*

**West Town.**—Brinton's serpentine quarry, 3 m. S. of West Chester, clinochlore, jefferisite, amethyst, tourmaline, beryl.

**West Whiteland.**—At Gen. Trimble's iron-mine (southeast), *stalactitic hematite! wavellite!* in radiated stalactites, cœruleolactite.

**Warwick.**—French Creek mines (Elizabeth mine and Keim's mine, 1 m. N. of Knauertown), *garnet! micaceous hematite, pyrite* (octahedral)! chalcopyrite massive and in *crystals!* in thuringite, *magnetite, brown garnet*, calcite, pyroxene, in part alt. to amphibole, scapolite, siderite, rhodochrosite, stilbite, *apophyllite*, erythrite, *byssolite!* serpentine. Near village of St. Mary's, magnetite (dodecahedral), *melanite, garnet, actinolite*. At Hopewell iron mine, 1 m. N. W. of St. Mary's, *magnetite* in octahedral crystals.

**Yellow Springs.**—Allanite.

**DAUPHIN CO.**—Near **Hummelstown.**—Green garnets, cryst. *smoky quartz*, feldspar.

**DELAWARE CO.**—**Aston Township.**—*Amethyst, corundum* (Village Green), *sillimanite*, black tourmaline, *margarite, sunstone, asbestus*, antholite, steatite, quartz in modified cryst., also with implanted rutile cryst. Bridgewater Station (the locality in Chester township), *titanite!* in twins 2 inches long and translucent. At Peter's mill-dam in the creek, *garnet*.

**Bethel.**—*Garnet.*

**Birmingham.**—*Sillimanite, kaolin* (abundant), *rutile, amethyst*. At Bullock's old quarry, zircon.

**Chester.**—*Amethyst, black tourmaline, beryl, crystals of* orthoclase, *garnet, molybdenite, molybdite, muscovite.*

**Chichester.**—Lower Chichester.—Orthoclase, tourmaline, beryl, garnet, kaolin, cyanite. Upper Chichester.—Spessartite, titanite, amethyst, orthoclase, green garnet, gahnite.

**Concord.**—*Mica, feldspar, kaolin, drusy quartz, garnet, sillimanite*, amethyst, *manganesian garnet*, meerschaum. In Green's creek, *garnet.*

**Darby.**—*Blue* and *gray cyanite, beryl, garnet*, smoky quartz, titaniferous garnet, zoisite, Babel quartz

**Edgemont.**—*Amethyst.* One m. E. of Edgemont Hall, *rutile* in quartz, limonite.

**Leiperville.**—Garnet, zoisite (thulite), heulandite, leidyite, *beryl* (Deshong's quarry), *black tourmaline.*

**Marple.**—*Tourmaline, andalusite*, andalusite-pseud, (damourite), amethyst, *actinolite, bronzite*, talc, *radiated actinolite* in talc, chromite, beryl, *ilmenite in quartz*, amethyst.

**Middletown.**—*Amethyst, beryl*, black mica, *mica* with dendritic magnetite, *manganesian garnets!* some 3 inches in diameter, indurated talc, *rutile, mica, green quartz! anthophyllite*, radiated tourmaline, staurolite, ilmenite, sillimanite, serpentine.

At Lenni, lennilite, *chlorite*, green and bronze *vermiculite! green feldspar*. At Mineral Hill, crystals of *corundum*, some of 6 inches, *actinolite*, bronzite, *green feldspar* (Lea's lennilite, etc.), *moonstone, sunstone*, magnesite, *chromite* (octahedrons), columbite, *beryl*, asbestus, microcline, talc, muscovite, deweylite, stilbite, enstatite, rutile, melanosiderite, hallite. At Painter's Farm, *zircon* with oligoclase, painterite, tremolite, tourmaline. At Hibbard's Farm and at Fairlamb's Hill, chromite in brilliant octahedrons. John Smith farm, meerschaum,

Also orthoclase, muscovite, rose quartz, gahnite, zircon, amethyst, vermiculite, ferruginous quartz, prase.

**Newtown.**—Serpentine, hematite, enstatite, stalactitic quartz.

**Upper Providence.**—*Antholite, radiated asbestus, andalusite, radiated actinolite*, tourmaline, *beryl, green feldspar, amethyst* (one of 7 lbs. from Morgan Hunter's farm), *andalusite!* At Blue Hill, *green quartz* in chlorite, chrysotile in serpentine; cassinite, enstatite, clinochlore, bronzite, diaclasite, apatite.

**Lower Providence.**—*Amethyst*, garnet, feldspar! (large crystals).

**Radnor.**—Enstatite, serpentine, pseudomorph after asbestus, quartz after serpentine, genthite, picrolite, hornstone, chrysotile, chromite, garnet, staurolite, labradorite, blue quartz.

**Springfield.**—*Andalusite, tourmaline*, beryl, ilmenite, garnet. On Fell's Laurel Hill, beryl, garnet. Near Lewis's paper-mill, allophane, mica, albite.

**Waterville.**—Near Chester and Upland, chabazite.

**FRANKLIN CO.—Lancaster Station.**—Barite, fluorite.

**LANCASTER CO.—Drumore Township.**—Quartz crystals.
**Fulton.**—At Wood's chrome mine, near Texas, *brucite!!* zaratite (emerald nickel), pennite, *clinochlore! kämmererite! bronzite, baltimorite, chromite,* williamsite, *chrysolite!* marmolite, *picrolite,* hydromagnesite, *dolomite,* magnesite, *aragonite,* calcite, serpentine, hematite, ilmenite, genthite, chrome-garnet, millerite. At Low's mine, *hydromagnesite, brucite, picrolite,* magnesite, *williamsite, chromite,* talc, zaratite, baltimorite, serpentine, hematite. On M. Boice's farm, 1 m. N. W. of village, *pyrite,* enstatite. Near Rock Springs, *chalcedony,* carnelian, *moss agate, green tourmaline* in talc, titanic iron, chromite, *octahedral magnetite in chlorite.* At Reynolds's old mine, calcite, *talc,* picrolite, *chromite.* At Carter's chrome mine, brookite (one crystal found).
**Gap Mines.**—Chalcopyrite, *pyrrhotite* (niccoliferous), *millerite* (botryoidal radiations), *vivianite!* actinolite, *siderite,* hisingerite, pyrite. Noblis mine, *cacoxenite!* on limonite.
**Pequea Valley.**—8 m. S. of Lancaster, argentiferous galena, vauquelinite, rutile, at Pequea mine. 4 m. N. W. of Lancaster, *calamine,* galena (with octahedral cleavage), sphalerite; *pyrite* in cubes near Lancaster. At the Lancaster zinc mines, *calamine,* sphalerite, tennantite? *smithsonite* (pseud. of dolomite), *aurichalcite.*

**LEBANON CO.—Cornwall.**—*Magnetite, pyrite* (cobaltiferous), chalcopyrite, *native copper, azurite, malachite, chrysocolla, cuprite* (hydrocuprite), *allophane, brochantite,* serpentine, quartz pseudomorphs; fluorite, covellite, hematite (micaceous), opal, asbestus, sphalerite, prehnite.

**LEHIGH CO.—Friedensville.**—At zinc mines, *calamine, smithsonite,* hydrozincite, massive sphalerite, greenockite, quartz, allophane, mountain leather, aragonite, lanthanite, sauconite. Near Allentown, magnetite, pipe-iron ore. Near Bethlehem, on S. Mountain, allanite, with zircon, magnetite, martite, black spinel, tourmaline, chalcocite, chloropal.
**Ironton.**—Psilomelane in stalactitic, botryoidal, and reniform masses.
**Macungie.**—*Wavellite!*
**Shimerville.**—*Corundum!* in fine crystals, black spinel.

**LUZERNE CO.—Scranton.**—Under peat, phytocollite.
**Drifton.**—Pyrophyllite.

**MIFFLIN CO.**—Opposite Mount Union.—Strontianite, aragonite.

**MONROE CO.**—In **Cherry Valley,** *calcite,* chalcedony, quartz. In Poconac Valley, near Judge Mervine's, cryst. quartz.

**MONTGOMERY CO.—Conshohocken.**—Fibrous tourmaline, ilmenite, aventurine quartz, phyllite, limonite, cacoxenite, pyrite. In the quarry of Geo. Bullock, *calcite* in hexagonal prisms, aragonite.
**Lafayette,** at the Soapstone quarries.—Talc, jefferisite, garnet, albite, serpentine, zoisite, staurolite, chalcopyrite. At Rose's Serpentine quarry, opposite Lafayette, enstatite, serpentine, *millerite!* genthite, chalcanthite, bornite, epsomite, aragonite, chlorite, tremolite, steatite, dolomite, serpentine pseudomorph after staurolite.
**Lower Providence.**—Perkiomen lead and copper mines, near village of Shannonville, azurite, *sphalerite, galena,* pyromorphite, cerussite, wulfenite, anglesite, barite, calamine, chalcopyrite, malachite, chrysocolla, ankerite, cuprite, covellite (rare), melaconite, pseudomalachite.
**White Marsh.**—D. O. Hitner's iron mine, limonite in geodes and stalactites, *göthite,* pyrolusite, wad, lepidocrocite. At Edge Hill Station (P. R. R.), ilmenite, braunite, pyrolusite, limonite, turgite, braunite, velvet manganese, titaniferous hematite, rutile, wad.
Near Marble Hall, at Hitner's marble quarry, white marble, granular barite, resembling marble. At Spring Mills, limonite, pyrolusite, göthite. At Flat Rock Tunnel, opposite Manayunk, *stilbite, heulandite, chabasite,* ilvaite, beryl, feldspar, mica.

**NORTHAMPTON CO.—Bethlehem.**—Axinite, zircon (¾ m. N.).
**Bushkill T.**—Crystal Spring on Blue Mountain, *quartz crystals.*
**Nazareth**—Quartz crystals.
Near **Easton.**—*Zircon!* (exhausted), coccolite, tremolite, pyroxene, salite, limonite, magnetite, purple calcite, bowenite.
**Williams Township.**—Pyrolusite in geodes in limonite beds, göthite (lepidocrocite) at Glendon.

**NORTHUMBERLAND CO.**—Opposite **Selin's Grove.**—Calamine.

**PHILADELPHIA CO.—Frankford.**—At quarries on Frankford Creek, *stilbite! molybdenite!* in fine crystals, hornblende, titanite, apophyllite, tourmaline, fluorite, calcite, bornite, chalcopyrite, malachite, chrysocolla, hyalite colored by uranium, apatite, lepidomelane, titanite, randite, Iceland spar, orthoclase, oligoclase. On the Connecting Railroad, wad, earthy cobalt, basanite in the drift.

**Fairmount Water-works.**—*Autunite! torbernite, orthoclase*, beryl, tourmaline, albite, wad, intercrystallized black and white mica.

Near Girard Avenue and the Schuylkill, ilmenite. Thirty-sixth Street and Penn. R. R., garnet, wad. Fifty-ninth Street and Penn. R. R., halotrichite, glockerite. Darby Tunnel, B. & O. R. R., anhydrite.

**Wissahickon Creek.**—McKinney's quarry on Rittenhouse Lane, orthoclase, apatite, stilbite, heulandite, epidote, bornite, malachite, chalcopyrite, chrysocolla, laumontite. Near Gorgas's and Crease's Lanes, tourmaline, cyanite, staurolite. Near Heft's Mill, alunogen, tourmaline, cyanite.

**Cresheim Creek.**—Antholite in radiated masses. One half mile above, staurolite, ilmenite, hyalite, apatite, green mica, iron garnets in abundance.

**Thorp's Lane.**—Talc, magnetite.

**Falls of Schuylkill.**—Chabazite, titanite, fluorite, apatite, muscovite, tourmaline, prochlorite, quartz crystals, crocidolite laumontite, analcite.

**SCHUYLKILL CO.**—**Tamaqua** (near Pottsville), in coal mines.—*Kaolinite.* Lansford, near Tamaqua, in an anthracite mine, lansfordite, nesquehonite.

Near **Mahanoy City.**—Pyrophyllite, alunogen, copiapite, in coal-mines.

**YORK CO.**—Bornite, rutile in slender prisms in granular quartz.

## DELAWARE.

**KENT CO.**—Near **Middletown**, Polk's marl-pits (not open).—*Vivianite!*

**East Dover.**—Limonite.

**NEWCASTLE CO.**—**Brandywine Springs.**—*Fibrolite*, salite, pyroxene. Brandywine Hundred, *muscovite* inclosing reticulated magnetite, *garnet.*

**Dixon's Feldspar Quarries**, 6 m. N. W. of Wilmington (not open).—*Beryl, apatite, cinnamon-stone!* magnesite, serpentine, asbestus, black *tourmaline!* cyanite.

**Eastburn's Limestone Quarries**, near the Pennsylvania line (not always worked).—*Tremolite, bronzite.*

**Hockessin**, on the Del. West. R. R.—Kaolin (large deposit), feldspar.

**Kennett Turnpike**, near Centreville.—Cyanite and garnet.

Near **Newark**, on the railroad.—Sphærosiderite on drusy quartz, jasper (ferruginous opal), cryst. siderite in cavities of cellular quartz, quartz crystals loose in soil; limonite mined at Chestnut Hill pits.

**Quarryville.**—Garnet, fibrolite.

On **Talley's Farm** near Shellpot Creek.—Feldspar, muscovite inclosing reticulated magnetite and layers of quartz, kaolin, hypersthene.

**Way's Quarry**, 2 m. S. of Centreville (not open).—*Feldspar* in cleavage masses, *apatite, mica, deweylite, granular quartz.*

Near **Wilmington.**—Hornblende, bog-iron ore, hypersthene.

**Wilmington Granite Co. Quarries** on the Brandywine.—Metalloidal diallage, black hornblende, tourmaline, chalcopyrite, stilbite ! (rare).

**Wooddale Quarries.**—Garnet, biotite, feldspar.

**SUSSEX CO.**—Near **Cape Henlopen.**—Vivianite. At various localities, limonite.

## MARYLAND.

**BALTIMORE CO.**—**Baltimore City**, Jones Falls gneiss quarries.—*Microcline, lepidomelane*, epidote, titanite, siderite (sphærosiderite), barite, calcite, apatite, pyrite, *chabazite* (*haydenite*), *heulandite* (*beaumontite*), *stilbite, laumontite*, harmotome (rare). In pegmatyte veins, muscovite, tourmaline, apatite, molybdenite, samarskite (?).

**Bare Hills.**—At the copper mines in hornblende gneiss, *octahedral magnetite! amphibole-anthophyllite!* bornite, chalcopyrite. At Blue Mount on Northern Central R. R., dodecahedral garnet, sillimanite, and octahedral magnetite in chlorite schist.

**Bare Hills** and **Soldier's Delight.**—In serpentine, *chromite, kämmererite, talc*, steatite, chrysotile (baltimorite), *magnesite* (crystalline and earthy).

**Texas.**—In white marble, *phlogopite, tremolite*. pyrite, pink scapolite, brown and black tourmaline, rutile, green muscovite.

**Owing's Mills, Western Run**, and **Warren Mills.**—In muscovite-gneiss, staurolite, cyanite, garnet.

**Green Spring Valley,** Shoemaker's quarry.—In quartz schist, *stretched black tourmaline!* muscovite.

**CARROLL CO.—Marriottsville.**—In marble, *white augite, changed to tremolite!* phlogopite.

Near **Union Bridge** (Mountain View lead mine).—In white limestone, galena, *anglesite, cerussite,* sulphur.

**Finksburg.**—At copper mines in hornblende gneiss, chalcopyrite, bornite, siegenite, *carrollite, remingtonite,* malachite, magnetite.

**Mineral Hill.**—*Chalcopyrite,* bornite, magnetite, gold.

**Sykesville** (Florence and Springfield mines, exhausted).—Gold on magnetite, *chalcopyrite, bornite,* pyrite, *carrollite.*

**Piney Run.**—In pyroxenyte, bronzite altering to talc, steatite.

**CECIL CO.**—Near the Pennsylvania line.—*Chromite* in serpentine.

**CHARLES CO.**—In Cretaceous clay, radiating groups of large gypsum crystals.

**FREDERICK CO.—Dolyhyde** copper mine (abandoned).—Formerly bornite, chalcopyrite, malachite, *ottrelite.*

**Liberty** copper mine.—Black, gray, and purple copper ore, chalcocite, malachite, hematite in dolomite.

**Catoctin Furnace.**—*Limonite, ocher, hematite,* and franklinite in vein quartz.

1 mile south of **Mechanicstown.**—Manganese.

**Middletown Valley.**—*Smoky quartz!* stibnite.

**HARFORD CO.—Cooptown** and **Tarrettsville.**—In serpentine, *chromite, kämmererite,* green talc, chrysotile, tourmaline.

Near **Deer Creek.**—In chlorite schist, *octahedral magnetite.*

On **Broad Creek**.—*Mottled and veined serpentine* (quarried). In metamorphic sandstone at "The Rocks" of Deer Creek, *blue cyanite! magnetite, chlorite.*

At **Pylesville.**—Graphite.

**HOWARD CO.—Ellicott City.**—Envelope titanite, allanite-epidote, parallel growths (p. 525), at the quarries on left bank of Patapsco River.

**Ilchester**.—In pegmatyte, *microcline,* garnets, black and white micas. In peridotyte, near station, pœcilitic hornblende, and *talc after hornblende.* In pyroxenyte, near Gray's Bridge, *smaragdite after pyroxene.* In porphyritic norytc, *hypersthene.* In gabbro-dioryte, "*titanomorphite,*" titanite around rutile and ilmenite.

**MONTGOMERY CO.—Etchison P. O.**—In serpentine, *chromite, chrome-tourmaline! fuchsite.* Great Falls and Sandy Spring, *gold* in vein quartz, manganese formerly mined, beryl, orthoclase, mica.

**ST. MARY'S CO.**—In Miocene clay, groups of large gypsum crystals.

**WASHINGTON CO.—Maryland Heights,** opposite Harper's Ferry.—Thuringite (owenite).

## DISTRICT OF COLUMBIA.

Near **Washington.**—Prochlorite, yellow titanite, rutile, ilmenite, calcite, gold.

## VIRGINIA.

Virginia affords some gold, both in gold gravel and in gold quartz; limonite abundantly, also hematite and magnetite; manganese (pyrolusite) in large quantities in Augusta Co., also Rockbridge and Smythe Cos., etc.; lead and zinc ores (galena, calamine, smithsonite, sphalerite) in Wythe and Pulaski Cos.; copper ores (chalcopyrite, etc.) in Floyd Co., Carroll Co., etc. Rock salt is obtained in Saltville, Smythe Co.; also salt from brines in Washington and Lee Cos.

**ALBEMARLE CO.—Faber's.**—*Galena, sphalerite,* fluorite, gold, *serpentine* or potstone, graphite.

**Ragged Mountains,** 4 miles west of Univ. of Virginia.—Quartz crystals. 6 miles west, garnet. 1 mile south of Univ. of Virginia, pseudomorphs of limonite after pyrite.

**ALLEGHANY CO.**—Limonite, hematite. The deposits also extend into Bath, Bland, Craig, Giles, and Highland Cos.

**AMELIA CO.**—Near Court House, *mica! orthoclase, albite, microlite! columbite,* allanite, helvite, *spessartite! topazolite, amethyst,* fluorite, apatite, white beryl, *monazite,* phenacite, fergusonite

**AMHERST CO.**—Along the west base of Buffalo Ridge, *copper ores*.
On N. W. slope of **Friar Mtn.**—*Allanite*, magnetite, zircon, sipylite, ilmenite.

**AUGUSTA CO.**—**Crimora.**—*Pyrolusite* (cryst.) and *psilomelane*, abundant ($\frac{19}{20}$ of product of U. S., 1890). W. foot of Blue Ridge, hematite, limonite, graphite.
1 mile E. of **Staunton.**—Pseudomorphs of limonite after pyrite. At Weyer's (or Weir's) cave, *calcite*, stalactites.

**BEDFORD CO.**—Near **Montvale.**—Bronzite, pyrite. Near the Peaks of Otter, allanite. Tscheffkinite (exact local. not given).

**BOTETOURT CO.**—Limonite, hematite, psilomelane, pyrolusite.

**BUCKINGHAM CO.**—*Gold* at Garnett and Moseley mines, also pyrite, pyrrhotite, calcite, garnet. At Eldridge mine (now Loudon and Virginia mines) and the Buckingham mines near Maysville, gold, auriferous pyrite, chalcopyrite, tennantite, *barite*, *cyanite*, *tourmaline*, *actinolite*.
**Arvon** slate quarries.—Octahedrite. Willis Mt., *cyanite*, *tourmaline*.

**CAMPBELL CO.**—Near **Lynchburg.**—Rutile.

**CARROLL** and **GRAYSON COS.**—*Chalcopyrite*, pyrite, *melaconite*, *galena*, sphalerite, pyrrhotite, magnetite, limonite.

**CULPEPPER CO.**, on Rapidan River.—Gold, pyrite.

**FAUQUIER CO.**, Barnett's mills.—Asbestus, gold mines, *barite*, *calcite*.

**FLOYD CO.**—*Pyrrhotite!* magnetite, hematite, gold.

**FLUVANNA CO.**—Gold at Stockton's mine. Also tetradymite, at "Tellurium mine." Phenix Copper Mine, *chalcopyrite*, etc.

**FRANKLIN CO.**—Grayish *serpentine*, "potstone." [This substance is not steatite (as Rogers calls it), having much iron (27 p. c. FeO) and little or no alumina; the same is true of all in this belt, Albemarle, etc.—F. P. D.] Also *bornite*, chlorite, muscovite, *pyrrhotite*, magnetite.

**GOOCHLAND CO.**—Gold mines (Moss and Busby's).

**GREENE CO.**—Malachite, pyrolusite (also in Madison Co.), native copper in felsyte, hematite.

**HALIFAX CO.**—Chalcopyrite, graphite.

**HENRICO CO.** (also Hanover, Chesterfield, Caroline, Prince William, Spottsylvania, and Stafford Cos.).—Glauconite (greensand marl).

**JEFFERSON CO.**—**Shepherdstown.**—Fluorite.

**LOUDON CO.**—*Tabular quartz*, *prase*, *pyrite*, *talc*, *chlorite*, *soapstone*, asbestus, *chromite*, *actinolite*, *quartz crystals*, *micaceous hematite*, bornite, malachite, epidote, near Leesburg (Potomac mine).

**LOUISA CO.**—Walton gold mine, gold, pyrite, chalcopyrite, argentiferous galena, siderite, sphalerite, anglesite. Boulangerite, sphalerite (at Tinder's mine). Corundum (40 m. N. of Richmond). *Pyrite* in large quantities, pyromorphite, cerargyrite.
**Tolersville.**—Pyrite.

**MONTGOMERY CO.**—Chalcopyrite, pyrite, pyrrhotite, magnetite.

**NELSON CO.**—Near **Fawbers.**—Fluorite.
Near **Lowesville.**—Allanite. 6 miles east of Lowesville, massive rutile.
Near **Arrington.**—Crystallized rutile.—Also galena, chalcopyrite, malachite, *allanite*. Isolated mass of tscheffkinite at Hat Creek.

**ORANGE CO.**—Western part, Blue Ridge, hematite. Gold at the Orange Grove and Vaucluse gold mines, worked by the "Freehold" and "Liberty" Mining Companies.

**PAGE CO.**—**Luray Cave.**—Stalactites. On Stony Man Mtn., malachite, limonite.

**PATRICK CO.**—*Magnetite, staurolite*, chloritoid, cyanite, corundum.

**PITTSYLVANIA CO.**—Barite, hematite.

**PULASKI CO.**—Hematite, limonite.

**ROANOKE CO.**—At **Bonsacks.**—Smithsonite, sphalerite.

**ROCKBRIDGE CO.**—On **Irish Creek.**—Cassiterite, wolframite, arsenopyrite (auriferous), epidote, fluorite, pyrite.

Near **Lexington.**—Pyrite, limonite pseud. after pyrite. Three m. S. W. of Lexington, barite, *dufrenite*, in bed 10 in. thick, with strengite. In Petetes Gap, zircon.

Near **Buena Vista.**—Wad, göthite. Mouth of Irish Creek, pyrolusite. In James River Gap, epidote (crystals). West of Lexington, galena, quartz crystals (in crystalline limestone) calcite. In the Blue Ridge, magnetite.

**SHENANDOAH CO.**—Near **Woodstock.**—Fluorite.

**SMYTH CO.**—Near **Marion.**—Barite.

**SPOTTSYLVANIA CO.**, 2 m. N. E. of **Chancellorsville.**—*Cyanite;* gold mines at the junction of the Rappahannock and Rapidan; on the Rappahannock (Marshall mine); Whitehall mine, affording also tetradymite.

**STAFFORD CO.**—8 or 10 m. from **Falmouth.**—Micaceous iron, gold, tetradymite, silver, galena, vivianite.

**WASHINGTON CO.**—18 m. from **Abingdon.**—Halite, *gypsum.*

**WYTHE CO.**—**Austin's Mines.**—*Cerussite, minium, plumbic ocher*, sphalerite, *calamine, galena*, graphite, aragonite.

**Bertha Mines.**—*Calamine ! !* sphalerite, hematite, limonite.

## WEST VIRGINIA.

**MASON CO.**—**Glenwood and Mason.**—Cassiterite.

**MINERAL CO.**—**Brady's**, 5 m. S. of Cumberland, Md.—In Helderberg, limestone, *blue celestite !*

There are also hematite, limonite, siderite mines; also salt wells, as in Mason Co.

## NORTH CAROLINA.*

The following is a general statement in regard to the most important economic minerals of the state: *Gold* is found in quartz veins in gneissic, granitic, and dioritic rock, also in talcose, chloritic, argillaceous, and arenaceous slates or in beds in the slates; in veins generally associated with pyrite, chalcopyrite, more rarely with galena and sphalerite, and the products of their oxidation; or in auriferous gravels. The principal counties in which it has been found in quantity are: Franklin, Nash, Granville, Alamance, Chatham, Moore, Guilford, Davidson, Randolph, Montgomery, Stanly, Union, Cabarrus, Rowan, Mecklenburgh, Lincoln, Gaston, Catawba, Caldwell, Burke, McDowell, Rutherford, Polk, Cleveland, Cherokee, Jackson, Transylvania, and Watauga.

*Iron Ores.*—Valuable deposits of *hematite* and *limonite* are found in the counties of Chatham, Orange, Gaston, Lincoln, Catawba, Caldwell, Madison, and Watauga. *Magnetite* of superior quality occurs in belts, stretching through many counties for a distance of over 20 miles in the direction

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* See the Minerals of North Carolina by F. A. Genth, Bulletin 74 of the U. S. Geol. Survey, 1891. The list here given has been condensed for this place by Dr. Genth.

of the inclosing strata from N. E. to S. W.: titaniferous ores often in parallel bands between pure magnetite. The principal counties in which they occur are: Chătham, Davidson, Guilford, Forsyth, Rockingham and Stokes, Yadkin, Davie, Lincoln and Gaston, Catawba, Swain, Madison, Mitchell, Ashe, and several others. West of the Blue Ridge many *mica* mines are worked, especially in Macon, Jackson, Haywood, Buncombe, Ashe, McDowell, Mitchell, Yancey, Alexander, Cleveland, and other counties; these mines have furnished many highly interesting minerals. Corundum is also found in the same region in connection with chrysolite rocks—which latter have furnished by their decomposition many interesting magnesian minerals. The state has also yielded large quantities of zircon, monazite, etc.

**ALEXANDER CO.—White Plains.**—Scorodite, columbite, tourmaline, beryl, rose quartz, *smoky quartz, rutile* in geniculated and acicular crystals in limonite and in quartz, *spodumene*, in emerald and yellowish green crystals (hiddenite).

**Price and Keever Place.**—Beryl, tourmaline, columbite, autunite, muscovite.

**Lead Mine.**—Amethyst.

**Hiddenite P. O.**—*Beryl!* and *emerald! monazite! spodumene* (hiddenite), green and yellowish crystals! *apatite.* calcite, *dolomite!* siderite, *rutile! muscovite!* hisingerite, tourmaline. Taylorsville, three miles distant, smoky quartz, rock crystal, tourmaline, beryl.

**Marshall's Farm.**—Garnets.

Elsewhere.—Green, brown, and black tourmaline, graphite, magnetite, tantalite, beryl (yellow, blue, green) *quartz crystals!* (highly modified), *monazite*, asbestus, pyrite, magnetite, chalcopyrite, pyrolusite, limonite pseudomorph after siderite, siderite, kaolinite, orthoclase, large crystals (one of 40 pounds), biotite, muscovite, *rutile!* very fine at Milholland's mill, *tourmaline!*

**ALLEGHANY CO.—Peach Bottom Mine.**—Pyrite, chalcopyrite, malachite, galena, cuprite, sphalerite, molybdenite.

**ASHE CO.—Ore Knob Mine.**—Pyrite, calcite, chalcocite, arsenopyrite, malachite, metallic copper.

**New River** (South Fork, near mouth).—Chrysolite, chalcopyrite, magnetite.

**Gap Creek** (Copper Knob mine).—Gold, silver, hematite, epidote, bornite, chalcocite, chalcopyrite, chrysocolla, malachite. On Gap Creek, cyanite, hornblende.

**Elk Knob.**—Chalcopyrite, epidote.

**Phœnix Mountain.**—*Rock crystal!*

**BUNCOMBE CO.—Asheville.**—Garnet, magnetite, serpentine, *barite* (granular). On Fox Branch, chrysolite. 19 to 20 miles north, pyrrhotite, magnetite, hematite, corundum with hornblende and culsageeite, serpentine, prochlorite, asbestus, actinolite, kaolin, jefferisite.

**Black Mountain.**—Almandite garnet, cyanite at Bowlen's Pyramid.

**Balsam Gap mine.**—*Allanite! beryl, muscovite,* biotite, albite, black garnet, columbite, tourmaline.

**Ivy River.**—Chrysolite, chromite, hornstone, genthite, talc, asbestus, tremolite.

**Brushy Mountain Mine.**—Muscovite, kaolinite, orthoclase, albite.

**Ream's Creek.**—Garnet, large crystals.

**Burnet Mine.**—*Muscovite, orthoclase* crystals, large (100 to 1,000 pounds).

**Swannanoa Gap.**—*Corundum* in cyanite! muscovite.

Elsewhere.—Muscovite in many mica mines with beryl, talc, columbite, garnet, ilmenite.

**BURKE CO.—Brindletown.**—At Mills's and other placer gold mines, crystallized *gold*, tetradymite, montanite, *brookite. octahedrite. rutile, zircon* and *malacon*, cyrtolite, *monazite, xenotime*, sometimes in crystals an inch across, and rarely of a sage- to grass-green color, samarskite, columbite, fergusonite, hydrofergusonite, ilmenite, hematite, magnetite, chromite, limonite, pyrite, titanite, cyanite, fibrolite, corundum, muscovite, vermiculite, enstatite, hornblende (green and black) steatite, tourmaline (green and black) orthoclase, albite, zoisite (?), garnet, actinolite, beryl, talc, asbestus, quartz (clear, smoky, and amethystine) psilomelane, arsenopyrite (?), allanite, thorite, diamond.

**Bear's Knob.**—Corundum with muscovite, 4 miles southeast.

**Linnville Mountain.**—Ilmenite, hematite, *itacolumyte!* radiated pyrophyllite, limonite, graphite.

**Shoup's Ford.**—Beryl, garnet, corundum, in part altered to fibrolite gold, magnetite, ilmenite, cyanite, tourmaline.

**South Mountains.**—*Quartz crystals!* inclosing liquid, *garnet!* beryl! yellowish green and deep green (aquamarine), *tourmaline!* serpentine, talc, chlorite, actinolite, hematite, magnetite, asbestus, magnesite, breunnerite, chrysolite, garnet, tremolite, corundum, arsenopyrite.

**Sugar Mountains.**—Quartz crystals, asbestus, gold, rutile, magnetite, beryl.

**CABARRUS CO.**—Gold in many veins and placers, sulphur, chalcopyrite, magnetite, limonite.

**Daniel Barnhardt's Farm.**—Barnhardtite.

**Barringer's Mine.**—Gold, arsenopyrite in calcite.

**Boger's Mine.**—*Tetradymite*, chalcopyrite, azurite.

**Cosby's Mine.**—Wolframite, *scheelite*, cuproscheelite, siderite, barite.

**Cullen's Mine.**—*Tetradymite*, *cuprite* (cubes), pseudomalachite, *scheelite*, *malachite*, in part pseudomorphous after cuprite, azurite.

**Flowe's Mine.**—*Wolframite! scheelite*, barite.

**George Ludwick's Mine.**—Gold, *arsenopyrite*, *tetrahedrite*, *scorodite*, pyrite, chalcopyrite.

**McMakin's Mine.**—Silver, argentite, galena, sphalerite, proustite(?), tetrahedrite, var. *freibergite!* pyrolusite, pyromorphite, barite, goslarite, rhodochrosite, magnesite, calcite, wad, barite, talc.

**Phœnix Mine.**—Gold, *tetradymite*. In Orchard vein, barite, pyrite, chalcopyrite. Numerous mines of gold and copper ores.

**CALDWELL CO.**—**Baker's Mine.**—Galena, serpentine, picrolite, *chrysotile*, chrysolite, pyromorphite, anglesite, cerussite, asbestus, marmolite, psilomelane, chromite.

Elsewhere.—Gold, in placers and veins, chalcopyrite, mouth of Rocky River, amethyst, kaolin, halloysite.

**CATAWBA CO.**—Many valuable magnetite deposits.

**Hickory.**—Graphite, crystallized, *pyrite*, alunogen, wad, amphibole, hematite, pyrolusite, limonite, quartz crystals, *amethyst*, *garnet*, muscovite, pyrrhotite, magnetite, chalcopyrite.

Elsewhere.—Gold, in placers and veins, graphite, *rutile* in acicular crystals in amethyst, *rock crystal*, quartz crystals inclosing liquid, *beryl! garnet!* cyanite, kaolinite, alunogen, wad, beryl.

**CHATHAM CO.**—Many deposits of magnetite, hematite and limonite, and black band and ball ore.

**Buckhorn.**—Rutile in quartz, manganese garnet.

**Carbonton.**—*Pyrophyllite* slate.

**Clegg's Mine.**—Galena, bornite, chalcopyrite, pyrite in cubo-octahedrons, cuprite, chrysocolla, *pseudomalachite*, *cerussite*, *malachite*, fibrous and earthy, azurite, anthracite, calcite, galena, prochlorite (?).

**Deep River.**—*Pyrophyllite* slate.

**Egypt.**—Siderite (black band and ball ore), *dufrenite*.

**Evans's Mine.**—Hematite, chloritoid in pyrophyllite slate.

**Farmville and Gulf.**—*Siderite* (black band and ball ore).

**CHEROKEE CO.**—**Marble Creek.**—Tremolite, talc, calcite (granular), white, pink, gray!

**Murphy.**—Galena, pyrolusite, *limonite*, wad, tremolite, *talc*, cerussite, gold, galena (argentiferous).

**Nantehaleh River.**—Niter in slates, *calcite*, granular, white, and pink, talc, massive white.

**Parker Mine.**—*Staurolite!* gold, garnet.

**Valley River.**—Hematite, phlogopite, talc, calcite (granular), dolomite, gold in placers, staurolite, corundum in cyanite.

**Valleytown.**—Rutile.

Elsewhere.—*Staurolite*, pseudomorphs of muscovite after staurolite.

**CLAY CO.**—**Cullakenee Mine, Buck Creek.**—*Corundum!* white, gray, pink, and ruby, frequently altered into other minerals, *spinel*, *chromite*, drusy quartz, black hornblende or arfvedsonite, smaragdite, *chrysolite*, *zoisite*, *andesine*, *labradorite*, *orthoclase*, tourmaline, serpentine, massive and variety *picrolite*, willcoxite, *margarite!* talc, albite, cyanite, enstatite, augite (?) prochlorite.

**Shooting Creek.**—*Corundum*, pseudomorphous quartz after feldspar(?), actinolite, chrysolite, talc, prochlorite, willcoxite, margarite, rock crystal, magnetite, cyanite, muscovite, gold in placers, rutile in black crystals, garnet, pyrite, chalcopyrite, micaceous hematite, limonite, prochlorite (?).

**Tusquittah Creek.**—Gold in placers and veins, staurolite, rutile.

**Tipton's.**—Corundum, cyanite (green), muscovite.

**CLEVELAND CO.**—**Whiteside Mine.**—Gold in placers.

**Mountain Mine.**—*Rock crystal*, *tourmaline*, garnets, gold in placers, graphite, arsenopyrite, galena, *muscovite*, melanterite, alunogen, pyrite, abundant in gneiss and mica schists, tourmaline.

**Shelby.**—Within a few miles, muscovite in large plates, magnetite, actinolite, tourmaline.

**Double Shoals.**—Arsenopyrite.

**DAVIDSON CO.—David Beck's Mine.**—*Tetradymite, montanite.*

**Conrad Hill.**—Chalcopyrite, hematite, limonite, siderite, malachite, barite.

**Allen Mine.**—Gold, pyrite, chalcopyrite, arsenopyrite, tetradymite.

**Silver Hill.**—*Silver!* argentite, highly argentiferous *galena, sphalerite,* chalcocite, pyrite, chalcopyrite, cuprite, melaconite, zoisite (?), *orthoclase,* calamine, *pyromorphite!* (green, yellow, brown, black, and colorless) *wavellite, stolzite, anglesite,* goslarite, *chalcanthite,* calcite, *cerussite!* in fine crystals, massive and in pseudomorphs after pyrite, malachite.

**Silver Valley.**—Galena, sphalerite, pyromorphite.

**Uwharie River.**—Sphalerite.

**Russell Mine.**—Gold, pyrite.

**Ward's Mine.**—Gold, electrum, pyrite, chalcopyrite.

**FORSYTH CO.**—Large beds of magnetite and titaniferous magnetite.

Near **Salem.**—Magnetite, manganese garnet, halloysite, hematite, micaceous hematite, graphite, emery variety of corundum, wad, halloysite.

Near **Kernersville.**—Bronzite, chrysolite, tourmaline, magnetite, hematite, chlorite, pyrite.

**FRANKLIN CO.—Portis Mines.**—*Gold* in placers, *diamond.*

**GASTON CO.—Asbury's Mine.**—Silver, tetradymite, galena, pyrrhotite, pyrite, leucopyrite, auriferous arsenopyrite, bismite, scorodite, montanite (?), cerussite, *bismutite.*

**Cansler and Shuford Mine.**—Gold ! galena.

**Clubb's Mountain.**—*Corundum,* red and blue ! *rutile!* tourmaline, *cyanite! pyrophyllite!* muscovite ! *lazulite !* talc, quartz crystals.

**Clear Mountain.**—Lazulite.

**Crowder's Mountain.**—*Corundum,* red and blue ! *rutile!* gold, ilmenite, *cyanite, pyrophyllite! muscovite, lazulite!* barite, with galena (argentiferous), tourmaline, pyrite, chalcopyrite, manganese garnet, pyromorphite.

**King's Mountain.**—Gold, galena, altaite, chalcopyrite, sphalerite, tetrahedrite, nagyagite, magnetite, bismite, calcite, dolomite, pyrrhotite, chalcopyrite, limonite, barite, pyrite, graphite, cassiterite.

**Long Creek Mine.**—Niccoliferous *psilomelane,* gold, pyrite, fluorite, sphalerite, arsenopyrite, galena.

**White's Mills.**—Epidote, biotite, orthoclase ! pycnite, titanite.

**All-Healing Springs.**—Barite.

**GRANVILLE CO.—Bowling's Mountain.**—Radiated pyrophyllite.

**Sassafras Fork.**—Gold, pyrite, (a few miles north) malachite, tourmaline, quartz crystals, agate.

Near **Shiloh Church.**—Epidote, labradorite, calcite.

Elsewhere.—Stibnite, in the northern part of the county, on land of N. A. Gregory.

**GUILFORD CO.**—Numerous gold veins with associated copper ores.

**Friendship.**—Granular corundum (emery), titaniferous magnetite.

**McCulloh Mine.**—Copper, *cuprite* in acicular crystals, pyrite, chalcopyrite, siderite, malachite.

**North Carolina (Fentress) Mine.**—*Cuprite* in acicular crystals, pyrite, chalcopyrite, siderite, malachite.

**Phœnix Mine.**—Chalcopyrite, covellite.

**HAYWOOD CO.—Presley Mine.**—Corundum, blue and gray, altered into muscovite and albite; the muscovite in large crystals, also cryptocrystalline and compact.

**HENDERSON CO.—Coleman's Station.**—Zircon, phlogopite, jefferisite.

**Green River.**—On south side of Blue Ridge, at Freeman's, *zircon,* granular calcite. At Jones's mine, xanthitane, allanite, titaniferous garnet; also stilbite, orthoclase, epidote, titanite in granite, auerlite. On Price's farm, *zircon,* auerlite, staurolite. On the Davis land, *polycrase, zircon, monazite, xenotime,* cyrtolite, magnetite, apatite.

**IREDELL CO.—Belt's Bridge.**—Pyrite in soapstone, *corundum* in globular masses, partly altered into muscovite, etc. Corundum in hexagonal crystals ! partly altered into soda-margarite at Hendrick's farm.

**Dr. Halyburton's.**—Leucopyrite, scorodite.

**King's Mill.**—*Graphite,* hematite in hexagonal plates in quartz, *rutile!* in quartz, *rock crystal,* chalcedony, *tourmaline.*

**Mount Pisgah.**—*Rutilated quartz,* chloritic mineral resembling thuringite.

**Spring Mountain.**—*Graphite.*

**Statesville.**—Near Statesville, titanite in gneiss, *quartz crystals*, allanite, *corundum* rarely altered into *cyanite, orthoclase, cyanite, muscovite*, göthite in thin scales, in light red feldspar (sunstone), titanite.

**Bethany Church.**—Allanite, with small crystals of zircon.

**Hunting Creek.**—Albite, blue corundum altered into rhätizite. Near Campbell's Mill, large boulders of cyanite inclosing crystals of blue corundum.

**JACKSON CO.**—**Casher's Valley.**—Bismutite, talc, muscovite, amethyst, rock crystal, gold, pyrite, chalcopyrite.

**Cullowhee Mine.**—Chalcocite, pyrite, melaconite, chalcopyrite ! hornblende, malachite.

**Hogback Mine.**—*Corundum*, rutile in corundum, chromite, drusy quartz, *chrysolite, andesine*, tourmaline, *muscovite*, dudleyite, *margarite*.

**Savannah Mine.**—Chalcopyrite, hornblende, tourmaline, malachite.

**Waryhut Mine.**—Chalcocite, chalcopyrite, cuprite, malachite.

**Webster.**—Corundum, chromite, pyrolusite, wad, chalcedony, drusy quartz, *enstatite, tremolite, actinolite*, asbestus, *chrysolite, talc*, serpentine, marmolite, deweylite, genthite, *penninite*, magnesite ! crystalline and earthy, magnetite, kaolin, kämmererite.

**Wolf Creek Mine.**—Chalcocite, native copper, chrysocolla, chalcopyrite, malachite.

**Ainslie's.**—Chrysolite, chromite, talc, chlorite, enstatite, smaragdite (?), asbestus, tremolite, garnet, actinolite, albite.

**Scott's Creek.**—Chrysolite, chromite, talc, penninite (var. kämmererite), enstatite, chlorite, corundum (blue and pink).

**LINCOLN CO.**—**Cottage Home.**—Diamond ! gold, chalcopyrite.

**Randleman's.**—Quartz crystals, amethyst !

**MACON CO.**—**Culsagee Mine or Corundum Hill.**—*Corundum !* in beautiful varieties crystallized and massive, and frequently in part altered into other minerals; also *chromite, spinel* in crystals and granular, *rutile* rare, diaspore, one specimen only known, drusy quartz and quartz crystals, chalcedony, hyalite, *enstatite*, tremolite, *chrysolite*, oligoclase, *tourmaline*, talc, *serpentine*, deweylite, genthite, culsageeite, lucasite, kerrite, maconite, penninite, prochlorite, willcoxite, margarite, *anthophyllite*, actinolite, magnetite.

**Highlands.**—Bismutite, beryl, gold, rose quartz.

**Jacob's Mine.**—Corundum, asbestus, tremolite, chrysolite.

**Nantehaleh River.**—Asbestus, talc, compact limestone, niter. At mouth of river, orthoclase.

**Tennessee River**, below Franklin.—Garnet, staurolite, cyanite, muscovite, columbite.

**Tibbet's Mine.**—Pleonaste, zircon.

**West's Mine.**—Ruby corundum with cyanite.

**Ellijay Creek.**—Near Higdon's, corundum, chlorite, asbestus, chromite, magnetite; hematite, garnet, chrysolite.

**MADISON CO.**—**Mars Hill.**—Monazite in large masses, zircon.

**Carter's Mine.**—*Corundum !* in peculiar white and pink varieties, *spinel*, chromite, tremolite, chrysolite, *andesine, prochlorite*, culsageeite, ilmenite, beryl !

**French Broad River.**—Orthoclase.

Near **Marshall.**—Rutile, limonite, *magnetite*, galena, bornite, chalcopyrite, epidote, talc, fluorite, hematite, *corundum*. 3 miles below Marshall, *prochlorite*, margarite, barite, smoky quartz, in doubly terminated crystals.

**Haynie Mine.**—Blue corundum, rutile, margarite, green crystals of hornblende, magnetite, chlorite, ilmenite.

**M'DOWELL CO.**—**Kirksey's Mine.**—Tetradymite.

**In the gold placers.**—Gold, corundum, ilmenite, rutile, chromite, brookite, pyrope, *zircon*, epidote, sillimanite, *xenotime, monazite*, diamond, octahedrite.

**MECKLENBURG CO.**—Numerous gold veins, associated with copper ores, pyrite, etc.

**Beattie's Ford.**—Rutile ! in acicular crystals.

**Davidson College.**—Radiated cyanite, pyrophyllite, gold. 7 miles south, fine crystals of rutile.

**McGinn Mine.**—Gold, pyrite, chalcopyrite, barnhardtite, cuprite in acicular crystals, melaconite, *pseudomalachite*.

**Todd's Branch.**—Gold, *diamond, zircon*, garnet, *monazite*.

**Tuckasegee Ford.**—Epidote, labradorite near Tuckasegee Ford.

**MITCHELL CO.**—**Bakersville.**—*Muscovite*, chalcopyrite, pyrite, pyrophyllite, chromite ! quartz crystals, chalcedony, enstatite, tremolite, actinolite, chrysolite, talc, rutile penetrating corundum, serpentine, deweylite, penninite, magnesite, asbestus, At Hawk Mine, oligoclase ! On Yellow Mountain, cyanite !

**Buchanan Mine.**—Gummite, yttrogummite (?), asbestus, beryl, *allanite, muscovite, albite, phosphuranylite*, cyanite, graphite, manganese garnet, black garnet, magnetite, limonite, apatite, orthoclase.

**Cane Creek.**—*Ilmenite!* actinolite, talc, asbestus, (near head) graphite, rutile, garnet, samarskite.

**Cranberry.**—*Magnetite*, pyroxene, epidote, picrolite, hematite, orthoclase.

**Plum Tree Creek.**—Corundum crystals, hyalite.

Near **White Plains.**—Gummite with uraninite in a mica mine.

**Deake Mine.**—Quartz, flattened out between muscovite, *muscovite! columbite!* gummite, albite, gahnite, monazite

**Flat Rock.**—*Ilmenite, uraninite, gummite*, zircon, garnet, epidote, zoisite, var. *thulite, muscovite, albite, orthoclase, uranotil, phosphuranylite*, autunite!

**Grassy Creek.**—*Samarskite, ilmenite*, kaolinite, beryl, large muscovite, autunite, hyalite, columbite, montmorillonite.

**Green's Mine.**—Fergusonite.

**Point Pizzle.**—*Albite, apatite*, pyrophyllite, actinolite, beryl, garnet, manganese garnet, muscovite.

**Unaka Mountains.**—*Magnetite, zircon*, epidote, hematite.

**Wiseman Mine.**—*Muscovite!* kaolinite, *hatchettolite, columbite, samarskite!* altered samarskite, rogersite, cyrtolite, epidote, garnet.

**North Toe River.**—Orthoclase, muscovite, chrysolite, talc, chrysotile, prochlorite, wad, garnet, serpentine, kaolin, chalcedony.

**Young's.**—On South Toe River, serpentine, garnet, talc, chrysolite, prochlorite, tremolite, pyrite.

MONTGOMERY CO.—**Cottonstone Mountain.**—*Pyrophyllite!*

**Crump Mine.**—*Gold* in placers.

**Steele Mine.**—*Gold!* galena, sphalerite, chalcopyrite, albite, prochlorite, calcite.

**Swift Island Mine.**—*Gold!* in fine crystals.

MOORE CO.—**Cheek Mine.**—Chalcopyrite, malachite, azurite, galena, red jasper, epidote, talc, calcite, argentite, pyroxene, limonite.

**Soapstone Quarry.**—Slaty pyrophyllite! pseudomalachite.

ORANGE CO.—**Hillsboro.**—Pyrite in cubes, wad, limonite, hematite, *pyrophyllite*, chlorite in fine scales, epidote, *barite*. At Latta Mine, braunite (?).

PERSON CO.—**Barnett Mountain.**—*White cyanite.*

**Dillahay's Mine.**—Gold, radiated quartz.

**Gillis Mine.**—Chalcocite, pyrite, covellite, micaceous hematite, chrysocolla, cuprite, malachite, calcite, garnet, quartz, epidote.

**Leasburg.**—Tourmaline, albite (?).

POLK CO.—Numerous placer mines, with the usual associated minerals.

RANDOLPH CO.—Gold in beds and placers in numerous places.

Near **Ashboro.**—Pyrophyllite.

**Franklinsville.**—Five to seven miles west-northwest, leucopyrite.

**Pilot Klob.**—*Pyrophyllite*, gold in placers, acicular rutile in quartz.

ROCKINGHAM CO.—**Madison.**—Chalcopyrite at W. Lindsay's, manganese garnet.

**Leaksville.**—Semi-bituminous coal.

ROWAN CO.—**Gold Hill.**—*Gold*, bismuthinite, pyrite, chalcopyrite, *arsenopyrite* at Honeycutt's, magnetite.

**Salisbury.**—Orthoclase!

RUTHERFORD CO.—**Brindletown Creek.**—Diamond!

**Rutherfordton.**—Quartz, pseudomorphous after calcite!

**Shemwell Mine.**—Arborescent gold!

**Twitty's Mine.**—*Diamond.*

**At the gold placers generally.**—Gold, corundum in grains and crystals, ilmenite, rutile, chromite, brookite, garnet, *zircon!* epidote, samarskite, *xenotime!* monazite, fergusonite, octahedrite, fibrolite.

STANLEY CO.—Gold in veins and placers.

STOKES CO.—**Bolejack's Quarry.**—*Calcite*, phlogopite, actinolite.

**Coffee Gap.**—*Lazulite* with muscovite in quartz.

**Danbury.**—*Magnetite*, pyrolusite, cyanite, actinolite. At Roger's ore bank, titanite, sulphur !

**Dan River.**—Opalescent quartz, anthracite and bituminous coal, prochlorite, hematite, magnetite.

**Germanton.**—*Fossil wood.* 2 miles east, serpentine, calcite, garnet.

**Peter's Creek.**—*Sulphur.*

**Sauratown Mountain.**—*Itacolumyte*, asbestus.

**Snow Creek.**—Phlogopite, granular calcite, agate, amethyst, hyalite, jasper, hematite, albite, pyrolusite.

**Stokesburg.**—Rock crystal, anthracite and bituminous coal.

SURRY CO.—Magnetic iron-ore beds at numerous localities.

**Dobson.**—Pyrolusite, talc in green crystals, serpentine, steatite, actinolite, breunnerite, magnesite, magnetite, chlorite, wad. Near Dobson, magnetite in prochlorite.

**Ararat River.**—Pyrite ! magnetite ! garnet, white cyanite !

**Chestnut Mountain.**—Octahedral magnetite !

**Pilot Mountain.**—Talc !

SWAIN CO.—**Bryson City.**—Rutile, zoisite, limonite after pyrite.

**Oconaluftee River.**—Gold, galena (argentiferous), pyrite, chalcopyrite.

**A Nichols's.**—Pyrolusite, chalcocite, tourmaline.

**Quallatown.**—Gold in placers.

TRANSYLVANIA CO.—**Boyston River.**—Gold in placers, granular calcite, limonite.

**Brevard.**—Chlorite, graphite, limonite after pyrite, kaolin.

Elsewhere.—Pyrite, chalcopyrite, rose quartz, pyrrhotite, tourmaline, graphite. Near mouth of Looking-glass Creek, kaolin.

UNION CO.—Gold in numerous veins and beds mostly associated with galena and sphalerite.

**Pewter Mine.**—Electrum.

**Stewart Mine.**—*Gold, electrum*, galena, sphalerite, pyrite, arsenopyrite, pyromorphite.

**Walkup's Mine.**—Barite !, granular.

WAKE CO.—**Northwest corner of county**—Serpentine, asbestus, actinolite, steatite, cyanite.

**Raleigh.**—*Ilmenite*, graphite, smoky quartz.

Graphite ! at Tucker's Mill.

WATAUGA CO.—**Beech Mountain.**—Fine-grained *galena*, pyrite, magnetite, hematite. At Pogie, galena.

**Cooke's Gap.**—Arsenopyrite, *hematite, magnetite*, itacolumyte, limonite, martite.

**Rich Mountain.**—Head of Cove Creek, chromite, quartz crystals, actinolite, chrysolite, epidote, penninite, tremolite.

**Elk Knob.**—Pyrite, chalcopyrite, pyrrhotite, epidote, limonite, garnet.

**Flannery Mine.**—Argentiferous galena.

**Boone Fork.**—Quartz crystals (fine).

Elsewhere.—Gold in placers, galena, fluorite, epidote, limonite, magnetite, cyanite, talc, chromite, chlorite, ilmenite, asbestus.

WILKES CO.—**Brushy Mountains.**—Asbestus.

**Elk Creek.**—Galena, cerussite.

**Flint Knob.**—Galena (argentiferous), pyrite.

**Elkin Creek.**—Barite, limonite, galena, cerussite.

**Honey Creek.**—*Rutile* in acicular crystals in brownish amethyst.

**Trap Hill Mine.**—Galena, pyrrhotite, chalcopyrite (auriferous), pyrite, rutile, garnet, tourmaline, magnetite.

Elsewhere.—Graphite, *corundum* mostly altered into cyanite, pyrite, *cyanite*, mixture of muscovite, margarite, etc., resulting from the alteration of cyanite.

YADKIN CO.—**Near Yadkinville.**—Gold.

**Hobson's Mine.**—Magnetite, tremolite, *magnetite*. At East Bend and elsewhere.

**Jonesville.**—Pyrite in cubes in slate, chalcopyrite.

YANCEY CO.—**Grassy Knob (Black Mountains).**—Cyanite, muscovite.

**Black Mountain.**—Graphite.

**Bald Mountain.**—Grayish green actinolite, magnetite.

**Hampton's, Mining Creek.**—*Chromite*, chalcedony, enstatite, *tremolite*, actinolite, asbestus, *chrysolite*, orthoclase, *talc*, serpentine, deweylite, penninite, magnesite, *epidote* in fine green crystals, bronzite, hornblende, prochlorite (?).

**Hurricane Mountain.**—*Cyanite*, titanite, muscovite.

**Ray's Mica Mine.**—*Fluorite*, pseudomorphous after apatite, yttrocerite (?), *beryl*, garnet, zircon, rutile, *muscovite*, also a scaly pink variety, orthoclase, *tourmaline*, black and yellowish green; kaolinite, columbite, apatite, monazite, autunite, amazon stone, cyanite, albite, smoky quartz, quartz crystals, actinolite, talc, glassy feldspar.

**South Toe River.**—Muscovite, garnet, hyalite, gummite, autunite, garnet.

**Proffit's.**—Corundum, muscovite, asbestus, garnet, penninite (?). talc, chrysotile, fibrous talc.

**Young's Mine.**—Chlorite, serpentine, chrysolite, chromite, talc, asbestus, tremolite, pyrite, manganese garnet and garnet crystals, bronzite, tourmaline, muscovite.

**Presnell (Young's) Mine.**—Muscovite, albite, apatite, autunite.

**Gibb's Mine.**—Muscovite, albite, garnet, glassy feldspar.

**Guggenheim's Mine.**—Muscovite, albite, manganese garnet, apatite, hyalite, tourmaline, autunite.

## SOUTH CAROLINA.

The chief economic minerals of South Carolina are gold and calcium phosphate. The gold belt extends from the N. Carolina border southwest across the counties York, Lancaster, Chesterfield (incl. the Brewer mine), Kershaw, Fairfield, Union, Spartanburgh, Greenville, Pickens, Abbeville; there are also auriferous gravels, chiefly in York, Union, and Spartanburgh Cos. (Min. Res. U. S.). The phosphatic deposits are in Charleston, Berkeley, Colleton, and Beaufort Cos., as noted on p. 769.

ABBEVILLE CO.—**Oakland Grove.**—*Gold* (Dorn mine), galena, pyromorphite, amethyst, garnet.

ANDERSON CO.—Near **Storeville.**—*Zircon!* red, brown, gray, and black, in the surface-soil. Most abundant at Thompson's and at Strickland's. Also columbite, fergusonite, magnetite, and ilmenite. *Corundum* in crystals and massive, in the soil and in place, at Thompson's and elsewhere in the vicinity. *Muscovite*. with some columbite, at Wharton's, near the Savannah River. Garnet (spessartite) at Island Ford, Rocky River. (Note.—Three hundred pounds of zircons—some of over 2 oz.—were gathered *by hand*, in about two weeks, from the region about Storeville, in 1888.—Hidden.)

**Pendleton.**—*Actinolite*, galena, kaolin, *tourmaline*, *zircon*.

**Cheowee Valley.**—Galena, tourmaline, gold.

CHESTERFIELD CO.—Gold (Brewer's mine), talc, chlorite, pyrophyllite, pyrite, native bismuth, bismuth carbonate, red and yellow ocher, whetstone, enargite.

GREENVILLE CO.—Near **Marietta**, *polycrase!* (pure black and a yellow hydrated variety), *uraninite* (nivenite), *allanite*. On **Gap Creek**, on Baynes' land, pyromorphite and cerussite) (argentiferous); on Tankersly's land, titanite, zircon, and corundum. Near **Tigersville**, zircon (pyramidal) in surface-soil.

Also galena, kaolin, chalcedony in buhrstone, beryl, graphite, epidote, *tourmaline*.

KERSHAW CO.—*Rutile*.

LANCASTER CO.—Gold (Hale's mine), talc, chlorite, cyanite, itacolumyte, pyrite. Gold at Blackman's mine, Massey's mine, Ezell's mine.

LAURENS CO.—Corundum, damourite.

NEWBERRY CO.—Leadhillite.

PICKENS CO.—Gold, manganese ores, kaolin.

RICHLAND CO.—Chiastolite, novaculite.

SPARTANBURGH CO.—*Magnetite*, chalcedony, *hematite*. At the Cowpens, limonite, *graphite*, limestone, copperas. Morgan mine, leadhillite, pyromorphite, cerussite.

UNION CO.—Fairforest gold-mines, pyrite, chalcopyrite.

YORK CO.—Gold at Magnolia mine; whetstones, witherite, barite, tetradymite.

## GEORGIA.

Gold is present over a considerable portion of the state, particularly the northern part; it is mined both in quartz veins and as placer deposits, thus in Barton, Lumpkin, Rabun Cos.; also in Lincoln, Wilkes Cos., etc. (cf. p. 18). Hematite is also mined, as in Dade, Cherokee, and other northern counties; also limonite in Polk, Floyd Cos., etc.; pyrolusite at Cartersville, Bartow Co. There are also phosphatic deposits. The corundum belt extends across N. and S. Carolina to the northern part of this state as noted on p. 213.

**BARTOW CO.—Cartersville, Stegall, Allatoona**, barite **Cartersville** graphite, *pyrolusite* (mined). **Stegall Station**, graphite.

**BURKE and SCRIVEN COS.**—Hyalite.

**CHEROKEE CO.**—At **Canton Mine**, chalcopyrite, galena, clausthalite, plumbogummite, hitchcockite, *arsenopyrite*, lanthanite, *harrisite*, *cantonite*, pyromorphite, automolite, zinc, staurolite, cyanite. Ball-Ground, spodumene. Mines of hematite.

**CLARK CO.—Clarksville.**—Gold, *xenotime*, zircon, rutile, cyanite, hematite, garnet, quartz.

**FANNIN CO.**—*Staurolite!* chalcopyrite.

**HABERSHAM CO.**—*Gold*, pyrite, chalcopyrite, *galena*, *amphibole*, garnet, quartz, kaolinite, soapstone, chlorite, *rutile*, iron ores, tourmaline, staurolite, zircon.

**HALL CO.**—*Gold*, quartz, kaolin, diamond. **Gainesville**, corundum, margarite, etc.

**HEARD CO.**—*Molybdenite*, quartz.

**LEE CO.**—At the Chewacla Lime Quarry, dolomite, barite, *quartz crystals*.

**LINCOLN CO.**—*Lazulite! rutile!* hematite, cyanite, ilmenite, *pyrophyllite*, gold.

**LUMPKIN CO.**—At Field's gold-mine, near **Dahlonega**, *gold*, *tetradymite*, pyrrhotite, chlorite, ilmenite, allanite, apatite.

**PAULDING CO.—Dallas**, pyrite.

**POLK CO.**—Various limonite mines.

**RABUN CO.**—Gold. *chalcopyrite*, *muscovite*, *beryl*, *corundum*.

**SPAULDING CO.**—Tetradymite.

**TOWNS CO.—Hiawassee.**—*Corundum*, pink, millerite, genthite.

**WASHINGTON CO.**—Near **Saundersville**, *wavellite*, *fire-opal*.

**WHITE CO.—Racoochee Valley**, diamond.

## FLORIDA.

The phosphatic deposits, which have come into prominence since 1886, are noted on p. 769; cf. also Wyatt's work mentioned on p. 1027.

Near **Tampa Bay.**—Limestone, sulphur springs, chalcedony, agate, *silicified shells and corals*.

## ALABAMA.

Hematite is extensively mined in the northern half of the state; this industry is of recent development and has gained great importance; the center is at Birmingham, Jefferson Co. (cf. p. 216). There are, further, limonite deposits, as in Cherokee, Etowah Cos., etc. Gold also occurs in quartz veins and gravels as in the adjoining states, thus in Talladego, Clay Cos., etc.

**BIBB CO.—Centreville.**—*Iron ores*, marble, *barite*, coal, cobalt.

**CHAMBERS CO.**—Near **La Fayette**, *steatite*, garnets, actinolite, *chlorite*. East of **Oak Bowery**, steatite.

**CHILTON CO.**—*Muscovite*, graphite, limonite, rutile.

**CLEBURNE CO.**—At **Arbacoochee Mine**, gold, pyrite, and three miles distant, cyanite. garnets. At **Wood's Mine**, *black copper*, azurite, *chalcopyrite*, pyrite.

**CLAY CO.**—*Steatite*, magnetite. Near Delta and Ashland, *muscovite;* southeast of Ashland, cassiterite.

**COOSA CO.**—Tantalite, gold, muscovite, cassiterite, rutile, mica. Near **Bradford**, zircon, *corundum*, *asbestus*. Near **Rockford**, *tantalite*.

**JEFFERSON CO.—Birmingham.**—*Hematite* mines.

**RANDOLPH CO.**—Gold, pyrite, tourmaline, muscovite. At **Louina**, *porcelain clay*, garnet.

**TALLADEGA CO.**—*Limonite*.

**TALLAPOOSA CO.—Dudleyville.**—*Corundum*, margarite, ripidolite, spinel, tourmaline. actinolite, *steatite*, *asbestus*, chrysolite, damourite, corundum altered to tourmaline (containing a nucleus of corundum), dudleyite.

**TUSCALOOSA CO.**—Galena, pyrite, vivianite, limonite, calcite, dolomite, cyanite, steatite, quartz crystals, manganese ores.

## LOUISIANA.

Rock salt (halite) is mined at Petite Anse Is., Saint Mary's parish, 4 miles west of Vermillion Bay. The deposit, of Tertiary age, is of considerable extent and is still productive (cf. p. 155). Gypsum is mined in Calcasieu parish near Lake Charles; there is also here a bed of native sulphur.

## TEXAS.

**BURNET CO.**—Calcite rhombohedrons in Bat Cave on D. G. Sherrard's land on **Spring Creek**; lithographic limestone in ledges on Wood's land and elsewhere in the neighborhood; *vesuvianite, hessonite,* near **Clear Creek.** "Balls" of iron-ore in road, on the route to **Llano C. H.** near Colorado River; epidote, at Dupre's. Crystals of quartz, orthoclase, pyrite, and epidote, occasionally, at "**Capitol Rock.**"

**Beaver Creek Distr.**, galena.
Also sparingly cassiterite.

**CASS CO.**, also **MARION CO.**, and elsewhere in eastern Texas.—Iron ores, chiefly limonite.

**EDWARDS CO.**—Native sulphur.

**EL PASO CO.**, etc.—In the Trans Pecos region, gold, native silver, cerargyrite, and other silver ores, native copper, chalcopyrite, chalcocite, galena, zinc ores, wulfenite, etc.; also cuprodescloizite (Clarke).

**GILLESPIE CO.**—Magnetite, hematite; further, garnet, beryl.

**LAMPASAS CO.**—**Lampasas.**—Celestite crystals, sometimes of gigantic size.

**LLANO CO.**—Near **Bluffton** (5 m. south).—At Barringer's mine, *gadolinite! yttrialite, rowlandite, fergusonite* (several varieties), and *allanite,* all in large masses, rarely as crystals; also *thorogummite, nivenite,* gummite, molybdenite, molybdite, cyrtolite, fluorite, tengerite (?), *orthoclase* in large crystals, magnetite, martite, and rarely quartz crystals in open pockets. At Hiram Castner's, 1 m. S., *gadolinite,* fergusonite, and cyrtolite, in a coarse granitic vein. Also huge orthoclase crystals.

**Babyhead Distr.**—At the Mexican Diggings, galena, chalcopyrite, tetrahedrite,
Also azurite, malachite; further, gold, magnetite, hematite, limonite, cassiterite.

**MASON CO.**—Iron ores, manganese ores (Spiller mine, south of Fly Gap), galena, cassiterite.

**MITCHELL CO.**—Rock salt near Colorado City at a depth of 850 ft.

**TOM GREEN CO.**—Native sulphur.

**TRAVIS CO.**—Celestite at Mount Bonnel, near Austin.

## ARKANSAS.*

**HOT SPRING and GARLAND COS.**—In the elæolite-syenite and related rocks of **Magnet Cove**, near Hot Springs, *elæolite,* biotite, orthoclase, *garnet, schorlomite,* pyroxene, *ægirite! eudialyte!* (eucolite), titanite, astrophyllite, ilmenite, magnetite (incl. lodestone), microcline, apatite, ozarkite (thomsonite); cancrinite (secondary), fluorite, wollastonite, natrolite, apophyllite, manganopectolite, brucite. Also in leucitic dike rocks, *pseudo-leucite* (leucite altered to sanidine, etc. p. 426), elæolite, pyroxene, ægirite, melanite, titanite. Further as a result of contact metamorphism, in sandstone and novaculyte, *quartz crystals!* in the Crystal Mts., also *brookite!* (arkansite, in part alt. to rutile), *rutile!*; in calcite, *perovskite!* (dysanalyte), hydrotitanite, *monticellite!* apatite, *vesuvianite,* phlogopite. Also wavellite, thuringite.

At the Potash Sulphur Springs region, elæolite and sodalite-syenite, with characteristic species, also as contact minerals, natroxonotlite (near wollastonite), apatite, quartz.

Also rectorite, in the Blue Mt. mining distr., Marble township, 24 miles north of Hot Springs; further manganese ores.

**INDEPENDENCE and IZARD COS.**—Manganese ores, incl. psilomelane, braunite, pyrolusite, wad.

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* See Arkansas Geol. Surv. (J. C. Branner). Report for 1888, vol. 1, pp. 274–292, T. B. Comstock. Also on the manganese deposits of the state, Rep. for 1890, vol. 1, Penrose; these deposits include (1) the Batesville region, chiefly in Independence and Izard Cos., and (2) the region in the southwestern part of the state extending from Pulaski Co. to Polk Co. and Indian Territory. On the igneous rocks of Arkansas, chiefly of the elæolite-syenite type, also in part leucitic, and their associated minerals, e.g. Fourche Mt., Pulaski Co., of Saline Co., and of the Magnet Cove region, Garland Co., see Rep. for 1890, vol. 2, by J. Francis Williams. Considerable deposits of bauxite occur in Salina and Pulaski Cos. Antimony mines occur in Sevier Co. in the southwestern corner of the state.

**Lawrence Co.**—*Smithsonite*, dolomite, galena, niter. At **Calamine**, smithsonite.

**Marion Co.—Wood's Mine.**—Smithsonite, hydrozincite (marionite), galena. Poke bayou, *braunite?* Morning Star mine, *yellow smithsonite* (containing cadmium, "turkey-fat ore").

**Montgomery Co.**—Variscite, wavellite and *quartz;* manganese ores; galena, tetrahedrite, bournonite, cerargyrite.

**Newton Co.—Sneeds Creek.**—Newtonite.

**Polk Co.**—Manganese ores, incl. bog manganese, etc.

**Pulaski Co.—Kellogg Mine.**—10 m. north of Little Rock, *tetrahedrite, tennantite,* nacrite, galena, sphalerite, quartz, bauxite.

**Saline Co.**—Elæolite, astrophyllite, eudialyte. Rabbit Foot mine, millerite, bauxite.

**Sevier Co.**—In the Antimony district (northern part of county) on the Cossatot river, at the Stewart Lode, etc., *stibnite,* stibiconite, bindheimite, jamesonite, zinkenite, dufrenite, eleonorite.

## MISSOURI.

For the distribution of the lead-mines, which are of great importance, see page 50. Mine la Motte, and some old openings in Madison Co., afford cobalt and nickel ores, associated with the galena; the amount of these ores, however, does not exceed 1 to 3 p. c. of the lead ore. At Granby, Newton Co., and Aurora, Madison Co., calamine is abundant in the surface ores, but below a depth of about 100 feet gives place to sphalerite. In other sections of central and southwestern Missouri, sphalerite is the prevailing ore. Smithsonite is very rare in the southwest region, so much so as to be a mineralogical curiosity. At Carthage in Jasper county, smithsonite occurs massive and crystalline, formed by a pseudomorphic replacement of irregular masses of limestone included in the ore body, at the Porter mines. Sphalerite is now the most abundant zinc ore, aggregating more than 90 p. c. of the total production. The ores of this region were originally deposited as galena and sphalerite, the other minerals being formed by their oxidation and decomposition (Jenney). Gold has been found in the drift sand of Northern Missouri (Broadhead).

**Adair Co.**—Göthite in calcite.

**Burton Co.**—McCarrow's mine, pickeringite.

**Cole Co.—Old Circle Diggings** and elsewhere. *Barite!* galena, chalcopyrite, malachite, azurite, pyrite, calcite, calamine, sphalerite.

**Cooper Co.—Collins Mine.**—Malachite, azurite, chalcopyrite, *smithsonite, galena, sphalerite,* limonite.

**Crawford Co.**—At Scotia iron bed, hematite, amethyst, göthite, dufrenite at the Cherry Valley mines, cacoxenite, malachite.

**Dade Co.**—Smithsonite.

**Franklin Co.—Cove Mines,** Virginia Mines, and **Mine à Burton.**—Galena, minium, cerussite, anglesite, barite. At Stanton copper-mine, native copper, chalcotrichite, malachite, azurite, chalcopyrite. Also, Mexican onyx.

**Iron Co.**—At **Pilot Knob** and Shepherd Mountain, *hematite,* magnetite, limonite, manganese oxide, bog manganese, serpentine, talc.

**Jasper Co.—Joplin Mines.**—Crystallized *galena!* often octahedral, *sphalerite!* pink and white crystallized *dolomite,* crystallized *calcite!* in scalenohedrons with curved faces, bitumen, *marcasite! greenockite* coating sphalerite, chalcopyrite in small sphenoidal crystals.

**Webb City** and **Carterville.**—Galena, crystallized sphalerite, *ruby blende* (small brilliant crystals of transparent ruby-red or garnet-colored sphalerite, adhering to massive sphalerite and dolomite), crystallized *marcasite,* occasionally in brilliant iridescent crystals, ferro-goslarite.

At the **Cave Springs mines**, near Kansas boundary, crystallized pyrite associated with sphalerite.

At the **Empire mines,** 2½ miles southwest of Joplin, *galena, sphalerite, greenockite,* marcasite, barite.

**Jefferson Co.—Valle's.**—*Galena, cerussite,* anglesite, *calamine,* smithsonite, sphalerite, hydrozincite, chalcopyrite, malachite, azurite, pyrite, *barite,* witherite, limonite.

**Frumet Mines.**—Galena, *barite! smithsonite!* pyrite, limonite.

**Lawrence Co.—Aurora Mines.**—Galena, sphalerite, crystallized *calamine,* cerussite, dolomite, zinciferous tallow clay, crystallized *calcite.*

**Madison Co.—Mine la Motte.**—*Galena! cerussite! siegenite* (nickel-linnæite), smaltite, *asbolite* (earthy black cobalt ore), bog manganese, *marcasite, chalcopyrite,* malachite, caledonite, plumbogummite, wolframite, *aragonite.*

At **Einstein Silver-mine**, *galena* (argentiferous), *sphalerite, wolframite, pyrite*, quartz, muscovite, actinolite, fluorite, tungstite (common). Also arsenopyrite, almandite, lepidolite in granite.

**MORGAN CO.—Cordray Diggings.**—*Galena, sphalerite*, crystallized *barite*. At Florence, flat crystals of barite banded with light blue. In the eastern part of the county, crystallized sphalerite.

**NEWTON CO.** (adjoins S. E. Kansas).—**Granby Mines.**—*Galena!* mimetite on galena (rare), *cerussite, calamine! sphalerite*, smithsonite, hydrozincite, buratite, greenockite (on sphalerite), pyromorphite, dolomite, *calcite!* bitumen. The cerussite and calamine occur in stalactites in small caves in the upper parts of the ore bodies. Zinciferous tallow clay is also very abundant in the upper parts of the ore bodies.

**PETTIS CO.**—Near **Smithton** and **Sedalia**, *barite* in flat crystals banded with white.

**ST. FRANCOIS CO.—Iron Mountain.**—Specular-hematite, ilmenite, limonite, rhodochrosite in seams, mangano-calcite, calcite, hessonite, apatite, tungstite, wolframite.

**ST. GENEVIEVE CO.**—At the **Cornwall Copper-mines**, *chalcopyrite*, cuprite, malachite, azurite, covellite, chalcocite, bornite, melaconite, chalcanthite, chrysocolla.

**ST. LOUIS CO.**—Near **St. Louis.**—*Millerite* (in the Subcarboniferous St. Louis limestone, largely a magnesian limestone) with *calcite!* and cryst. *dolomite*, barite, *fluorite*, anhydrite, gypsum, strontianite.

**Cheltenham.**—*Gypsum* in clay. Quarantine, magnesite.

**WASHINGTON CO.**—At **Potosi**, *galena, cerussite*, anglesite, barite.

**WAYNE CO.**—Granite bend, copiapite (rare) on pyrite, hyalite.

## TENNESSEE.

There are copper mines in Polk Co.; extensive hematite and limonite deposits; zinc mines in Union and Jefferson Cos., etc.

**Brown's Creek.**—Galena, sphalerite, barite, celestite.

**CLAIBORNE CO.**—*Calamine*, galena, smithsonite, chlorite, steatite, magnetite.

**COOKE CO.**—Near **Bush Creek.**—Cacoxenite ? dufrenite, iron sinter, stilpnosiderite, brown hematite.

**DAVIDSON CO.**—Selenite, with granular and snowy *gypsum*, or alabaster, crystallized and compact *anhydrite, fluorite* in crystals, *calcite* in crystals.

Near **Nashville.**—Blue *celestite* (crystallized, fibrous, and radiated), with *barite* in limestone, anhydrite. Haysboro', galena, sphalerite, with barite as the gangue of the ore.

**DICKSON CO.**—Manganite.

**GREENE CO.**—12 miles from Greeneville, barite in veins in dolomite.

**JEFFERSON CO.—Mossy Creek.**—*Calamine*, smithsonite, sphalerite, galena, fetid barite.

**KNOX CO.**—Magnesian limestone, *native iron, variegated marbles.*

**MAURY CO.**—Wavellite in limestone.

**MCMINN CO.—Whetwell**, near Mouse Creek.—Barite.

**MONROE CO.—Carter Mine.**—Galena. At Buck Miller mine, argentiferous tetrahedrite.

**POLK CO.—Ducktown Mines**, S. E. corner of state.—Melaconite, chalcopyrite, pyrite, native copper, bornite, rutile. *zoisite*, galena. *harrisite*, alisonite, sphalerite, *pyroxene, tremolite, sulphates of copper and iron* in stalactites, allophane, rahtite, chalcocite (ducktownite), chalcotrichite, azurite, malachite, *pyrrhotite*, limonite, graphite.

**ROANE CO.**—E. declivity of Cumberland Mts., wavellite in limestone.

**SEVIER CO.—Alum Cove.**—Alum (in part apjohnite), epsomite melanterite in shale. In caverns, epsomite, soda alum, niter, nitrocalcite, *breccia marble.*

**SMITH CO.**—Barite, gangue of lead vein, fluorite.

**Smoky Mt.**—On declivity, amphibole, garnet, staurolite.

**UNION CO.—Stiner's Zinc-mine**, Powell's River.—Sphalerite, calamine, smithsonite. Caldswell mine, galena.

## KENTUCKY.

**ANDERSON CO.**—Galena, barite.

**BOURBON CO.—Paris.**—Barite.

**BOYLE CO.**—Witherite, also in Garrard and Lincoln Cos.

**CLINTON CO.**—Geodes of quartz.

**CRITTENDEN CO.—Columbia Mines.**—Galena, fluorite, calcite.

**EDMONDSON CO.—At Mammoth Cave,** *gypsum rosettes!* calcite stalactites, niter, epsomite.

**FAYETTE CO.**—6 m. N. E. of Lexington, galena, barite, witherite, sphalerite.

**LIVINGSTON CO.**—Near the line of Union Co., galena, chalcopyrite, large vein of fluorite.

**LYON CO.—Eddyville.**—Vivianite.

**MERCER CO.—At McAfee,** *fluorite, pyrite,* calcite, barite, celestite.

**MONROE CO.—Sulphur Lick.**—Sphalerite, galena.

**OWEN CO.**—Galena, barite.

## OHIO.

**Bainbridge** (Copperas Mt., a few miles east of B.).—Calcite, barite, pyrite, copperas, alum.
**Canfield and Ellsworth.**—*Gypsum!*
**Lake Erie.**—Green or Strontian Island, *celestite!* Put-in-Bay Island, *sulphur!* calcite.
**Sinking Springs.**—Hematite.
**White House.**—Celestite, calcite.
**Youngstown.**—Rock salt in borings for gas.

## INDIANA.

**Limestone Caverns,** Corydon Caves, etc.—*Epsomite.*
In most of the southwest counties, *pyrite, iron sulphate,* and *feather alum.* On Sugar Creek, pyrite and *iron sulphate.* In sandstone of Lloyd Co., near the Ohio, *gypsum.* At the top of the blue limestone formation, brown *spar, calcite.*

**LAWRENCE CO.**—Indianaite.

**PUTNAM CO.—Eaglesfield.**—Siderite.

## ILLINOIS.

Lead ores, chiefly galena, are extensively mined in the northwestern part of the State (cf. p. 50), thus in Jo Daviess and Stephenson Cos.

**GALLATIN CO.,** on a branch of Grand Pierre Creek, 16 to 30 m. from Shawneetown, down the Ohio, and from a half to eight miles from this river.—*Violet fluorite!* in Carboniferous limestone, barite, *galena,* sphalerite, limonite.

**HANCOCK CO.—At Warsaw,** *quartz geodes* containing *calcite! chalcedony, dolomite, sphalerite!* brown spar, pyrite, aragonite, gypsum, bitumen.

**HARDIN CO.—Near Rosiclare.**—*Calcite,* galena, sphalerite, chalcopyrite, *fluorite.* 5 m. back from Elizabethtown, bog-iron. One mile north of the river, between Elizabethtown and Rosiclare, *niter.*

**JO DAVIESS CO.—At Galena,** *galena,* calcite, *pyrite,* sphalerite. At Marsden's diggings, *galena! sphalerite, marcasite* (all together in stalactites), pyrite, *cerussite.*
**Quincy.**—*Calcite!* pyrite.
**Scales Mound.**—*Barite,* pyrite.

**POPE CO.**—Galena, fluorite.

## MICHIGAN.

### A. LOWER PENINSULA.

**BRANCH CO.—Coldwater.**—Kidney ore, siderite and limonite.

**IOSCO CO.** (Saginaw Bay).—*Alabaster!* gypsum.
**Aux Grees River** (headwaters).—Gypsum.

**JACKSON CO.—Jackson.**—Pyrite, kidney ore.

**KENT CO.—Grand Rapids.**—*Gypsum* (selenite), *calcite, dolomite, anhydrite.*
**Grandville.**—Gypsum, etc.

**MONROE CO.—Brest.**—*Calcite,* amethystine quartz, apatite, celestite.
**Monroe.**—Aragonite, apatite.
**Point aux Peaux.**—Amethystine quartz, apatite, celestite, calcite.
**Stony Point.**—Apatite, amethystine quartz, celestite, calcite.

**TUSCOLA CO.**—S. 16, T. 13, R. 11.—Sphalerite.

**B. UPPER PENINSULA.**—The principal regions are the Marquette, Menominee, and Gogebic iron ranges, and the Keweenaw copper range.

**MARQUETTE CO.—Presque Isle.**—Serpentine, galena, pyrite, chalcopyrite, dolomite, chalcedony, agate, chrysotile, enstatite, diallage, olivine, native copper, sphalerite, calcite, chromite.
**Partridge Island.**—Agate (in narrow veins in gabbro).
**Picnic Islands.**—Epidote, hornblende.
**Mount Mesnard.**—Chalcocite, hematite.
**Chocolate River.**—Galena, chalcocite.
**Marquette.**—[The above localities are not far from the city], manganite, galena.
**Holyoke Mine District.**—Galena, *gold,* sphalerite, chalcopyrite.
**Negaunee.**—*Hematite!* martite, *limonite, göthite,* pyrolusite, manganite, psilomelane, wad, *barite! kaolinite, rhodochrosite,* jasper, calcite, quartz, orthoclase, tourmaline. The Jackson mine is prominent for minerals.
**Goose Lake.**—*Dolomite,* in flesh-colored rhombs, on lighter ground in bluffs N. E. of lake.
**Palmer.**—Hematite. At the Wheat mine, *rhodochrosite, dolomite, orthoclase, calcite,* pyrite, chalcopyrite, *chloritoid!* especially ½ m. S. of the town, also in other places near by and in a line from here to Champion.
**Ishpeming.**—*Hematite!* micaceous, botryoidal and in cubes after pyrite, *limonite,* göthite, jasper, pyrite, quartz, feldspar.
**Moss Mountain** (near Ishpeming).—*Talc.*
**Ishpeming Gold Range.**—Ropes, Michigan Gold, and other mines, *gold, pyrite,* pyrrhotite, tourmaline, epidote, molybdenite, magnetite, pyroxene, dolomite, picrolite, *precious serpentine!* williamsite, chrysotile, *talc!*
**Humboldt.**—*Chloritoid!* tourmaline. *magnetite,* hematite (*martite*), grünerite, garnet.
**Republic.**—*Magnetite, hematite,* hornblende, *garnet.* N. W. of the town, between here and Michigamme, *staurolite,* etc.
**Champion.**—Near the old furnace, magnetite, hematite, *grünerite,* garnet. At the mine, *chloritoid! garnet,* tourmaline, *apatite, muscovite,* chlorite, *magnetite* (lodestone), hematite (*martite*), *grünerite,* pyrite, jasper.
**Michigamme.**—*Garnet,* changed to chlorite, *magnetite,* etc.
**Lake Michigamme.**—On the islands, e.g. Goat Island and Silver Island, *staurolite* in schist, *garnet,* margarite, and in quartz veins *andalusite!* green *apatite!* mica, chlorite.
**Wetmore, Webster, and Beaufort Mines.**—Limonite, botryoidal and mammillary.

**BARAGO CO.**—Graphite, wad, limonite, pyrite, especially near L'Anse.
**Huron Islands.**—Native copper in granite.

**ONTONAGON, HOUGHTON, and KEWEENAW COS.**—The productive copper-mines lie in these counties. At the north end of Keweenaw Point the copper is mainly in fissure-veins across the formation, and from them some of the best crystallized specimens have come, but most of the mines are not now worked. About Portage Lake in Keweenaw County the copper occurs mainly impregnating amygdaloids and conglomerates, while near Rockland, in Ontonagon Co., the copper is collected in fissures running with the formation. So many minerals occur throughout the district, and the exact mines which may be open or yield a particular mineral vary so from time to time that only one list of minerals is given, and, further, after particular minerals the mine is mentioned with which they are or have been most closely associated.

*Native copper!* (Phœnix mine), *native silver!* chalcopyrite, chalcocite, domeykite (Albion mine, Keweenaw Co., also Sheldon and Columbia mine, Houghton), whitneyite (Houghton), algodonite (Houghton), bornite (Mendota, Mt. Bohemia, Huron mine), horn-silver, melaconite (Copper Harbor), *cuprite,* manganese ores, saponite, azurite, malachite, chrysocolla, *prehnite* (Tamarack and Quincy mines), *laumontite* (leonhardite, white), *datolite* (crystals from Copper Falls, the porcelain-like var. widespread, e.g. Isle Royale, Quincy, Minnesota mines), heulandite, orthoclase (Superior mine), *analcite!* (Houghton, Phœnix, pink at Copper Falls), chabazite, *mesotype* and natrolite (Copper Falls mine), *apophyllite* (Cliff mine), wollastonite (ib.), *calcite!* (large water-clear crystals often inclosing copper at many places, e.g. Central, Phœnix and Cliff, Quincy and Franklin and National mines), dolomite (Phœnix and National mines), *quartz* crystals from Franklin and Minnesota mines, amethystine out on Keweenaw Point), *barite* (Centennial mine), *selenite* (National mine).

**Isle Royale.**—Formation and minerals similar to those of Keweenaw Point; also *chlorastrolite*, barite.

**IRON, DICKINSON, MENOMINEE, and DELTA COS.**—In these counties is the Menominee iron range, with the usual iron minerals; the ores are mainly soft hematite and limonite, with *calcite* (of peculiar habit at the Bessie, Metropolitan, and Chapin mines), *siderite, chalcopyrite* Chapin Mine), orthoclase (Norway), dolomite.

In this district occur large crystals of *tremolite* and *diopside* in altered dolomites, e.g. at Metropolitan and S. 35, T. 42, R. 29, also S. 35, T. 42, R. 30.

**Emmet Mine.**—*Pyrite*, calcite, hematite, martite, chalcopyrite, azurite, malachite.

**GOGEBIC CO.**—Like the Menominee Range, hematites, limonite, jasper.

**Bessemer.**—With the iron ores, calcite, *feldspar*, kaolinite! aragonite, pyrite, dolomite, marcasite.

**Copp's Mine**, 6 m. N. of Marenisco.—The usual iron ores, and near by galena, chalcopyrite, chert, sphalerite, pink dolomite, siderite.

**ALGER, LUCE, SCHOOLCRAFT, CHIPPEWA, MACKINAC COS.**—Formation sedimentary with dolomite, calcite, fluorite, celestite, and bog-iron ore at times.

**St. Ignace**, gypsum. **Drummond Is.**, celestite.

## WISCONSIN.

Galena is extensively mined in La Fayette, Grant, Iowa, and Green Cos.; also zinc ores, smithsonite ("dry-bone"), and in the same region sphalerite. Iron (hematite, also limonite) is mined in the Menominee range, Florence Co.; in the Penokee-Gogebic range (in part magnetite), Lincoln and Ashland Cos.; also in Dodge Co. the Clinton red hematite or "fossil ore."

**Blue Mounds.**—Cerussite.

**Hazelgreen** (Grant Co.).—*Calcite*, cerussite.

**Lac de Flambeau R.**—Garnet, cyanite.

**Douglas Co.**, Left-Hand R. (near small tributary).—Malachite, chalcocite, native copper, cuprite, malachite, niccolite, tetrahedrite, epidote, quartz crystals.

**Madison** (Dane Co.).—Quartz with secondary enlargements (Potsdam sandstone of C. & N. E. R. R. cut).

**Marshfield** (Wood Co.).—Graphite.

**Mineral Point** and vicinity, in S. W. counties of Wisconsin.—Copper and lead ores, chrysocolla, *azurite!* chalcopyrite, malachite, *galena*, cerussite, *anglesite* (rare), leadhillite? sphalerite, *pyrite, barite, calcite, marcasite, smithsonite!* (including pseudomorphs after calcite and sphalerite, so-called "dry-bone"), calamine, bornite, hydrozincite, melanterite, sulphur. Shullsburg, *galena!* sphalerite, pyrite. At Emmet's digging, *galena* and pyrite.

**Montreal River Portage.**—Galena in gneissoid granite.

**Penokee** and **Menominee** Iron Ranges S. of L. Superior. *Hematite, magnetite, siderite,* actinolite, garnet.

**Plum Creek** (Pearce Co.).—Diamonds.

**Sauk Co.**—Hematite, malachite, chalcopyrite.

**Scales Mound.**—Barite crystals.

**Tomah** (Monroe Co.).—Glauconite.

**Wauwatosa** (Milwaukee Co.).—Celestite.

**Wisconsin River.**—Kaolin (near Grand Rapids), serpentine (below mouth of Copper River).

## MINNESOTA.

Hematite and magnetite are extensively mined as ores of iron in Itasca, St. Louis, Lake, and Cook counties; labradorite (anorthite, R. D. Irving, Mon. 5, U. S. G. Survey, p. 438 *et seq.*) occurs in huge blocks in diabase and even forms mountain masses around Little Saganaga lake; several species of zeolites are abundant at many points in the diabase rocks of the N. shore of Lake Superior, e.g. in Cook Co.

**Brown and Nicollet Cos.**—Geodes and lenticular masses of calcite.

**Carlton Co.**—Amphibole (actinolite).

**Chisago Co.**—Calcite, copper, dolomite, epidote, malachite.

**Cook Co.**—Agate, apophyllite, bornite, barite, chlorite, copper, gold, graphite, hematite, labradorite, *laumontite, thomsonite,* lintonite, magnetite, ilmenite, chrysolite, silver, sphalerite, stilbite.

**Fillmore, Houston, and Winona Cos.**—Calcite (travertine), limonite (pseudomorph after marcasite of the cockscomb form).

**Goodhue Co.**—Amethyst and chert in cavities in dolomite.

**Hennepin and Ramsey Cos.**—Calcite, pyrite, selenite.

**Itasca Co.**—*Hematite, magnetite.*

**Kanabec Co.**—Muscovite, amphibole (actinolite).

**Lake Co.**—*Hematite*, labradorite, *magnetite*, ilmenite, chrysolite.

**Morrison Co.**—Actinolite, garnet, hypersthene, chrysolite, quartz, staurolite.

**Olmsted Co.**—Gold in small placer deposits.

**Pine Co.**—Copper, epidote, thomsonite?

**Pipestone and Rock Cos.**—Catlinite.

**Redwood Co.**—Amphibole, orthoclase, red ocher, lignite.

**Renville Co.**—Quartz in partially filled veins in gneiss.

**St. Louis Co.**—*Hematite, calcite, copper*, chlorite, diallage and labradorite in large cleaved fragments from the gabbro, epidote, fluorite, hematite, heulandite, titaniferous magnetite, quartz.

**Todd Co.**—Apatite and epidote.

**Washington Co.**—Sphalerite.

**Yellow Medicine Co.**—Orthoclase.

## IOWA.

Galena is extensively mined in the north-eastern part of the state near the Mississippi river, thus in Clayton, Allamakee Co. (p. 50).

**Dubuque Lead Mines**, and elsewhere.—*Galena! calcite, sphalerite*, black oxide of manganese' barite, pyrite. At Ewing's and Sherard's diggings, *smithsonite*, calamine.

**Des Moines.**—Quartz crystals, selenite.

**Makoqueta R.**—Limonite. Near Durango, galena. 7 m. from Dubuque, aragonite.

**Cedar River**, a branch of the Des Moines.—*Selenite* in crystals, in the bituminous shale of the Coal measures; also elsewhere on the Des Moines, gypsum abundant, argillaceous iron ore, siderite.

**Fort Dodge.**—*Celestite, gypsum*, pyrite.

**New Galena.**—Octahedral galena, anglesite.

**Bentonsport**, and elsewhere in southern Iowa, in geodes.—*Chalcedony, quartz, calcite, dolomite, pyrite, kaolinite.*

## SOUTH DAKOTA.

The Black Hills region, in Lawrence, Pennington, and Custer counties, affords gold both in quartz veins and placers, tin (cassiterite) in some quantity and in similar relations; further, mica, feldspar, also columbite, tantalite, beryl, spodumene, uraninite, hübnerite, triphyllite, etc.

**CUSTER CO.**—Arsenopyrite, *cassiterite, mica.*

**Buffalo Gap.**—*Calcite!*

**LAWRENCE CO.**—**Nigger Hill Distr.**—*Columbite, cassiterite.*

Also galena, cerussite, cerargyrite, chalcopyrite, sphalerite.

**Redwater Valley**—*Gypsum.* Bear Lodge range, gold.

**PENNINGTON CO.**—**Etta Tin Mine.**—*Cassiterite, spodumene! mica, orthoclase, columbite! arsenopyrite*, scorodite, olivenite, tourmaline, garnet, hübnerite.

**The Ingersoll Claim**, 10 m. E. of Harney Peak.—Cassiterite, *columbite, tantalite* beryl.

**Bald Mtn.**—Uraninite, torbernite or autunite.

**Nickel Plate Tin Mine.**—Triphylite, spodumene, beryl.

**Silver City.**—Galena, arsenopyrite, jamesonite.

**Rockford.**—Graphite.

**Sunday Gulch.**—Barite, corundum.

**Queen Bee Mine.**—Galena, arsenopyrite.

Near **Hill City.**—Ottrelite.

The Bad Lands of North Dakota are stated to afford corundum; also fine jet is said to occur near Fort Berthold, N. D. (J. S. Murphy).

## KANSAS.

Zinc and lead are extensively mined in the south-eastern part of the state in the counties adjoining Missouri. Rock-salt is obtained by borings in Saline, Harper, Davis, Ellsworth, Rice, and other counties, in beds of considerable extent and great purity; also gypsum in Saline Co., and common elsewhere.

**Brown Co.**—*Red celestite.*

**Cherokee Co.**—*Galena*, cerussite, anglesite, sphalerite, calamine, amorphous white *sphalerite* (p. 62), chalcopyrite in tetrahedral crystals, greenockite coating sphalerite.

**Linn Co.**—Lead and zinc ores. On Short Creek, *galena*, cerussite, anglesite, *sphalerite*, *calamine*.

**Saline Co.—Salina.**—Barite, *halite*, gypsum.

**Wallace Co.**, etc.—*Gypsum* in crystals.

## COLORADO.

**BOULDER CO.**—The Central part, between Jamestown and Magnolia, is noted for rich tellurides with tellurium.

**Central Distr.** (Smuggler mine, etc., in mica schist or gneiss).—Tellurides, pyrite.

**Gold Hill Distr.** (Red Cloud, etc., mines).—Gold, tellurides of gold, silver, mercury and lead, tetradymite, pyrite, sphalerite, chalcopyrite.

**Magnolia Distr.**—Tellurides, etc., tellurium ores of the range including *altaite, hessite, petzite, sylvanite, tellurite, native tellurium, calaverite, coloradoite, melonite, magnolite*, and the associated ores, argentite, amalgam, native mercury, native bismuth, bismuthinite, bismutite, pyrargyrite, iodyrite, kobellite, *schirmerite*, hübnerite. Sunshine and Sugar Loaf districts afford tellurides.

**Ward Distr.**—Aurif. pyrite and chalcopyrite, gold.

**Grand Island Distr.**, Caribou mine.—Silver, *argentif. galena*, chalcopyrite, pyrite, gold, sphalerite. Sugar Loaf distr., chalcocite, pyrrhotite, manganesian garnet.

**CHAFFEE CO.—Arrow Mine,** *jarosite* with turgite. Gold gravels at Cash Creek, etc.

**Calumet.**—Calumet mine, epidote.

**Cotopaxi Mine.**—Gahnite, galena, sphalerite, chalcopyrite.

**Monarch Distr.**—Massive *anglesite*, cerussite, brochantite, etc.

**Mt. Antero** (about 10 miles N. W. of Salida).—*Phenacite! bertrandite! aquamarine! topaz! orthoclase*, hematite in crystals, bismutite, fluorite, *muscovite, smoky quartz*.

**Nathrop.**—In cavities in rhyolite, *topaz, garnet* (spessartite).

**Salida.**—At Sedalia copper mine, *garnet!* chalcopyrite, malachite, azurite and chrysocolla; corundum in mica schist.

**CLEAR CREEK CO.—Georgetown.**—Argentif. *galena, native silver, pyrargyrite*, argentite, tetrahedrite (tennantite), pyromorphite, sphalerite, azurite, *polybasite* (Amer. Sister's mine), aragonite, barite, fluorite, polybasite (Terrible Lode), mica. Trail Creek, garnet, epidote.

**Freeland Lode.**—*Tennantite, chalcopyrite*, anglesite, caledonite, cerussite, tenorite, siderite, azurite, minium. Champion Lode, tenorite, azurite, chrysocolla, malachite. Gold Belt Lode, vivianite. Coyote Lode, malachite, cyanotrichite.

**Virginia District.**—Galena, chalcopyrite, pyrite, tetrahedrite.

**Idaho Springs.**—*Pyrite, chalcopyrite*, fine crystallized *tennantite* at Crocett Mine, *opal*.

**CUSTER CO.**—Near Rosita and Silver Cliff, 6 m. W. of R., argentif. galena, sphalerite, pyrite, chalcopyrite, annabergite, carrying silver and gold, ores at the latter place incrusting fragments or pebbles of country rock, *calamine, smithsonite, jamesonite, tetrahedrite*, tellurides of silver and gold, *niccolite*. Rosita Hills, alunite, diaspore.

At the Racine Boy mine, cerussite, cerargyrite. At the Gem mine, 12 m. N. of Silver Cliff, niccolite, bornite, pyrite. East slope of Sangre de Cristo, Verde mine, *chalcopyrite, tetrahedrite*, pyrite, annabergite.

**EAGLE CO.—Red Cliff.**—Black Iron mine, fibroferrite. Holy Cross Mt., turquois.

**DOUGLAS CO.—Devil's Head.**—*Topaz! microcline, albite, phenacite, smoky quartz, göthite*, fluorite, allanite, manganite, gadolinite, samarskite, cassiterite.

**EL PASO CO.**—In the granite of the Pike's Peak region, *microcline! albite, smoky quartz*, topaz, etc. Thus near **Florissant,** 12 m. N. W. from the Peak, *microcline! topaz!* On **Elk Creek,** phenacite, microcline (*amazon-stone*), *smoky quartz! amethyst! albite, fluorite, zircon! columbite!* South of Manitou, in Crystal Park, *topaz, phenacite*, zircon. **Topaz Butte,** 16 m. from Peak, *phenacite*.

W. of Cheyenne, N. E. base of **St. Peter's Dome,** in quartz vein, *zircon, astrophyllite, arfvedsonite, cryolite, thomsenolite*, gearksutite, prosopite, ralstonite, elpasolite, tysonite, bastnäsite, xenotime, rutile, danalite (rare), fayalite. In another vein, *prosopite*, zircon, fluorite, kaolinite, yellowish mica, cryolite.

Between Colorado Springs and Cañon City, barite.

Garden of the Gods, celestite, rhodochrosite.

**GILPIN CO.**—Veins in gneiss or granite. Near **Central City,** orthoclase crystals in porphyry, tennantite. Gregory distr. (near Central City), about **Black Hawk** (Bobtail mine, etc.), chalcopyrite, pyrite, sphalerite, galena, *enargite*, massive *uraninite*, and fluorite. In Willis Gulch uraninite (Wood mine). Nevada district (next west of Gilpin), galena, chalcopyrite, pyrite, sphalerite, etc. Russell distr. (in Russell Gulch), *galena*, tetrahedrite, *enargite*, pyrite, *fluorite*, *chalcopyrite*, pyrite, epidote, tennantite.

**GUNNISON CO.** (W. of Sawatch Mts. and S. of Elk Mts.).—Ruby district, arsenopyrite, in quartz vein, proustite, tetrahedrite, pyrargyrite. On Brush Creek, W. base of Teocalli Mtn., niccoliferous *löllingite*, *smaltite*, marcasite, *native silver*, proustite, pyrargyrite, argentite, galena, chalcopyrite, in a gangue of siderite, barite, and calcite.

**Augusta Mt.**—Freieslebenite.

**Domingo Mine.**—Uraninite, warrenite.

**Redwell Basin.**—Kaolinite.

**HINSDALE CO.**—**Lake City,** Hotchkiss Lode, *petzite*, calaverite. Lake district, argent. *galena*, *freibergite*, *sphalerite*, aurif. chalcopyrite, argentobismutite. Park district, *stephanite*, *galena*, chalcopyrite. Galena district, argent. galena, freibergite, sphalerite, chalcopyrite, *rhodocrosite*, stephanite, ruby silver, gold, silver.

**HUERFANO CO.**—Southern border, N. slope, W. Spanish Peaks, galena, pyrite, chalcopyrite, tetrahedrite.

**JEFFERSON CO.**—Near **Golden,** on Table Mtn., leucite, *analcite*, *apophyllite*, *chabazite*, levynite, laumontite, mesolite, natrolite, scolecite, ptilolite, stilbite, thomsonite, calcite, aragonite. Turkey Creek, columbite.

**LARIMER CO.**—**Fort Collins.**—Muscovite.

**LAKE CO.** (between Mosquito Mts. and Sawach Range, both Archæan at center), supplying three fourths of the silver and gold of Colorado, with Paleozoic rocks between, and great eruptive formations. About **Leadville** (or California mining district), on W. portion of Mosquito Range, and mostly confined to Lower Carbonif. limestone, and generally beneath eruptive rocks, *silver*, *galena*, cerussite, aragonite, *anglesite*, *cerargyrite*, *bromyrite*, iodyrite, *embolite*, *aurif. chalcopyrite*, native arsenic, descloizite and *pyrite*, *sphalerite*, *pyromorphite*, mimetite, calamine, minium, pyrolusite, *rhodochrosite*, sphalerite, bismuthinite, bismutite, gold.

Alicante (16 m. N. of Leadville).—*Rhodochrosite!* sphalerite, pyrite; *minium* (Stone mine).

Lillian Mines (on Printerboy Hill), kobellite, lillianite, cerussite, caledonite. Also Florence mine, bismutite. Ute and Ule mines, *stephanite*, *galena*, *sphalerite*, *chalcocite*.

Homestake Peak, N. W. corner of county, *argent. galena*. Golden Queen mine, *scheelite*, *gold*.

**LA PLATA CO.** (S. of San Juan Co.).—S. side of La Plata Mts., 2½ m. N. of Parrott City, *aurif. pyrite*, galena, tetrahedrite, cosalite, sphalerite, tellurides, sylvanite, gold (Comstock mine).

**LASSEN CO.**—**Susanville.**—Muscovite.

**OURAY CO.** (W. of N. end of Hinsdale Co., with Uncompaghgré Mts. between).—**Near Ouray,** *argent. galena*, some *freibergite*, *chalcopyrite*, *pyrite*, *hübnerite*, rhodochrosite, tetrahedrite.

At Silver Bell mine, kobellite, barite, chalcopyrite.

At **Sneffels** (near Mt. Sneffels).—Freibergite, pyrargyrite, stephanite, argent. galena, cerussite, etc. Upper San Miguel and Iron Springs districts, similar ores. Yankee Girl Mine, stromeyerite, proustite.

**PARK CO.**—Mines chiefly along its northwest side, on the E. slope of the Mosquito Range, in the Paleozoic region of its eastern side, near eruptive rocks. In N. part Hall's Valley, veins in gneiss, galena, cuprobismutite (Missouri mine), tetrahedrite, enargite, pyrite, sphalerite, fluorite, barite, ilesite.

Near Grant, Baltic Lode, beegerite. N. W. of Alma, on Mt. Bross and Mt. Lincoln, in Carbonif. limestone, *argent. galena*, *cerussite*, *anglesite*, *cerargyrite*, *barite*, manganese oxide. In Buckskin Gulch (between these mts.), in Cambrian quartzyte, aurif. pyrites, gold, silver, galena.

Sweet Home and Tanner Boy Mines, S. W. side of Mt. Bross, in Archæan, *rhodochrosite* in the latter. In Mosquito Gulch, south of Alma, near Horseshoe, *argent. galena*, *cerussite*. Mines of Lincoln Mtn. at 13,000 to 14,000 ft. elevation.

**PITKIN CO.** (between Elk Mts. and Sawatch Range).—At **Independence,** on W. slope of Sawatch, on the Roaring Fork, in Archæan, and west of Aspen, on the N. E. slope of Elk Mts., Alpine Pass, Pitkin and Tin Cup mines, in limestone, cerussite, cerargyrite, cuprite.

**Aspen.**—*Polybasite*, *tennantite*, *argentite*, *pyrite*, *silver*, *aragonite*, chalcopyrite, bornite.

**PUEBLO CO.**—**Turkey Creek,** near Pueblo, muscovite.

**RIO GRANDE CO.**—At head of Rio Alamosa, near Summitville, E. part of San Juan Mts., *gold*, in quartz vein, enargite.

**SAN JUAN CO.** (S. and S. E. of E. end of San Miguel Co., crossed by the San Juan Mts.).—

**Silverton.**—North Star mine, Sultan Mountain, *tetrahedrite. chalcopyrite,* pyrite, *hübnerite, rhodochrosite,* all in good crystals. Bonita Mt., hübnerite. Zuñi mine, *zunyite* embedded in *guitermanite.* Whale Mine, massive anglesite.

**Red Mountain District.**—*Enargite, tetrahedrite* (argent.), *tennantite, chalcopyrite, bornite, stromeyerite, polybasite,* argentite, cerussite, azurite, *kaolinite.*

Poughkeepsie Gulch, Alaska mine, alaskaite, chalcopyrite, tetrahedrite, barite, tellurite. Yankee Girl mine, cosalite.

**SAN MIGUEL CO.** (S. of Ouray Co., eastern part including N. portion of San Juan Mts.).—At Telluride, galena, stephanite, chalcopyrite, gold, electrum.

**SUMMIT CO.**—In southeastern part, on W. slope of Archæan "Front Range," near Montezuma and Peru, argent. galena, etc. In southern part, near headwaters of Blue R., S. of Breckenridge, near Robinson, on Quandary Park, etc., in limestone, *argent. galena, pyrite,* native gold, sphalerite. cerargyrite.

Chalk Mtn., junction of Summit Park and Eagle Cos., in rhyolyte (nevadite), *sanidine, topaz* in small crystals.

Snake River District, alabandite (Queen of the West mine), with rhodochrosite, galena, argentite, pyrite. Black Prince mine, stromeyerite.

French Creek, native bismuth in placers.

Kokomo, *orthoclase!* in crystals.

Breckenridge, crystallized *gold!*

Near Montezuma, Rust Tunnel, *pyrite!* Josephine mine, *pyrite.*

**WELD CO.**—Near Sterling, *blue barite!*

## WYOMING.

**Albany Co.**, 14 m. S. W. of Laramie City.—*Mirabilite.*

**Laramie Co.**—Near Hartville, chalcocite, chrysocolla, cuprite, malachite. 18 m. E. of Laramie City, graphite.

**Sweetwater Co.**—Near Atlantic City, S. Pass City, and Miner's Delight, gold in quartz veins. Near Independence Rock, sodium carbonates (trona, etc.).

In fossils in Bad Lands, *barite crystals.*

**YELLOWSTONE PARK** and Vicinity.—At the Geyser Basins, *geyserite!* native sulphur. Mammoth Hot Springs, *calcareous sinter!* At the Joseph Coats Springs, scorodite, realgar, orpiment, sulphur.

**Obsidian Cliff.**—Tridymite, anorthoclase, fayalite. Between Clark's Fork and East Fork in the Hoodoo Mts., mordenite.

**Specimen Mt.**—*Amethyst! quartz crystals! silicified wood,* calcite, calcite rombohedrons coated by quartz crystals.

**Absaroka Range.**—Leucite.

**Glade Creek.**—Quartz crystals in rhyolyte, tridymite, fayalite.

## MONTANA.

**Beaver Head Co.**—Placer gold, gold in quartz, wire gold in calcite, auriferous chalcopyrite, nagyagite, argentiferous galena, pyromorphite, vanadinite, descloizite, pyrite, chalcocite, azurite, malachite, jasper, magnetite, limonite. At Dillon, cassiterite.

**Deer Lodge Co.**—Gold, nagyagite, argentiferous galena, pyrargyrite, argentiferous sphalerite, pyrite, pyrolusite, tetrahedrite.

**Jefferson Co.**—Gold, argentiferous galena with sphalerite and pyrite, auriferous pyrite, black and white wood-opal (silicified wood).

**Lewis and Clarke Co.**—Gold, auriferous arsenopyrite, pyrite, argentiferous galena, argentiferous sphalerite, bituminous and lignite coal.

Ruby, El Dorado, and other bars in the Missouri River, about 16 miles from Helena, *corundum!* both sapphire and ruby, mined for gem purposes; also topaz, garnet, cyanite, cassiterite, chalcedony, etc.

**Madison Co.**—Placer gold, gold in veins, argentiferous galena, silver, cerargyrite, minium, chalcopyrite, cuprite, azurite, malachite, calcite, garnet, compact serpentine.

**Missoula Co.**—Lead ores, cerussite, yellow pyromorphite in St. Regis district.

**Park Co.**—Gold, auriferous chalcopyrite, argentiferous galena, cerussite, sphalerite, tetrahedrite, coking coal.

In the Crazy Mts., sodalite, nephelite, häuynite.

**Silver Bow Co.**—**Butte City** and vicinity, gold, silver, *argentite, cerargyrite,* silver on chalcocite, argentiferous pyrolusite, bornite, chalcocite, malachite, copper and cuprite in granite, rhodonite, *rhodochrosite,* siderite, calcite, galena, sphalerite, tetrahedrite.

Wurtzite at the Original Butte mine; goslarite at the Gagnon mine.

## IDAHO.

Every county in the state yields placer gold.

**Alturas Co.**—The mining region is known as the **Wood River district** which includes Ketchum, Hailey, Atlanta, and the Sawtooth Range of mountains. Placer gold, auriferous pyrite, arsenopyrite carrying gold and silver, silver, proustite, pyrargyrite, argentite, cerargyrite, argentiferous galena, auriferous and argentiferous sphalerite, anglesite, cerussite, cervantite, stibnite, tetrahedrite, azurite, malachite, magnetite, hematite, bog iron.

At the Jay Gould mine, native lead, minium.

**Ada Co.**—Lignite, placer gold, auriferous sphalerite.

**Boisé Co.**—Deposits of lignite, placer gold, gold finely crystallized, rubies in placers bordering on Ada Co., mica (Payette), pyrolusite, dufrenoysite, argentite, cerargyrite, and other silver ores.

**Bingham Co.**—Copper ores, besides placer gold.

**Custer Co.**—Gold, argentite, stephanite, cerargyrite, argentiferous galena, cerussite, azurite and other copper ores, asbestus.

**Idaho Co.**—Mica, native copper and other copper minerals; placer gold, silver ores.

At Warren's Camp (veins in slate and limestone), gold, silver, cerargyrite, etc., scheelite with gold (Charity mine).

**Kootenai Co.**—Placer gold.

**Latah Co.**—*Opals!* at Moscow, mica.

**Lemhi Co.**—Gold, argentiferous galena, cerargyrite, argentite, copper ores, chalcocite, cerussite.

**Nez Percés Co.**—Placer gold.

**Oneida Co.**—Placer gold, silver ores, silver, cerargyrite.

**Owyhee Co.**—Gold, silver, argentite, cerargyrite in thin transparent plates, stephanite, stibnite, lignite.

**Shoshone Co.**—Cœur d'Alene district includes the camps Mullan, Burke, Wallace, and Bunker Hill mines. Argentiferous galena, cerussite, anglesite, pyromorphite, *plattnerite* (As You Like mine), malachite and azurite carrying cerargyrite (and bromyrite?), bornite, chalcopyrite, argentiferous tetrahedrite, massive barite, placer gold.

**Washington Co.**—Mining districts are **Helena** (Seven Devils) and **Mineral City**. Placer gold, plates of gold in malachite, bornite carrying silver, chalcocite, chalcopyrite, chrysocolla, malachite, azurite, covellite (impure), limonite, micaceous magnetite, quartz, dark tourmaline, brown garnet rock, cinnamon garnet, epidote, powellite, limestone, silver ores.

## UTAH.

The silver mines are mostly in limestone, with eruptive rocks in the vicinity, and argentif. galena, cerussite, anglesite, cerargyrite, etc., the common ores. The veins in slate or quartzyte in part carry copper ores. There are also sandstones in Southern Utah impregnated by ores (cerargyrite, etc.) over large regions.

**BEAVER CO.**—**Bradshaw.**—Cerussite, cuprite, malachite, aragonite.

**Frisco.**—Cerussite, anglesite, galena, dufrenoysite, proustite, pyrargyrite, cerargyrite, argentite, barite.

**Star.**—Cerussite, cerargyrite, malachite, aurichalcite (Cave mine), bismuthinite.

**IRON CO.**—**Coyote District.**—Orpiment, realgar, thin layer in strata under lava, stibnite.

**JUAB CO.**—**Tintic District.**—*Galena*, *anglesite*, *cerussite*, malachite, bornite, cuprite, *bismuthite*.

Copperopolis mine (formerly called the "American Eagle"), *conichalcite! clinoclasite, erinite, scorodite, enargite, tyrolite, olivenite! chenevixite, melaconite, lettsomite, selenite! mixite*, borickite (?).

Mammoth mine, *tyrolite! chalcophyllite! clinoclasite! olivenite! pharmacosiderite, jarosite! conichalcite, erinite, enargite! azurite! malachite, mixite, brochantite!* jarosite.

Carissa mine, *mixite!* bismutite.

Eureka Hill mine (at Eureka, 6 m. from Silver City), *utahite, olivenite*, enargite, cerussite.

**MILLARD CO.**—**Cove Creek.**—Sulphur.

Shoebridge and Dragon mines, 40 m. N. of Sevier Lake and 40 m. W. N. W. of Deseret, *topaz* in rhyolyte, with garnet and sanidine.

**PIUTE CO.**—**Ohio.**—*Galena, cerussite*, malachite, chalcopyrite, chalcocite, tetrahedrite.

**Mt. Baldy.**—*Galena, cerussite, anglesite, wulfenite*, argentite (Pluto mine).

**Marysvale.**—Onofrite, tiemannite

**SALT LAKE CO.**—**Big Cottonwood.**—*Galena, cerussite, anglesite;* aurichalcite (Keeler mine), chrysocolla (at Emma mine), malachite, with sometimes pyrolusite. Little Cottonwood, same, with sometimes argentite, *dufrenoysite, wulfenite*, linarite (?), chalcopyrite, enargite (at Oxford and Geneva mine). **West Mountain**, same ores, with argentite, pyrargyrite, rhodochrosite, barite at Queen mine; binnite, etc., at Tiewaukee mine; dufrenoysite, etc., at Winnamuck mine.

**Butterfield Cañon.**—Orpiment, realgar, mallardite, luckite.

Wasatch Mts., head-waters of Spanish Fork, ozocerite in beds. Great Salt Lake, mirabilite.

SUMMIT CO.—**Uinta.**—*Cerussite, anglesite, cerargyrite, tetrahedrite, argentite,* malachite.

TOOELE CO.—**Camp Floyd.**—Stibnite, etc.

**Ophir.**—*Galena, cerussite, malachite, chalcopyrite, cerargyrite.* Rush Valley, same ores. American Fork and Silver Lake, same ores.

WASATCH CO.—Blue Ledge and Snake Creek, galena, cerussite, pyromorphite, sphalerite, etc.

WASHINGTON CO.—**Harrisburg.**—In sandstone and clay, ***native silver, cerargyrite, argentite;*** fossil plants sometimes replaced by silver and cerargyrite.

## NEW MEXICO.

DOÑA ANA CO.—Victoria mine, 40 m. below Nutt, *anglesite.* In the **Organ Mts.**, ***aragonite*** (flos ferri), *wulfenite.*

GRANT CO.—**Burro Mts.**, S. W. of Silver City.—Turquois.

**Santa Rita Mines.**—Azurite, malachite, native copper.

**Ballard's Peak.**—Pyrargyrite.

**Georgetown.**—Mimbres mine, *vanadinite!*

In N. E. corner of county, S. part of Mimbres Mtn., E. of Silver City.—Ores in limestone or shale, argentif. galena, cerargyrite, argentite, native silver, barite, fluorite.

**Pinos Altos Mtn.**, N. of Silver City —Argent. galena, cerargyrite, cerussite, argentite, silver, gold, chalcopyrite, barite. Burro Mts., S. W. of Silver City, similar ores. In S. W. part of Co., near Barney's Station, and Warren, Virginia distr., veins of quartz, with argent. galena, cerargyrite, native silver. Atlanta distr., near Silver City, Gold Hill, and Kingston, pyrargyrite, silver, argentite.

LINCOLN CO.—**Bonita Mt.**, near White Oaks.—Hübnerite.

SANTA FÉ CO.—**Los Cerillos Distr.**, 22 m. S. W. of Santa Fé, in Los Cerillos Mts.—*Turquois* in trachyte, argent. galena, cerussite, wulfenite, manganese ores. **Silver Bute distr.**, in quartzyte, gold, pyrite, azurite, malachite, cuprite, chalcopyrite, bournonite, chrysocolla.

SIERRA CO.—At **Lake Valley.**—In the Sierra mines, in limestone, *argent. galena, cerussite, cerargyrite, embolite,* iodyrite, manganese ores, vanadinite, *endlichite, descloizite,* native silver, pyrolusite, manganite, fluorite, apatite. At Kingston, in Black Range, aragonite. Near Hillsboro', gold in veins and placers.

**Grafton.**—Gold, cerussite, chalcocite, bornite, malachite, chalcopyrite, cerargyrite, amethyst. Headwaters of Gila River, alunogen, halotrichite.

SOCORRO CO.—3 m. from Socorro, in Socorro Mts., *cerargyrite, vanadinite,* vanadiferous mimetite, *barite.* In Magdalena Mts., 27 m. W. of Socorro, galena, cerussite, anglesite, calamine, sphalerite. Oscuro Mts. to E., chalcopyrite, azurite, malachite, associated with fossil wood and plants. Merritt mine, willemite.

## ARIZONA.

APACHE CO.—**Copper Mountain.**—Chalcocite, azurite, melaconite, sphalerite, pyrite. And at Greenlee Gold Mountain, chalcocite, malachite, cuprite, auriferous gravel.

Near **Holbrook,** in Chalcedony Park.—Forest of *petrified wood!* ("Jasperized" wood), *amethyst.*

**Navajoe Reservation** (also in part in N. Mexico).—*Pyrope garnets! chrysolite* (Job's tears)! chrome-diopside.

COCHISE CO.—**Bisbee.**—Copper Queen mine (and Holbrook mine), *azurite! malachite! cuprite! chrysocolla,* melaconite, paramelaconite, footeite, wad, *calcite* inclosing malachite, *stalactites* of either aragonite or calcite (or perhaps both) aurichalcite.

**Tombstone.**—Emmonsite. At West Side mine, hessite, yellow wulfenite. At Empire mine, yellow wulfenite. At Contention mine, yellow wulfenite and hyalite. Lucky Cuss mine, descloizite, cuprodescloizite.

GILA CO.—**Globe.**—Old Globe mine, *malachite! azurite, chrysocolla!* quartz on chrysocolla, *melaconite, calcite.* Vermont mine (near Globe), chalcocite. Stonewall Jackson mine (near Globe), native red silver in crystals, argentite.

**MARICOPA CO.—Vulture.**—Vulture mine (60 m. N. W. of Phœnix), *jarosite*, crystallized gold, yellow wulfenite. Farley's Collateral mine (about 20 m. N. E. of Vulture P. O.), *vanadinite*, red and yellow; yellow *vanadinite* in clear calcite! red *wulfenite*, chrysocolla, (and according to Silliman) crocoite, vauquelinite, etc. Phœnix mine (about 20 m. N. E. of Vulture), *vanadinite*, yellow and red, the former very like mimetite; descloizite.

**Hassayampa Distr.**—Montgomery mine, tetradymite.

**Santa Catarina Mts.** (also in Pinal and Pima Cos., exact locality not known).—*Aurichalcite!*

**Turquois Mts.**—Turquois.

**GRAHAM CO.—Clifton.**—At the Longfellow Mine (5 m. from Clifton), *malachite! azurite! cuprite!* native copper. Metcalf mine (6 m. from Clifton), brochantite. At the Bon Ton mines (exact locality doubtful), dioptase. Garfield mine (about 9 m. from Clifton, on Chase Creek), argentiferous *tetrahedrite*, azurite.

**Morenci.**—Humming Bird mine (about 6 m. from Clifton), *malchite* and azurite in short *stalactites* with concentric structure, *chrysocolla*, wad. Yavapai mine (about 5½ m. from Clifton, via the Longfellow mine, and 1 m. from Morenci), *chalcanthite* fibrous, brochantite, drusy azurite. Copper Mt. mine, in Morenci, *lettsomite! chalcotrichite!* cuprite! arborescent and bright *native copper*, *azurite.*

**Mineral Park.**—Turquois.

**PIMA CO.—Flux Mine.**—*Cerussite!*

**PINAL CO.—Oracle.**—At the Mammoth Gold mine, *descloizite! vanadinite!* wulfenite.

Near **Riverside.**—*Brochantite! dioptase!* in small but well-defined crystals.

**Pinal.**—Hollow quartz crystals, *chalcedony.*

**Silver King Mine** (near Pinal).—Fine aurichalcite, crystallized *silver! sphalerite*, argentite, pyrite, chalcopyrite. At Silver Queen mine (near Pinal), red *cerussite!*

**Picket Post.**—Red *wulfenite.* Black Prince mine, red *vanadinite.*

**YAVAPAI CO.—Boggs Mine**, in the Big Bug distr.—Bournonite.

**Grove Mine**, in the Humbug distr.—Embolite! Also in same distr., brown vanadinite, barrel-shaped crystals. 2 miles from Bradshaw, tetradymite crystals!

**Jerome** (30 m. N. E. of Prescott).—In the United Verde copper mines, *gerhardtite, atacamite, brochantite, azurite, chalcanthite.*

**Rio Verde**, near Camp Verde.—*Glauberite, thenardite*, mirabilite, halite, etc.

**YUMA CO.—Red Cloud Mine** (about 30 m. N. of Yuma).—*Red wulfenite!* mimetite, *cerussite*, hyalite, calcite. Also fine *vanadinite!* at the following mines: Hamburg, Princess, Clara, Black Rock, Rover, Melissa, etc. All of these mines (as also the Red Cloud) are in the "Silver District," and are one to five miles distant from the Red Cloud.

**Melissa and Rover Mines.**—*Wulfenite* (red), occasionally in simple octahedral crystals of small size.

**Clip** (about 5 m. N. of Red Cloud),—*Dumortierite!* cyanite.

**Castle Dome District** (about 30 m. N. E. of Yuma.).—*Wulfenite* in gray, waxy, almost cubical crystals, green and purple *fluorite* and crystallized *anglesite!* galena and cerussite, also anglesite of woody appearance!

## NEVADA.

The chief mining regions of Nevada affording silver and partly gold are either veins connected obviously with igneous eruptions, as the Comstock Lode, veins in granitic or metamorphic rocks, and in the Austin mines; and deposits of supposed veins in limestone, either of the Cambrian or later age, as the Eureka and White Pine mines.

**CHURCHILL CO.—Ragtown.**—*Gay-lussite, trona*, halite. **Cottonwood Cañon.**—*Niccolite, annabergite*, smaltite.

**ELKO CO.—Tuscarora**, veins in igneous rocks, *stephanite, cerargyrite, ruby-silver ores* (proustite and pyrargyrite), *argentite, stephanite, chalcopyrite*, pyrite, sphalerite, chrysocolla.

**ESMERALDA CO.**—In metamorphic slates and schists, or in granite, which are intersected by igneous rocks, at **Columbus**. gold, *cerargyrite, tetrahedrite*, galena, pyrite, sphalerite, pyrolusite, turquois, sulphur, stetefeldtite. Also gold in Esmeralda and Wilson in quartz. Silver, galena, and chalcopyrite in Oneota, in mica schist. Alum, 12 m. N. of Silver Creek. At Aurora, fluorite.

Near Mono Lake, native copper and cuprite, obsidian.

Columbus district, at Teel's Salt Marsh, Rhodes Marsh, Fish Lake Valley, etc., *ulexite, thenardite, borax*, common salt, sulphur; elsewhere, annabergite, variscite. Walker Lake, gypsum, hematite.

**EUREKA CO.—Eureka, Ruby Hill,** etc.—In Lower Cambrian limestone, *gold, silver, cerussite, galena, anglesite,* mimetite, *wulfenite,* limonite, aragonite.
**Cortez.**—*Cerargyrite, tetrahedrite,* silver, etc.

**HUMBOLDT CO.**—Veins in mesozoic slates, at **Paradise,** *silver, cerargyrite, tetrahedrite, pyrargyrite,* proustite, *stephanite,* arsenopyrite, chalcopyrite, sphalerite, pyrite. **Winnemucca,** between slate and granite, sulphides and antimonial sulphides of lead, with silver, jamesonite, stibnite, bournonite.
Near **Lovelock's Station.**—Erythrite, millerite, asbolite.
Humbolt House, sulphur. Rabbit Hole Springs, sulphur.

**LANDER CO.—Austin,** near Reese River, in the Toyabe Range, which has a granitic axis flanked by Paleozoic strata, and the veins in the granite of Lander Hill (yielding $1,000,000 of silver annually), situated near the western edge of the Paleozoic area of the eastern half of the Great Basin. *Tetrahedrite, pyrargyrite, proustite, cerargyrite, stephanite, polybasite,* rhodochrosite, embolite, chalcopyrite, pyrite, galena, azurite, whitneyite.
Also mines at Lewis of ruby silver, etc., in quartzyte. And at Battle Mountain, of galena in Paleozoic slate.

**LINCOLN CO.—Bristol.**—Galena, cerussite, etc. Eldorado, *cerargyrite, stromeyerite.* Jack-Rabbit, *argentif. galena, cerussite,* cuprite, malachite. Ely, gold, *cerargyrite, galena,* sphalerite, pyrite. Rio Virgin, *lalite* in large deposits.

**NYE CO.—Belmont** (vein in Silurian slate).—*Argent. galena, stephanite,* pyrite, chalcopyrite, *anglesite, stetefeldtite.*
**Morey.**—*Ruby silver* and other arsenical and antimonial ores, etc.
**Tybo.**—*Galena, cerargyrite,* etc.
**Union.**—*Cerargyrite,* galena, sphalerite, etc.
**Downieville.**—Anglesite, cerussite, wulfenite, sphalerite, pyrite.

**STOREY and LYON COS.**—Mines of the Comstock Lode, gold, *native silver, argentite, stephanite, polybasite, ruby silver ores,* tetrahedrite, cerussite, wulfenite, küstelite, etc.

**UNION CO.—Echo Distr.**—Boulangerite.

**WASHOE CO.—Steamboat Springs.**—Sulphur, metastibnite, orpiment cinnabar.

**WHITE PINE CO.—White Pine.**—In Devonian limestone, cerargyrite. At Ward, same limestone, sulphantimonides, probably stromeyerite, pyrite, etc. **Cherry Creek.**—Copper carbonate, sulphides, etc.

## CALIFORNIA.

The principal gold regions are in Amador, Butte, Calaveras, El Dorado, Fresno, Inyo, Mariposa, Mono, Nevada, Placer, Plumas, San Bernardino, San Diego, Shasta, Siskiyou, Sierra, Trinity, and Tuolumne counties.
Silver is mined chiefly in Inyo, Mono, San Bernardino, and Shasta counties. Copper mines are principally in Calaveras, Del Norte, Inyo, Nevada, and Plumas counties.
The principal mercury mines are the Altoona, in Trinity Co., the New Almaden in Santa Clara Co., the New Idria, in San Benito Co., the Bradford, Great Western, and Sulphur Bank, in Lake Co., the Manhattan, and Napa Consolidated, in Napa Co., and the Great Eastern, in Sonoma Co. Of these the Napa and Lake Co. mines are now producing one half the total yield of the State.

**ALAMEDA CO.**—Hydromagnesite, chromite, and pyrolusite, all abundant, alsc *halotrichite.*

**ALPINE CO.**—Morning Star mine, *enargite,* stephanite, polybasite, barite, quartz, pyrite, tetrahedrite, pyrargyrite.

**AMADOR CO.—Volcano.**—Chalcedony, *hyalite,* common garnet, *diamond.* **Ione Valley.**—chalcopyrite, ionite, lignite. **Fiddletown.**—Diamond. Gold at several mines with chalcopyrite, pyrite, galena.

**BUTTE CO.—Cherokee Flat.**—*Diamond,* platinum, iridosmine, chromite, zircon. **Forbestown.**—Prochlorite.

**CALAVERAS CO.—Copperopolis and Campo Seco.**—*Chalcopyrite,* malachite, *azurite, serpentine, picrolite,* native copper. Near Murphy's, jasper, albite, with gold and pyrite. **Melones Mine.**—*Calaverite, petzite.* **Stanislaus Mine.**—Calaverite, petzite, melonite, altaite; also opal, chalcopyrite, galena, gold, etc. **Bald Point.**—*Epidote* and *almandite.*

**COLUSA CO.—Sulphur Creek.**—*Electrum, sulphur* (cryst.), *cinnabar, aragonite* (all mined).

**DEL NORTE CO.—Crescent City.**—Agate, carnelian. **Low Divide.**—Chalcopyrite bornite, malachite; on the coast, in auriferous sand, iridosmine, platinum, gold, zircon, microscopic rubies, diamonds?

**EL DORADO CO.—Pilot Hill.**—Chalcopyrite. Near **Georgetown.**—Hessite, from placer diggings. Roger's Claim, **Hope Valley.**—*Grossular garnet*, in copper ore. **Coloma.**—*Chromite.* **Placerville.**—*Gold, brookite, octahedrite* implanted on quartz crystals. **Granite Creek.**—Roscoelite, gold. **Forest Hill.**—Diamonds. Cosumnes mine, molybdenite, pyrophyllite.

**FRESNO CO.**—Chowchillas, *andalusite.* **King's Creek Distr.**—Bornite, columbite. **North Fork Distr.**—Sphalerite, bismuthinite. **Raymond.**—*Molybdenite.* Also tourmaline and *satin spar.*

**HUMBOLDT CO.—Gold Bluff.**—Spinel ruby. **Yager.**—Vivianite. At **Red Cap Mines.**—*Chalcocite.* **Elk River.**—*Pyrrhotite.*

**INYO CO.—Inyo Distr.**—*Galena, cerussite, anglesite, barite*, calcite, *grossular garnet!* vesuvianite, datolite. **Panamint.**—Tetrahedrite, stromeyerite. **Kearsarge Mine.**—Cerussite, tetrahedrite, cerargyrite, argentite. **Cerro Gordo Mines.**—Wulfenite, cerussite anglesite, polybasite, *linarite! caledonite, calamine, bindheimite*, mimetite, smithsonite, willemite, etc. **Deep Spring Valley.**—Bismuthite. **Saline Valley.**—*Tincal, ulexite, halite*, tourmaline. **Death Valley.**—*Colemanite!* abundant, *borax, ulexite*, all mined.

**KERN CO.—Hot Springs Distr.**—*Antimony* (native), *stibnite*, jarosite, almandite, lepidolite, *chrysoprase.* **Green Monster Mine.**—Cuproscheelite.

**LAKE CO.**—Borax, *cinnabar, sulphur* cryst., all mined; also *semi-opal, hyalite, mercury* (native), chromite, copiapite, posepnyte (Gt. Western mine), *wollastonite*, glaucophane, zoisite, etc. **Borax Lake.**—*Borax!* sassolite, *glauberite.* Pioneer mine, cinnabar, native mercury, sulphur, hyalite, cinnabar. Lower Lake, chromite.

**LASSEN CO.**—*Selenite* in large slabs, andradite, tourmaline, smaltite, bernardinite.

**LOS ANGELES CO.—San Gabriel Canon.**—Asphaltum nodules with vivianite. At the "O. K. mine," *silver* (native), with *argentite, smaltite, erythrite.* On **Santa Catalina Island**, sphalerite. Near **Santa Ana River**, *anhydrite.* Williams Pass, chalcedony. **Soledad Mines.**—Chalcopyrite, *garnet*, gypsum. **Mountain Meadows.**—Garnet, in copper ores. **Compton.**—Kelsey mine, erythrite. Mt. Hoffman, *almandite, epidote.*

**MARIPOSA CO.**—Chalcopyrite, itacolumyte. **Centreville.**—Cinnabar. Pine Tree mine, tetrahedrite. **Burns Creek.**—Limonite. **Geyer Gulch.**—Pyrophyllite. **La Victoria Mine.**—*Azurite!* Near **Coulterville**, *cinnabar*, gold.

**MONO CO.—Blind Spring.**—Partzite (stibiconite), chalcocite, chalcopyrite, tetrahedrite. **Bodie.**—Gold, silver. **Oasis.**—Bismuthinite, bismutite. Mono Lake, thinolite.

**MONTEREY CO.—Alisal Mine.**—Arsenic. Near **Panche**, chalcedony, chromite. Near **Pacheco's Pass**, stibnite.

**NAPA CO.**—Chromite. At **Cat Hill**, Redington mine, *cinnabar, metacinnabarite*, marcasite, chromite, knoxvillite, redingtonite, napalite, *magnesite, epsomite. Botryoidal pyrite* at Manhattan mine. Phœnix mine, millerite.

**NEVADA CO.—Grass Valley.**—*Gold!* in quartz veins, with pyrite, chalcopyrite, sphalerite, arsenopyrite, galena, *quartz*, biotite. Near **Truckee Pass**, gypsum. **Excelsior Mine.**—Molybdenite, with gold. **Sweet Land.**—Pyrolusite.

**ORANGE CO.—Arch Beach.**—*Fuchsite.* **San Joaquin Ranch.**—A mercury mineral not yet positively determined. At same locality and **Santa Ana**, *gypsum.*

**PLACER CO.**—Near Dutch Flat in Green Valley, American River, chromite, uvarovite, kotschubeite, serpentine. Miner's ravine, *epidote!* with *quartz, gold.*

**PLUMAS CO.**—At Cherokee, chalcopyrite. **Taylorville.**—*Chrysocolla* and erubescite, at Engels' mine. **Rich Bar.**—Tremolite.

**SAN BENITO CO.—New Idria.**—*Cinnabar* (mined); at the Gypsy, Alta, and Ambrose mines, *stibnite* (mined), often in fine crystals.

**SAN BERNARDINO CO.—Colorodo River.**—Agate, trona. **Clarke and Silver Mountain.**—Stromeyerite, malachite. **Russ District**—Galena, cerussite. Francis mine, cerargyrite. **San Bernardino Mts.**—Graphite. At Calico, *colemanite!* with pandermite (or priceite), celestite, bernardinite, laumontite, cummingtonite, calamine, *halite*, Iceland spar, *loadstone* (Lake and Owen's mine). Stromeyerite at the Silver King mine.

**Colton.**—*Aragonite.*

**Borax Lake.**—*Borax, thenardite, halite, hanksite, sulphohalite, glauberite, trona.* **Oro Grande.**—Cookeite, lepidolite. Also realgar, 40 miles from the Needles.

The **Temescal** tin mines are situated in the northern end of the San Jacinto estate, see p. 1030.

**SANTA CLARA CO.**—**New Almaden.**—*Cinnabar*, mercury, *calcite, aragonite*, serpentine, chrysolite, quartz, *apophyllite*, gyrolite, metacinnabarite, aragotite. **North Almaden.**—Chromite. **Mt. Diabolo Range.**—Magnesite. Near **Gilroy**, *stibnite*.

**SAN DIEGO CO.**—*Lepidolite*, rubellite, graphite, chalcocite, pyrophyllite.

**SAN LUIS OBISPO CO.**—Asphaltum, cinnabar, native mercury, chromite, pyrophyllite, *onyx marble!*

**SAN MATEO CO.**—**Pescadero**—*Carnelian, agate.*

**SANTA BARBARA CO.**—On the islands of this county, sphærostilbite and gypsum crystals, *pectolite;* orthite. **San Amedio Cañon.**—Stibnite, asphaltum, bitumen, maltha, petroleum, cinnabar. **Santa Clara River.**—Sulphur. **Santa Barbara.**—Allanite. Point Sal, *gypsum.*

**Redwood City.**—Sphalerite.

**SHASTA CO.**—**Cow Creek.**—Sphalerite. **Tom Neal Mtn.**—*Molybdenite, green foliated talc.* **Shotgun Creek.**—Uvarovite. **Copper City.**—Chalcanthite, native zinc (?).

**SIERRA CO.**—**Goodyear's Bar.**—Asbestus. **Brandy City.**—Emery. **Forest City.**—Gold, arsenopyrite, tellurides.

**SISKIYOU CO.**—Ottrelite, barite, *aragonite.*

**SOLANO CO.**—*Aragonite!* (fine).

**SONOMA CO.**—**Guerneville.**—Actinolite, garnets, chromite, serpentine, cinnabar, bitumen, *silicified wood.*

**TEHAMA CO.**—Pectolite, *chromite*, wollastonite.

**TRINITY CO.**—**Altoona Mine.**—*Cinnabar; platinum* in nuggets found in hydraulic mines on the old channel of the Trinity River. **Cinnabar.**—Cinnabar, serpentine, realgar.

**TULARE CO.**—Minium, chrysoprase, sphalerite, graphite, *epidote, almandite, grossularite, molybdenite, tourmaline*, malacolite, *topazolite*, andradite, etc.

**TUOLUMNE CO.**—Tourmaline, tremolite. **Sonora.**—*Graphite*, gold, chalcopyrite, pyrite. **York Tent.**—Chromite. **Golden Rule Mine.**—Petzite, calaverite, altaite, hessite, magnesite, tetrahedrite, gold. **Whiskey Hill.**—*Gold!* **Jamestown.**—Mariposite.

## OREGON.

Gold is obtained west of the Cascade Range, in the southernmost counties, Josephine, Jackson, and Curry, in Coos and Douglas, the next north, and east of the range, in southeastern Oregon, in Grant and Baker counties, and to the north sparingly in Wasco, Umatilla, and Union counties. The most productive mines are in Baker Co.

**Baker Co.**—In northern part, about Baker City, Rye Valley, Bridgeport on Burnt River, Willow Creek, Silver Creek, gold; Rye Valley and Silver Creek, affording also stromeyerite, arsenopyrite, pyrite, malachite, azurite.

**Curry Co.**—Near Port Orford and Cape Blanco, and on the Rogue River, gold, platinum, iridosmine, laurite. On the seashore, 5 m N. of **Chetko**, *priceite*, in veins and in masses from 20 lbs. weight to the size of peas and smaller, with bluish steatite.

**Douglas Co.**—**New Idrian.**—Cinnabar, limonite. **Riddle.**—Hydrous nickel silicate, near genthite (garnierite), p. 677.

**Grant Co.**—Granite, in north part of county, tetrahedrite, polybasite, chalcopyrite, pyrite, sphalerite. At **Elk Creek**, auriferous gravel. Near **Canyon City** (on John Day's R.), cinnabar.

**Jackson Co.**—At **Applegate** and elsewhere, auriferous gravel.

**Josephine Co.**—At **Yank**, galena, chalcopyrite. Also in Jackson and Josephine counties, *native nickel-iron*, in placers.

## WASHINGTON.

**King Co.—Seattle.**—Scheelite, realgar, tourmaline. **Magnetite at Iron Mt., 3 m. N. W. of Snoqualmie Pass, and also copper ores at the Denny Co. mine.**

**Pierce Co.**—Mt. Ranier, tridymite.

**Spokane Co.**, Rockford, muscovite.

**Stevens Co.**—Colville district, mines of lead and silver reported.

**Whatcom Co.—Fidalgo.**—Tourmaline.

**Whitman Co.**, near Whelan, 20 miles S. W. of Colfax, *fire-opal.*

**Yakima Co.**—Auriferous gravel and quartz veins.

## ALASKA.

**Douglas Island.**—Auriferous pyrite.

**Fort Wrangell.**—At the mouth of the Stickeen River, *garnet!* in mica schist.

**Glacier Bay.**—Native silver, argentite, berthierite (?), tetrahedrite, graphite.

**Golovin Bay.**—Argentiferous galena, pyrite, graphite.

**Juneau.**—Sphalerite.

**Yukon R.**—Gold placers; nephrite at the Jade Mts.

Gold quartz at various points.

## DOMINION OF CANADA.

### PROVINCE OF QUEBEC.

**ARGENTEUIL CO.—Argenteuil.**—*Pyroxene, titanite,* tourmaline. **Chatham.**—Fetid calcite, garnet, orthoclase.

**Grenville.**—Wollastonite, titanite, *muscovite,* vesuvianite, calcite, pyroxene, serpentine, steatite (rensselaerite), chondrodite, *garnet* (cinnamon-stone), *zircon* (hyacinth), *graphite, scapolite,* fetid calcite, tourmaline, graphite, orthoclase, phlogopite. **Leeds.**—Chalcocite.

**ATHABASKA CO —St. Norbert.**—Amethyst in greenstone. **Tingwich.**—Chalcocite.

**BAGOT CO.—Acton.**—Bornite, chalcocite, kaolin. **Upton.**—Chalcopyrite, malachite, calcite.

**BEAUCE CO.—Aubert.**—Gold, iridosmine, platinum.

**Broughton.**—Serpentine, *chrysotile,* steatite, chlorite.

**Marlow** (also **Risborough**).—*Scheelite!* cryst., tungstite, galena, sphalerite, pyrite, chalcopyrite.

**Rivière du Loup.**—Platinum, iridosmine, gold, rutile.

**St. Francis.**—Gold, platinum, iridosmine, *ilmenite,* pyrite, magnetite, serpentine, chromite, soapstone, barite, actinolite, arsenopyrite, agalmatolite, garnet, pyrrhotite.

**Lake St. Francis.**—*Andalusite* (chiastolite) in mica schist.

**St. Joseph.**—Epidote in crystals in a concretionary epidotic rock.

**Ste. Marie.**—Wad. **Tring.**—Aragonite, wad.

**BERTHIER CO.—Maisonneuve Township.**—*Samarskite,* beryl, muscovite.

**BROME CO.—Bolton.**—*Chromite, magnesite,* serpentine, picrolite, *steatite,* bitter spar, wad, rutile actinolite, chalcopyrite, chlorite, chrysotile, kämmererite, pyrrhotite.

**Brome.**—*Magnetite,* chalcopyrite, *titanite,* ilmenite, chalcocite, galena, chloritoid, rutile. In elæolite-syenite, sodalite, cancrinite, orthoclase.

**Sutton.**—*Magnetite,* in fine crystals, hematite, *rutile,* dolomite, *magnesite,* chromiferous *talc,* bitter spar, steatite, bornite, pyrrhotite, chalcocite, chalcopyrite, chloritoid.

**CHAMBLEY CO —Boucherville.**—*Augite* in trap. **Chambly.**—Analcite, chabazite, and calcite in trachyte, ilmenite. **Montarville.**—*Augite,* chrysolite.

**CHAMPLAIN CO.—Cap de la Madeleine.**—Limonite (iron ocher) in large beds.

**CHARLEVOIX CO.—Bay St. Paul.**—*Ilmenite,* apatite, allanite, rutile.

**CHICOUTIMI CO. Jonquiére Township.**—*Beryl.*

**GASPÉ CO.—Mt. Albert.**—Shickshock Mts., chrysolite, chromite, amphibole, garnet, serpentine. **Mt. Serpentine.**—Gaspé Bay, serpentine.

**HOCHELAGA CO.—Montreal.**—*Calcite, augite,* titanite in trap, chrysolite, natrolite, analcite, *dawsonite* (near McGill College), sodalite, elæolite, acmite, cancrinite. At St. Helen's Is., strontianite.

**IBERVILLE CO.—Mt. Johnson.**—In dioryte, amphibole, titanite, oligoclase.

**JOLIETTE CO.—Daillebout.**—Blue spinel with seybertite.

**KAMOURASKA CO.—Riv. Ouelle.**—Chalcedony, jasper.

**L'ASSOMPTION CO.—St. Roch.**—On Achigan R., transp. *apatite,* augite.

**LEVIS CO.—Chaudière Falls,** kaolin. **Point Lévis,** glauconite. **St. Nicholas,** agalmatolite.

**MASKINONGE CO.—Hunterstown.**—*Scapolite,* titanite, vesuvianite, garnet, *brown tourmaline!*

**MEGANTIC CO.—Black Lake.**—Scolecite, thomsonite. **Coleraine.**—*Serpentine, chrysotile* (asbestus) mined. **Halifax.**—Bornite, chalcocite, chalcopyrite. **Inverness.**—Bornite, chalcocite, pyrite, orthoclase.

**Leeds**—Dolomite, chalcopyrite, gold, *chloritoid,* chalcocite, bornite, pyrite, *steatite,* chromite, magnetite, molybdenite, orthoclase.

**Thetford.**—Serpentine, *chrysotile!* (asbestus) extensively mined.

**MISSISQUOI CO.—St. Armand.**—Micaceous iron ore with quartz, epidote.

**MONTCALM CO.—Rawdon.**—Garnet, ilmenite, labradorite.

**MONTMORENCY CO.—Château Richer.**—*Labradorite, hypersthene,* andesine, ilmenite.

**OTTAWA CO.—Buckingham.**—*Apatite, phlogopite, titanite, asbestus,* coccolite, graphite, crocidolite.

**Clyde.**—Albite, garnet.

**Hull.**—Apatite, amphibole; *garnet,* titanite, tourmaline, barite, fluorite, jasper (Chelsea), graphite, magnetite, oligoclase, *wilsonite,* pyroxene.

**Lochaber.**—*Graphite.*

**Portland.**—*Apatite, wilsonite, pyroxene,* coccolite, scapolite, mizzonite, cinnamon garnet.

**Templeton.**—*Apatite!* rutile, *titanite, scapolite, tourmaline* (blk.), hematite (Haycock mine), wollastonite, *pyroxene, zircon, vesuvianite! phlogopite!* garnet, *chrysotile,* amphibole, prehnite, *wilsonite,* chabazite, stilbite, uralite, fibrous calcite, crocidolite. Barite (michel-lévyte) at Perkin's Mill.

**Villeneuve.**—*Albite, muscovite,* microcline, tourmaline, garnet, *monazite,* uraninite, spessartite.

**Wakefield.**—*Apatite! titanite, pyroxene, garnet, zircon,* vesuvianite, scapolite, phlogopite, calcite, *garnet!* spinel (blue), tourmaline (blk.), chrome garnet.

**PONTIAC CO.—Aldfield.**—*Molybdenite!* chondrodite, titanite, tremolite, *vesuvianite.*

**ALLEYN CO.**—Molybdenite, *molybdite.* **Clarendon.**—*Tourmaline,* pyrallolite.

**Grand Calumet Island.**—*Apatite, phlogopite! pyroxene!* sphalerite, titanite, *vesuvianite! serpentine,* tremolite, *scapolite,* brown and black *tourmaline!* pyrite, loganite. Calumet, sphalerite, retinalite, galena, pyrite.

**Lichfield.**—Calumet Falls, blue apatite, blue calcite, scapolite, loganite, serpentine, phlogopite, pyroxene, *tourmaline!*

**RICHMOND CO.—Brompton.**—Chalcocite. **Cleveland.**—Chalcocite, chlorite, bornite. **Melbourne.**—Chalcocite, chlorite, chrysotile, pyrite, massive epidote, bornite, kämmererite.

**ROUVILLE CO.—Belœil.**—In elæolite-syenite, acmite (ægirite), cancrinite. **Rougemont.**—Augite in trap, chrysolite.

**ST. MAURICE CO.—Point du Lac.**—Limonite.

**SHEFFORD CO.—Shefford.**—Chalcocite, chlorite, titanite. **Stukeley.**—Serpentine, *verd-antique!* schiller spar, chalcocite, chalcopyrite.

**SHERBROOKE CO.—Ascot.**—Chalcopyrite, chlorite. **Capelton.**—Chalcopyrite, pyrite, tennantite. **Lenox.**—*Arsenopyrite.*

**Orford.**—White garnet, *chrome garnet, millerite,* serpentine, *pyroxene,* diallage, magnetite, calcite.

**Sherbrooke.**—At Suffield mine, *albite! native silver,* argentite, chalcopyrite, sphalerite, *jasper!*

**STANSTEAD CO.—Barford.**—Pyrrhotite.

**TERREBONNE CO.—Abercrombie.**—*Labradorite.* **Mille Isles.**—*Labradorite!* ilmenite, hypersthene, andesine, *zircon.* **Morin.**—*Titanite, apatite, labradorite,* wollastonite **North River.**—Zircon.

**St. Jérôme.**—Titanite, *apatite, chondrodite, phlogopite, tourmaline, zircon, garnet,* molybdenite, pyrrhotite, wollastonite, *labradorite.*

**VAUDREUIL CO.—Vaudreuil.**—Limonite, vivianite.

**WOLFE CO.—Ham** (or Southam).—Chromite in serpentine, diallage, *antimony! senarmontite! kermesite! valentinite,* stibnite, chalcopyrite, chrysotile. **Wolfstown.**—Chromite.

**YAMASKA CO.—Yamaska Mt.**—Amphibole, titanite in trap.

## PROVINCE OF ONTARIO.

**ADDINGTON CO.—Clarendon.**—*Vesuvianite, tourmaline.* **Sheffield.**—Stibnite in crystallized dolomite.

**BROCKVILLE CO.—Brockville.**—Pyrite.

**FRONTENAC CO.—Marble Lake,** Barrie Township.—Meneghinite, galena.
**Bedford and Loughborough.**—Graphite.
**Kingston.**—*Celestite* in Trenton limestone. **Palmeston.**—*Hematite.*

**GREY CO.—Sydenham.**—Celestite, limonite.

**HASTINGS CO.—Elzevir.**—*Pyrite.* **Madoc.**—Magnetite, hematite, pyrite, rutile, uraconite.
**Marmora.**—*Arsenopyrite!* (argentiferous at Deloro), magnetite, serpentine, garnet, epsomite, hematite, lepidomelane, steatite. **Tudor.**—*Arsenopyrite,* native bismuth, bismuthinite, *pyrite.*

**HURON CO.—Clinton.**—Nat. sulphur.

**LAMBTON CO.—Enniskillen.**—Petroleum, bitumen.

**LANARK CO.—Bathurst.**—Barite, *black tourmaline, perthite* (orthoclase), *peristerite* (albite), *bytownite,* pyroxene, wilsonite, scapolite, apatite, titanite, amphibole.
**Dalhousie.**—Dolomite, amphibole, tremolite.
**Lanark.**—Raphilite (amphibole), serpentine, asbestus, perthite (aventurine feldspar), peristerite.
**Elmsley.**—Pyroxene, titanite, feldspar, *tourmaline,* apatite, biotite, zircon, red spinel, chondrodite, orthoclase, *garnet.*
**North and South Burgess.**—*Pyroxene,* albite, *mica,* corundum, titanite, chalcopyrite, *apatite, black spinel!* spodumene (in a boulder), serpentine, biotite, barite, graphite, orthoclase, *wilsonite,* wollastonite, phlogopite, samarskite, zircon, tourmaline.
**Perth.**—Apatite in large beds, phlogopite.

**LEEDS CO.—Bastard.**—Wollastonite. **Charleston Lake.**—Tourmaline.
**Elizabethtown.**—*Pyrrhotite, pyrite,* calcite, magnetite, talc, phlogopite, siderite, apatite, cacoxenite. **Leeds.**—Hematite.
**Lansdowne.**—*Celestite,* vein 27 in. wide, and fine crystals, *rensselaerite,* sphalerite, wilsonite, labradorite.
**North and South Crosby.**—Chondrodite, graphite. **Newborough.**—*Chondrodite,* graphite.

**NORFOLK CO.—Charlottesville.**—Nat. sulphur. **Walsingham.**—Limonite.

**PEEL CO.—Caledon** (forks of the Credit River).—Red celestite, dolomite.

**PETERBOROUGH CO.—Balsam Lake.**—Pyrite, pyrrhotite.
**Burleigh.**—*Albite* (*peristerite*). **Dummer.**—Barite, tourmaline.
**Galway.**—Barite, *calcite!* scapolite. **Snowdon.**—Uraconite, magnetite.

**PRESCOTT CO.—Little Rideau.**—Celestite (fibrous).

**RENFREW CO.—Algona.**—Scapolite, *tremolite!* **Arnprior.**—Calcite. **Blythfield.**—*Pyroxene, tourmaline, pargasite,* tremolite. **Brudensville.**—*Zircon!* **Calabogie Lake.**—Tremolite.
**Eganville.**—*Titanite! apatite, zircon,* etc., amphibole.
**High Falls of the Madawaska.**—*Pyroxene!* amphibole. **McNab.**—Hematite, barite.
**Ross Township.**—*Apatite, titanite,* amphibole, *pyroxene,* orthoclase, *scapolite,* chrysotile, molybdenite, molybdite, spinel, *tourmaline!*
**Sebastopol Township.**—*Apatite! titanite! zircon! hornblende, orthoclase,* microcline, *scapolite, pyroxene,* calcite (salmon-red).

**SIMSCOE CO.—Nattawasga.**—Limonite.

**VICTORIA CO.—Balsam Lake.**—*Molybdenite,* scapolite, quartz, pyroxene, pyrite.

**DISTRICT OF ALGOMA.—Bruce Mines** on Lake Huron.—*Calcite,* dolomite, quartz, *chalcopyrite, chalcocite.*
**Jackfish Lake,** Huronian Mine.—Sylvanite.
**Sudbury.**—Niccoliferous *pyrrhotite* and *chalcopyrite,* polydymite, *sperrylite,* cassiterite.

**DISTRICT OF NIPISSING.—Iron Islands** (Nipissing Lake).—*Red barite*, fluorite.
**McKim** and adjoining towns.—Chalcopyrite, pyrrhotite, smaltite.

**LAKE HURON, Owen Sound,** on the Grand Manitoulin Islands, etc.—*Celestite.*

**LAKE SUPERIOR**, North Shore (east of Thunder Bay distr.).—**Battle Island,** native copper. **Jarvis Island.**—Silver, argentite, barite, celestite, calcite. **McKellar's Island.**—Silver, sphalerite, galena, pyrite, argentite, barite, calcite.

**Michipicoten Island.**—*Domeykite, niccolite, genthite, chalcopyrite,* native copper, native silver, chalcocite, galena, amethyst, calcite, stilbite, analcite. At Maimanse Bay, coracite, chalcocite, chalcopyrite, native copper, agate, argentite, calcite, genthite.

**Neepigon Bay.**—Fluor Island, fluorite. St. Ignace Island, *calcite*, native copper, prehnite.

**Pie Island.**—Elæolite, zircon. On mainland opposite Pie Island, fluorite, barite.

**Point-aux-Mines.**—Native copper, coracite, mesolite, epidote, galena. **Prince's Mine.**—Erythrite, fluorite, calcite, galena.

**Silver Islet.**—Argentite, native silver, *galena*, niccolite, chalcocite, malachite, silver arsenide, pyrite, *calcite*. **Edwards Is.**—Native arsenic.

**Spar Island**—Apophyllite, argentite, silver, chalcocite, sphalerite, calcite. **Terrace Cove.**—Molybdenite.

**THUNDER BAY DISTRICT AND WESTWARD.—Amethyst Harbour.**—*Amethyst!* **Dog Lake.**—Native lead. **Duncan Mine.**—*Dog-tooth spar*, argentite. **McIntyre.**—*Siderite.* **McKellar's Point.**—Pectolite. **Mouth of McKenzie River.**—Amethyst, fluorite. **Neebing.**—Chalcopyrite, galena, marcasite. Neebing Lake, barite. **O'Connor.**—Beaver mine, asbestus. **Thunder Cape.**—Galena.

**RABBIT MTS.**—Twin Cities mine, witherite. 22 m. S. W. Port Arthur, *harmotome.*

## PROVINCE OF NOVA SCOTIA.

**ANNAPOLIS CO.—Chute's Cove.**—*Apophyllite*, natrolite, heliotrope.

**Gate's Mountain.**—Analcite, magnetite, *mesolite! natrolite*, stilbite.

**Granville.**—Carnelian.

**Margaretville.**—Apophyllite, gyrolite, *stilbite*, epistilbite, laumontite.

**Martial's Cove.**—*Analcite!* chabazite, *heulandite.* **Moose River.**—Beds of magnetite.

**Nictau River.**—At the Falls, bed of hematite. Paradise River, black tourmaline, *smoky quartz!*

**Peter's Point**, west side of Stonock's Brook.—*Apophyllite!* calcite, heulandite, *laumontite!* (abundant), native copper, stilbite.

**Port George.**—Faröelite, laumontite, mesolite, stilbite. East of Port George, on coast, apophyllite containing gyrolite.

**St. Croix's Cove.**—Chabazite, heulandite.

**ANTAGONISH CO.—College Lake.**—*Chalcopyrite.* On St. George's Bay, and elsewhere, *gypsum*, in thick strata. Frenchman's Barn, gieseckite. South Lake, chrysolite. Arisaig Pier, gieseckite.

**CAPE BRETON CO.**—At **Gabarus**, *molybdenite*, bismuthinite. At Loch Lomond, Salmon River, *manganese ore*.

**Plaister Cove**, Mabou, Port Hood, etc.—*Gypsum.* Near Sidney, copper ores.

**Little Glace Bay.**—Cannel coal, melanterite.

**New Annan.**—Covellite.

**COLCHESTER CO.—Five Islands, East River.**—*Barite*, calcite, dolomite (ankerite), gmelinite, hematite, chalcopyrite.

**Indian Point.**—Malachite, magnetite, red copper, tetrahedrite.

**Pinnacle Islands.**—*Analcite*, calcite, *chabazite!* natrolite, siliceous sinter.

**Londonderry**, on branch of Great Village River.—*Barite!* ankerite, *hematite, limonite, magnetite*, aragonite, sideroplesite, wad.

**Cook's Brook.**—Ankerite, hematite. **Martin's Brook.**—Hematite, limonite

**Folly River.**—Below Falls, ankerite, pyrite. On high land, east of river, ankerite, hematite, limonite.

**Archibald's Land.**—Ankerite, *barite*, hematite.

**Salmon River**, south branch of.—Chalcopyrite, hematite.

**Shubenacadie River.**—Anhydrite, calcite, *barite*, hematite, oxide of manganese. At the Canal, pyrite.

**Stewiacke River.**—*Barite* (in limestone; 300 tons mined in 1885). Near **Clifton**, göthite, pyrolusite, calcite, barite.

**Onslow.**—*Manganese ore*

**CUMBERLAND CO.**—Cape Chiegnecto, barite.

**Cape d'Or.**—*Analcite, apophyllite!* chabazite, faröeite, laumontite, *mesolite*, malachite, *natrolite, native copper*, obsidian, red copper (rare), vivianite (rare).

**Horseshoe Cove**, east side of Cape d'Or.—Analcite, calcite, stilbite.

**Isle Haute**, south side.—Analcite, *apophyllite!* calcite, *heulandite!* natrolite, mesolite, *stilbite!*

**Joggins.**—Coal, hematite, limonite. Malachite and tetrahedrite at Seaman's Brook.

**Partridge Island.**—Analcite, *apophyllite!* (rare), *amethyst!* agate, apatite (rare), *calcite!* chabazite (acadialite), chalcedony, cat's-eye (rare), gypsum, hematite, *heulandite!* magnetite, *stilbite!*

**Swan's Creek.**—West side, near the Point, calcite, gypsum, *heulandite*, pyrite. East side, at Wasson's Bluff and vicinity, *analcite! apophyllite!* (rare), *calcite, chabazite!* (acadialite), gypsum, *heulandite! natrolite!* siliceous sinter.

**Two Islands.**—Gmelinite, heliotrope, moss agate, analcite, calcite, chabazite, *heulandite.*

**McKay's Head.**—Analcite, calcite, heulandite, *siliceous sinter!*

**Amherst.**—Manganese ore.

**Spring Hill** coal field, Scotia mines. Alunogen.

**DIGBY CO.**—**Briar Island.**—Native copper, in trap, jasper.

**Digby Neck, Sandy Cove,** and vicinity.—*Agate, amethyst, calcite, chabazite, hematite! laumontite* (abundant), magnetite, *martite, stilbite*, quartz crystals.

**Gulliver's Hole.**—*Magnetite, stilbite!*

**Mink Cove.**—Amethyst, *chabazite!* quartz crystals.

**Nichols Mountain**, south side.—*Amethyst, magnetite!*

**Williams Brook**, near source.—*Chabazite* (green), heulandite, stilbite, quartz crystal.

**Trout Cove.**—Carnelian, chalcedony.

**GUYSBORO CO.**—Cape Canseau, *andalusite.* **Sherbrooke.**—*Octahedrite.*

**HALIFAX CO.**—Gay's River, galena in limestone. Southwest of Halifax, garnet, staurolite, tourmaline.

**Tangier.**—*Gold!* in quartz veins in clay state, associated with auriferous pyrite, galena, hematite, arsenopyrite, and magnetite. Gold at Country Harbour, Fort Clarence, Isaac's Harbour, Indian Harbour, Laidlow's Farm, Lawrencetown, Sherbrooke, Salmon River, Wine Cove, and other places. At Hammond's Plains and Musquodoboit, molybdenite, pyrolusite.

**HANTS CO.**—**Cheverie.**—*Oxide of manganese* (in limestone), *gypsum.* Petite River, gypsum, oxide of manganese.

**Walton.**—*Pyrolusite, manganite.*

**Teny Cape.**—Manganese ores, *dog-tooth spar.*

**Windsor.**—Calcite, *gypsum* (great bed), with cryptomorphite (baronatrocalcite), howlite, mirabilite selenite, aragonite, epsomite, ulexite. At Rawdon, manganite, *stibnite*, of which 758 tons were exported in 1885, turgite, hematite.

**Brookville.**—Howlite, ulexite, *cacholong!* carnelian.

**Newport Station.**—Howlite, ulexite. Noel, howlite.

**Douglas.**—Psilomelane, pyrolusite. Seven Mile Plain, *pyrite.*

**KINGS CO.**—**Black Rock.**—Centrallassite, cerinite, *dog-tooth spar*, cyanolite. A few miles east of Black Rock, prehnite? *stilbite!*

**Cape Blomidon.**—On the coast between the cape and Cape Split, the following minerals occur in many places (some of the best localities are nearly opposite Cape Sharp): *analcite! agate! amethyst! apophyllite!* calcite, *chalcedony* (blue), steeleite, chabazite, *gmelinite* (lederite), hematite, *heulandite!* laumontite, magnetite, malachite, *mesolite*, native copper (rare), *natrolite!* psilomelane, *stilbite!* thomsonite, faröelite, *quartz.*

**North Mountains.**—Amethyst, bloodstone (rare), *ferruginous quartz, mesolite* (in soil), *thomsonite!*

**Long Point**, five miles west of **Black Rock.**—*Heulandite, laumontite, stilbite!*

**Morden.**—*Stilbite, apophyllite, mordenite.*

**Scott's Bay.**—*Agate*, amethyst, *chalcedony*, rutile, mesolite, natrolite.

**Woodworth's Cove**, a few miles west of **Scott's Bay.**—*Agate! chalcedony! jasper*, rutile. Kentville, pyrolusite. Hall's Harbour, *stilbite*, sphærostilbite.

**LUNENBERG CO.**—**Chester.**—Gold River, gold in quartz, pyrite, arsenopyrite.

**Cape la Have.**—*Pyrite.* The "Ovens," *gold*, pyrite, arsenopyrite. Petite River, gold in slate.

**PICTOU CO.**—**Pictou.**—*Jet*, oxide of manganese, limonite. At Roder's Hill, six miles west of Pictou, barite. On Caribou River, gray copper and malachite in lignite.

**Albion Mines.**—Coal, limonite. East River, limonite, hematite, magnetite, siderite, ankerite. On Sutherland's R., *siderite.*

**Smithfield.**—Argentiferous galena

**QUEEN'S CO.—Westfield.**—Gold in quartz, pyrite, arsenopyrite.
**Five Rivers.**—Near Big Fall, gold in quartz, pyrite, arsenopyrite, limonite.

**RICHMOND CO.**—West of **Plaister Cove**, barite and calcite in sandstone. Nearer the Cove, calcite, *fluorite* (blue), siderite, *gypsum* in beds of great thickness (giving the name to Plaister Cove).

**SHELBURNE CO.—Shelburne.**—Near mouth of harbor, garnets (in gneiss). Near the town, rose quartz.
**Jordan and Sable River.**—*Staurolite* (abundant), schiller spar.

**SYDNEY CO.**—Hills east of **Lochaber Lake.**—Pyrite, chalcopyrite, siderite, hematite.
**Morristown.**—Epidote in trap, *gypsum* (making a cliff of 200 feet, near Ogden's Lake).

**YARMOUTH CO.—Cream Pot**, above Cranberry Hill.—Gold in quartz, pyrite. Cat Rock, Fouchu Point, asbestus, calcite.

## PROVINCE OF NEW BRUNSWICK.

**ALBERT CO.—Hopewell** on Shepody Bay.—Gypsum, manganese ores.
**Albert Mines.**—Near Hillsboro', *albertite* (largely exported).
**Shepody Mountain.**—Alunite in clay, calcite, pyrite, *manganite*, psilomelane, *pyrolusite*, gypsum (quarried), *anhydrite* (with the gypsum).

**CARLETON CO.—Woodstock.**—Chalcopyrite, hematite, limonite, wad.

**CHARLOTTE CO.—Campobello**, at Welchpool.—Sphalerite, chalcopyrite, bornite, galena, pyrite
At head of **Harbour de Lute.**—Galena.
**Deer Island**, on west side.—Calcite, magnetite, quartz crystals.
**Digdighash River.**—On west side of entrance, *calcite!* (in conglomerate), chalcedony. At Rolling Dam, graphite.
**Grand Manan.**—Between Northern Head and Dark Harbour, agate, amethyst, *apophyllite*, *calcite*, hematite, heulandite, jasper, magnetite, natrolite, *stilbite*.
**Moore's Mills.**—Andalusite (chiastolite), staurolite.
**Whale Cove.**—*Calcite!* heulandite, laumontite, stilbite, *semi-opal!*
**Wagaguadavic River**, at entrance.—Azurite, chalcopyrite, in veins, malachite.

**GLOUCESTER CO.—Tête-à-Gouche River**, eight miles from Bathurst.—Chalcopyrite (mined), *oxide of manganese!* formerly mined.

**KINGS CO.—Sussex.**—Near Cloat's mills, on road to Belle Isle, argentiferous galena. One mile north of Baxter's Inn, *specular iron* in crystals, limonite. On Capt. McCready's farm, *selenite!*
**Upham.**—*Manganese* ores, gypsum.

**RESTIGOUCHE CO.—Belledune Point.**—*Calcite! serpentine, verd-antique.* **Dalhousie**, agate, carnelian.

**ST. JOHN CO.—Black River.**—On coast, calcite, chlorite, chalcopyrite, *hematite!*
**Brandy Brook.**—Epidote, *hornblende*, quartz crystals.
**Carleton.**—Near Falls, calcite.
**Chance Harbour.**—*Calcite* in quartz veins, chlorite in argillaceous and talcose slate.
**Little Dipper Harbour.**—On west side, in greenstone, amethyst, barite, quartz crystals.
**Moosepath.**—Feldspar, amphibole, muscovite, black tourmaline.
**Musquash.**—On east side harbor, copperas, graphite, pyrite.
**Shannon's**.—Chrysolite, serpentine. East side of Musquash, *quartz crystals!*
**Portland.**—At the Falls, graphite.
**Fort Howe Hill.**—*Calcite*, graphite.
**Crow's Nest.**—Asbestus, *chrysolite*, magnetite. *serpentine*, steatite.
**Lily Lake.**—White augite? chrysolite, graphite, serpentine, steatite talc.
**How's Road.**—Two miles out, epidote (in syenite), steatite in limestone, *tremolite*.
**Drury's Cove.**—Graphite, pyrite, pyrallolite? indurated talc.
**Quaco**, at **Lighthouse Point.**—Large bed of oxide of manganese. Sheldon's Point, actinolite, asbestus, calcite, *epidote*, malachite, hematite.
**Cape Spenser.**—Asbestus, calcite, chlorite, hematite (in crystals).

**Westbeach.**—At east end on Evans's farm, chlorite, talc, *quartz crystals.* Half a mile west, chlorite, chalcopyrite, magnesite (vein), magnetite.

**Point Wolf and Salmon River.**—Asbestus, chlorite, chrysocolla, chalcopyrite, bornite, pyrite.

**VICTORIA CO.—Tabique River.**—*Agate, carnelian,* jasper. At mouth, south side, galena.

At mouth of **Wapskanegan.**—Gypsum, salt spring.

**Petticodiac.**—Selenite, gypsum. Three miles above, stalactites (abundant).

**Quisabis River.**—Blue phosphate of iron, in clay.

**WESTMORELAND CO.—Bellevue.**—Pyrite. Dorchester, on Taylor's Farm, cannel coal, clay ironstone. On Ayer's Farm, asphaltum, petroleum spring.

**Grandlance.**—Apatite, selenite (in large crystals). Memramcook, coal (albertite).

**YORK CO.**—Near **Fredericton**, Prince William parish, Brunswick mine, *stibnite* (mined), *native antimony,* jamesonite, berthierite, kermesite, valentinite.

**Pokiock River.**—Stibnite, *tin pyrites?* in granite (rare).

## PROVINCE OF BRITISH COLUMBIA.

**Barclay Sound**, Vancouver Is.—Ilvaite.

**Cariboo District.**—Native gold, galena.

**Cherry Creek**, 33 m. E. of Head of Okanagon Lake.—Argentif. tetrahedrite, galena, sphalerite.

**Frazer River.**—Near Lytton, boulders of nephrite. Foster Bar, 22 m. above Lytton, stibnite, massive garnet, tetrahedrite, ankerite. Seven m. up Wilson Creek, native arsenic. 10 m. below Lillicoot, platinum.

**Ominica District.**—Vital and Silver Creeks, native gold, argentiferous galena, native silver, arquerite.

**Howe's Sound.**—Bornite, molybdenite, mica.

**Texada Id.**—Magnetite. Malaspina copper mine, andradite, chalcopyrite, tremolite, dolomite.

**Shuswap Lake.**—*Bismuthinite.*

**Hi-hum Lake**, south of Loon L.—*Hyalite.*

**Kootanie Lake.**—At the International Claim and Hendrix Camp, galena (argent.), tetrahedrite.

**Jarvis Inlet**, Salmon Arm.—Bornite.

**Ice R.** (branch of the Beaver Foot, Rocky Mts.).—*Sodalite.*

**Hector** (or Kicking Horse) **Pass**, Rocky Mts.—At the Ebenezer mine, cinnabar.

**Illecillewaet R.**, Selkirk Range.—Tetrahedrite (argentif.), galena, pyrite, chalcopyrite, sphalerite.

**Kamloops Lake**, Tranquille R.—Gold, platinum, in gravel.

**Nicholas Valley.**—At the Stump mines, tetrahedrite.

**North Thomson R.**—Cyanite, tetrahedrite.

**Otter Tail Creek.**—Cookeite (?) with galena.

**Peace R.**—At Fort St. John, on cliffs of shale, mirabilite, epsomite.

**Similkameen R.**—In gravel, gold, platinum.

**Skeena R.**—*Garnet!* in mica schist.

**Tulameen R.**, Granite Creek.—In gravel, gold, platinum.

## NORTH-WEST TERRITORY.

**Keewatin.**—Mouth of Churchill river, lazulite.

**Smoky R.**—Native sulphur, sal-ammoniac.

**N. Saskatchewan.**—Chemawinite on the shores of Cedar Lake.

**Yukon R.**—Gold in placers, nephrite.

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## NEWFOUNDLAND.

**Antony's Island.**—*Pyrite.*

**Catalina Harbour.**—On the shore, *pyrite!*

**Chalky Hill.**—*Feldspar.*

**Copper Island**, one of the Wadham group.—*Chalcopyrite.*

**Conception Bay.**—On the shore south of Brigus, bornite and tetrahedrite.

**Bay of Islands.**—Southern shore, *pyrite* in slate.

**Lawn.**—*Galena, cerargyrite, proustite, argentite.*

**Placentia Bay.**—At La Manche, two miles eastward of Little Southern Harbour, *galena!* On the opposite side of the isthmus from Placentia Bay, barite in a large vein, occasionally accompanied by chalcopyrite.

**Shoal Bay.**—South of St. John's, chalcopyrite.

**Tilt Cove.**—*Niccolite.*

**Trinity Bay.**—Western extremity, barite.

**Harbour Great St. Lawrence.**—West side, galena.

# INDEX TO SPECIES.

NOTE.—Names of numbered species and of a few important synonyms are printed in heavy-faced type.

# FIRST APPENDIX

TO THE

# SIXTH EDITION

OF

# DANA'S SYSTEM OF MINERALOGY

BY

EDWARD S. DANA

PROFESSOR OF PHYSICS AND CURATOR OF MINERALOGY YALE UNIVERSITY

COMPLETING THE WORK TO 1899

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# PREFATORY NOTE.

**This First Appendix to the Sixth Edition of the System of Mineralogy issued in 1892 is** designed to make the work complete up to and including the early part of 1899.

This Appendix contains, first of all, full descriptions of the species announced as new since the publication of the System. There are no fewer than one hundred and sixty names here included, and their place in the general scheme of classification adopted in the System is shown in the classified list given in the Introduction. Unfortunately many of the new names, introduced into the science, during this period, have little claim to recognition, either because of the incompleteness of the original examination or the unsatisfactory nature of the material investigated. On the other hand a considerable part of the descriptions leave nothing to be desired both as regards fullness and accuracy. The relative importance of the new names is approximately indicated by the type used in the classified list.

In addition to the description of new minerals, this Appendix is intended to contain also references to all important papers on mineral species published during the period named; with each reference is given a concise statement of its character, and so far as possible a summary of its contents. Since, however, the additions to mineralogical literature have been very numerous, it has been necessary in order to keep this work within reasonable compass to adhere rigidly to a system of extreme brevity of expression and conciseness of arrangement. All minerals named are, for convenience, placed in alphabetical order.

For an explanation of the *Abbreviations* made use of in the case of periodicals, also of the crystallographical, optical and chemical symbols employed, reference is made to the Introduction to the System (1892), pp. xlv–li, and pp. xiii–xl. General abbreviations are explained on pp. lxi–lxiii.

The Bibliography includes the full titles of prominent volumes published since 1891. In addition attention is called to the large number of important memoirs on physical subjects, recently issued, particularly those on the molecular structure of crystals as related to the symmetry of form by Fedorow, Schönflies, Goldschmidt, Barlow, Viola, and others. These and other related papers will be found either in full or as abstracts in Groth's invaluable *Zeitschrift für Krystallographie und Mineralogie*, vols. 20–30 inclusive.

The thanks of the author are due to his colleagues, Prof. S. L. Penfield and L. V. Pirsson. The former has had the kindness to furnish brief accounts of some new species now for the first time publicly described.

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# INTRODUCTION.

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# CLASSIFIED LIST OF NEW NAMES.

## I. NATIVE ELEMENTS, Min. pp. 2–32.

**JOSEPHINITE** (p. 38), $Fe_2Ni_6$. Near Awaruite, Min. p. 29.
Graphitite (p. 31). Var. Graphite, Min. p. 7.

## II. SULPHIDES, TELLURIDES, ARSENIDES, ETC., Min. pp. 33–108.

**GRÜNLINGITE** (p. 31), $Bi_4TeS_3$. Near Tetradymite, Min. p. 39.
Quirogite (p. 58). An impure Galena, Min. p. 48 ?
Heazlewoodite (p. 33), Folgerite (p. 52). Essentially Pentlandite, Min. p. 65.
Gunnarite (p. 31), $Fe_3Ni_2S_8$ ? Near Pentlandite.
**Hauchecornite** (p. 33), $(Ni,Co)_7(S,Bi,Sb)_8$. Near Polydymite, Min. p. 75.
BARRACANITE, Cupropyrite (p. 21). Near Cubanite, Min. p. 79.
Blueite (p. 56), Whartonite (p. 56). Same as Pyrite, Min. p. 84.
**Willyamite** (p. 73), CoSbS.NiSbS. Near Ullmannite, Min. p. 91.
BISMUTOSMALTITE, NICKEL-SKUTTERUDITE (p. 63). Varieties of Skutterudite, Min. p. 98.
**Goldschmidtite** (p. 30), $Au_2AgTe_6$. Near Sylvanite, Min. p. 103.
KALGOORLITE (p. 38), $HgAu_2Ag_6Te_6$.

## III. SULPHO-SALTS, Min. pp. 109–151.

### 1. SULPHARSENITES, SULPHANTIMONITES, ETC.

**Andorite**, Webnerite, Sundtite (p. 4), $2PbS.Ag_2S.3Sb_2S_3$. Related to Zinkenite Group. Min. p. 111.
**Lorandite** (p. 43), $Tl_2S.As_2S_3$. Near Miargyrite. Min. p. 116.
**Pearceite** (p. 50), $9Ag_2S.As_2S_3$. Near Polybasite, Min. p. 146.
**Rathite** (p. 58), contains S,As(Sb),Pb. Related to Dufrenoysite, Min. p. 120, and Jamesonite, p. 122.

### 2. SULPHOSTANNATES.

**Canfieldite** (p. 13), $4Ag_2S.(Sn,Ge)S_2$. Near Argyrodite, $4Ag_2S.GeS_2$, p. 6, and Min. p. 150.
**Cylindrite**, Kylindrit (p. 21), $6PbS.Sb_2S_3.6SnS_2$.
**Franckeite** (p. 26), $5PbS.Sb_2S_3.2SnS_2$.

## IV. CHLORIDES, BROMIDES, IODIDES, Min. pp. 152–182.

### 1. ANHYDROUS CHLORIDES, ETC.

**Marshite** (p. 45), $Cu_2I_2$. In Group with Nantokite, p. 154.
**Miersite** (p. 47), $Ag_2I_2$. " " " " "
**Cupro-iodargyrite** (p. 21), CuI.AgI or $Cu_2I_2.Ag_2I_2$.

### 2. OXYCHLORIDES.

**Paralaurionite** (p. 50), $PbCl_2.Pb(OH_2)_2$. Near Laurionite, p. 171.
**Penfieldite** (p. 51), $PbO.2PbCl_2$.

CUMENGITE, PSEUDOBOLÉITE (p. 52). Near Percylite and Boléite, Min. pp. 172 and 1028.
METANOCERINE (p. 46). Near Nocerite, Min. p. 174?

## V. OXIDES. Min. pp. 183–260.

QUARTZINE, LUTÉCINE, LUTÉCITE (p. 58). Near Quartz, Min. p. 183.
Cubaite, Guanabaquite, Guanabacoite (p. 58). Same as Quartz.
MITCHELLITE (p. 17). Var. Chromite (Magnochromite), Min. p. 228.
**Baddeleyite**, Brazilite (p. 8), $ZrO_2$.
Dicksbergite (p. 23). Same as Rutile, Min. p. 237.
Mesabite (p. 30). Var. Göthite, Min. p. 247.
Schulzenite (p. 61). Near Asbolite, Min. p. 258.

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**Geikielite** (p. 28), $MgO.TiO_2$.
**Bixbyite** (p. 10), $FeO.MnO_2$.
**Senaite** (p. 61), $(Fe,Pb)O.2(Ti,Mn)O_2$.
**Zirkelite** (p. 75), $(Ca,Fe)O.2(Zr,Ti,Th)O_2$.
The above may properly be placed with the Titanates (Manganates, Zirconates).

## VI. 1. CARBONATES, Min. pp. 261–309.

**Northupite** (p. 49), $MgCO_3.Na_2CO_3.NaCl$.
**Pirssonite** (p. 53), $CaCO_3.Na_2CO_3.2H_2O$.
KTYPEITE (p. 39), $CaCO_3$.
Hydrocalcite (p. 36).
Taraspite (p. 67). Var. Dolomite, Min. p. 271.
Calcistrontite (p. 13). A mixture of Calcite and Strontianite.

## VI. 2. SILICATES.

### A. ANHYDROUS SILICATES, Min. pp. 310–562.

**Epididymite** (p. 24), $HNaBeSi_3O_8$. Near Eudidymite, Min. p. 313.
**Celsian** (p. 15), $BaAl_2Si_2O_8$. Barium Feldspar, near Anorthite, Min. p. 337.
**Urbanite**, Lindesite (p. 70), $(Ca,Mg)SiO_3 + 2Na\overset{iii}{Fe}(SiO_3)_2$. Pyroxene Group, Min. p. 314.
FEDOROVITE (p. 57). Bet. Ægirite-augite and Ægirite, Pyroxene Group, Min. p. 344.
**Hainite** (p. 31), contains Ti, Zr, Na, Ca. Related to Låvenite, p. 375, Wöhlerite, Min. p. 376, etc.
HASTINGSITE (p. 3), PHILIPSTADITE (p. 3), Xiphonite (p. 3). Referred to Amphibole, Min. p. 385.
RHODUSITE (p. 29). Near Glaucophane, Min. p. 399.
CATAPHORITE (p. 14). Bet. Arfvedsonite and Barkevikite, Min. pp. 401, 403.
CROSSITE (p. 20). Bet. Glaucophane and Riebeckite, Min. pp. 399, 400.
VALLÉITE (p. 71). Near Anthophyllite, Min. p. 384.
**Elpidite** (p. 24). $H_6Na_2ZrSi_6O_{18}$. Related to Catapleiite, Min. p. 412.
**Hardystonite** (p. 32), $Ca_2ZnSi_2O_7$. Near Ganomalite, Min. p. 422?
**Nasonite** (p. 48). $(Ca,Pb)_{10}Cl_2Si_6O_{21}$.
RHODOLITE (p. 28), LAGORIOLITE (p. 28). Varieties of Garnet, Min. p. 437.
Ransätite (p. 28). Same as Garnet (spessartite), Min. p. 442.
**Glaucochroite** (p. 29), $CaMnSiO_4$. Chrysolite Group, Min. p. 449.
Iddingsite (p. 36). Probably an altered Chrysolite, p. 451.
**Fuggerite** (p. 27). Near Gehlenite, Min. p. 476.
MANGANANDALUSITE (p. 4). MALTESITE (p. 4). Varieties of Andalusite, Min. p. 496.
**Thalenite** (p. 68), $H_2Y_4Si_4O_{15}$. Near Yttrialite, Min. p. 512.
CLINOZOISITE, Klinozoisit (p. 17). Calcium-epidote (monoclinic), Min. p. 516.
**Hancockite** (p. 32), contains Si, Pb, Ca, Sr, Al, $\overset{iii}{Fe}$. Epidote Group?
**Prolectite** (p. 55), probably $Mg[Mg(F,OH)]SiO_4$. Humite Group, Min. p. 535.

**Clinohedrite** (p. 17), $H_2ZnCaSiO_4$. Near Calamine, Min. p. 546.
**Lawsonite** (p. 41), $H_4CaAl_2Si_2O_{10}$. Near Carpholite, Min. p. 549.
**Roeblingite** (p. 60), $5H_2CaSiO_4.2CaPbSO_4$.
COSMOCHLORE, Kosmochlor, Kosmochromit (p. 20). A chromium silicate.

### B. OTHER SILICATES, CHIEFLY HYDROUS SPECIES, Min. pp. 562–711.

**Wellsite** (p. 72), $RAl_2Si_3O_{10}.3H_2O$. Phillipsite Group, Min. p. 579.
**Erionite** (p. 25), $H_2CaK_2Na_2Al_2Si_6O_{17} + 5H_2O$.
**Gonnardite** (p. 30), $(Ca,Na_2)_2Al_2Si_5O_{15} + 5\frac{1}{2}H_2O$.
METADESMINE (p. 65). Near Stilbite, Min. p. 583.
METASCOLEZITE (p. 61). Near Scolezite, Min. p. 604.
LEMBERGITE (p. 42), $5Na_2Al_2Si_2O_8 + 4H_2O$.
BADDECKITE (p. 7). Near Muscovite, Min. p. 614.
Caswellite (p. 14). Altered mica.
BEACONITE (p. 66). Var. Talc, Min. p. 678.
PSEUDOPYROPHYLLITE (p. 56). Near Pyrophyllite, Min. p. 691.
HOEFERITE (p. 35), $2Fe_2O_3.4SiO_2.7H_2O$. Near Chloropal, Min. p. 701.
ALEXANDROLITE (p. 7), contains $H_2O, Al_2O_3, Cr_2O_3, SiO_2$.
BATAVITE (p. 9), contains $H_2O, MgO, Al_2O_3, SiO_2$.
Taylorite (p. 67). A clay.
**Weldite** (p. 72), contains $SiO_2$, $Al_2O_3$, $Na_2O$.

### TITANO-SILICATES, TITANATES, Min. pp. 711–724.

LAMPROPHYLLITE (p. 40). Near Astrophyllite, Min. p. 719?
**Neptunite** (p. 49). Near Titanite, p. 712.
**Knopite** (p. 39). Near Perovskite and Dysanalyte, Min. pp. 722, 724.
Other Titanates are mentioned on the preceding page.

### VI. 3. NIOBATES, TANTALATES, Min. pp. 725–746.

**Mossite** (p. 48), $Fe(Nb,Ta)_2O_6$. Near Tapiolite, p. 738.
STIBIOTANTALITE, $Sb_2O_3.(Ta,Nb)_2O_5$?

### VI. 4. PHOSPHATES, ARSENATES, ETC., Min. pp. 747–861.

**Adelite** (p. 1, also Min. p. 1052), $(MgOH)CaAsO_4$. Wagnerite Group, Min. p. 775.
**Tilasite** (p. 68), Fluor-adelite, $(MgF)CaAsO_4$. " " " "
MANGANBERZELIITE (p. 10). Near Berzeliite (Pyrrharsenite), Min. 753.
Rhodophosphite (p. 59). Same as Apatite, Min. p. 762?
**Retzian** (p. 59). Basic arsenate of manganese, etc.
Gersbyite (p. 28). Near Lazulite, Min. p. 798.
HAUTEFEUILLITE (p. 33), $(Mg,Ca)_3P_2O_8 + 8H_2O$. Near Bobierrite, Min. p. 817.
**Wardite** (p. 71), $2Al_2O_3.P_2O_5.4H_2O$.
MINERVITE (p. 47), $Al_2O_3.P_2O_5.7H_2O$.
Utahlite (p. 71). Same as Variscite, Min. p. 824.
KEHOEITE (p. 38), $ZnO.4Al_2O_3.5P_2O_5.9H_2O$.
**Carnotite** (p. 13), $K_2O.2U_2O_3.V_2O_5.3H_2O$.

The following are imperfectly described arsenates, or antimonates, of manganese or iron, or both:

Basiliite (p. 9), Chloroarsenian (p. 16), Chondrostibian (p. 17), Elfstorpite (p. 24), Lamprostibian (p. 40), Magnetostibian (p. 44), Melanostibian (p. 44), Rhodoarsenian (p. 59), Sjögrufvite (p. 62).

### ANTIMONATES, Min. pp. 861–866.

**Tripuhyite** (p. 70), $2FeO.Sb_2O_5$.
**Derbylite** (p. 22), $6FeO.5TiO_2.Sb_2O_5$.

**Lewisite** (p. 42), $5CaO.2TiO_2.3Sb_2O_5$.
**Mauzeliite** (p. 45), $4(Ca,Pb)O.TiO_2.2Sb_2O_5$.

### PHOSPHATES (ARSENATES) WITH SULPHATES, Min. pp. 866–869.

**Lossenite** (p. 44), $2PbSO_4.3(FeOH)_3A_2O_8 + 12H_2O$.
Munkforssite (p. 48). Near Svanbergite, Min. p. 868.
Munkrudite (p. 48). " " " "

### VI. 5. BORATES, Min. pp. 874–889.

**Ascharite** (p. 6), $3Mg_2B_2O_5.2H_2O$.
**Sulphoborite** (p. 65), $4MgHBO_3.2MgSO_4.7H_2O$.

### URANATES, Min. pp. 889–893.

**Mackintoshite** (p. 44), $UO_2.3ThO_2.3SiO_2.3H_2O$. Near Thorogummite, Min. p. 893.

### VI. 6. SULPHATES, CHROMATES, Min. pp. 894–981.

**Langbeinite** (p. 40), $K_2SO_4.2MgSO_4$.
**Dietzeite** (p. 23), $7Ca(IO_3)_2.8CaCrO_4$.
BERESOVITE (p. 9), $6PbO.3CrO_3.CO_2$.
SALVADORITE (p. 60), $(Cu,Fe)SO_4 + 7H_2O$. Near Pisanite, Min. p. 943.
SIDEROTIL (p. 62), $FeSO_4 + 5H_2O$.
**Leonite**, Kaliblödite, Kaliastrakanite (p. 42), $K_2SO_4.MgSO_4 + 4H_2O$. Near Blödite, Min. p. 946.
Seelandite (p. 61). Near Pickeringite, Min. p. 953.
Masrite (p. 45). An alum near Halotrichite, Min. p. 954.
KAMAREZITE (p. 38), $(CuOH)_2SO_4.Cu(OH)_2.6H_2O$. Near Langite, Min. p. 961.
PLANOFERRITE (p. 54), $Fe_2O_3.SO_3.15H_2O$.
IDRIZITE (p. 36). Near Botryogen, Min. p. 972.
CUBEITE, Kubeit (p. 21), contains $SO_3,Fe_2O_3,MgO,H_2O$.
Kauaiite (p. 38), contains $SO_3,Al_2O_3,K_2O,Na_2O,H_2O$.
Bouglisite (p. 4). A mixture of anglesite and gypsum.

### VI. 7. TUNGSTATES, MOLYBDATES, Min. pp. 982–995.

**Raspite** (p. 58), $PbWO_4$. Wolframite Group, Min. p. 982 ?

### VIII. HYDROCARBON COMPOUNDS, Min. pp. 996–1024.

Alexjejevite (p. 2), Allingite (p. 2), Burmite (p. 12), Cedarite (p. 14). All near Succinite and Amber, Min. p. 1002.
Courtzilite (p. 20). Same as Uintahite, Min. p. 1020.
Pelionite (p. 51), Var. Cannel Coal.
Libollite (p. 43). Near Albertite, Min. p. 1020.
Tiffanyite (p. 68). Undetermined hydrocarbon.

# APPENDIX I.

**Acanthite**, p. 58.—Crystals of silver sulphide, prismatic and apparently orthorhombic, occur at the Enterprise mine, Rico, Colorado. Chester, School Mines Q., **15**, 303, 1894.

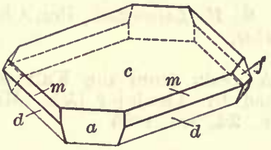
Wire-like forms from Guanajuato, Mexico, referred to acanthite, have been analyzed by Genth, Am. J. Sc., **44**, 383, 1892.

**Adelite**, p. 1052.—The following is a full description, Hj. Sjögren, G. För. Förh., **13**, 781, 1891; Bull. G. Inst. Upsala, **1**, 56, 1892:

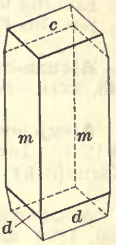
Monoclinic. Crystals rare, tabular ‖ *c* or prismatic (*m*). (Figs. 1, 2.) Observed forms: *a* (100), *c* (001), *m* (110), *f* (011), *d* ($\bar{2}21$). Measured angles: *ac* = 73° 15′. *mm‴* (110 ∧ $1\bar{1}0$) = 87° 5′*?, *m d* ($\bar{1}10$ ∧ $\bar{2}21$) = 24° 45′; a relation to wagnerite is suggested (see foot-note). Usually massive, in embedded grains.

Cleavage none. Fracture conchoidal to uneven. H. = 5. G. = 3·71–3·76. Luster resinous to greasy. Color gray, yellowish gray. Translucent. Optically +. $Bx_a \wedge \grave{c} = +38°\ 45'$. Axial angle large, 2E = 106° 40′, also $2K_{ay}$ = 58° 47′ (*n* = 1·6703); $\rho > v$.

1.



2.



Composition, $HCaMgAsO_5$ or $(MgOH)CaAsO_4$, analogous to the wagnerite group (p. 775). Analyses, R. Mauzelius, quoted by Sjögren:

| | G. | $As_2O_5$ | CaO | MgO | BaO | PbO | CuO | FeO | MnO | $H_2O$ | Cl |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Nordmark | 3·71 | 50·04 | 25·43 | 17·05 | *tr.* | 0·39 | — | — | 1·64 | 4·25 | 0·24 |
| | | | | | | | | [$Fe_2O_3$,$Al_2O_3$ 0·30 | | | Cu 0·26 = 99·60 |
| 2. Långban | 3·76 | 50·28 | 24·04 | 17·90 | 0·23 | 2·79 | 0·32 | 0·08 | 0·48 | 3·90 | *tr.* = 100·02 |
| 3. Jakobsberg | 3·72 | 48·52 | 23·13 | 19·25 | — | 2·41 | — | 0·09 | 1·27 | 3·99 | $SiO_2$ 1·88=100·54 |

Fuses easily B. B. to a gray enamel. With soda on charcoal yields arsenical fumes. Soluble in dilute acids. The water goes off completely only at a high temperature.

Occurs with grains of magnetite and scales of native copper at the Kittel mine, Nordmark, Sweden; also at the Jakobsberg mine with hausmannite, etc., in limestone; with other arsenates and manganese minerals at Långban. Named from ἄδηλος, *indistinct.*

A related mineral from the Moss mine gave Lundström (quoted by Sjögren, G. För. Förh., **7**, 412. 1884. Upsala. p. 60): $As_2O_5$ 49·73, CaO 25·52, MgO 18·98, BaO 0·81, MnO 1·69, ZnO? 0·08, $Al_2O_3$.$Fe_2O_3$ 0·83, loss ($H_2O$) 2 36 = 100. Its character is somewhat uncertain.

See also *Tilasite*, which is a *fluor-adelite*, $(MgF)CaPO_4$.

**Ægirite**, pp. 364, 1046.—Reported as occurring in the nephelite-syenite of Paisano Pass, Davis Mts., Texas, A. Osann, 4 Ann. Rep. Geol. Surv. Texas, 128, 1892. Noted also in rocks at various points, as Salem, Mass.; Cripple Creek, Colo.; Black Hills; Bearpaw Mts., Judith Mts. and Crazy Mts., Montana.

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* The author's angles and axes are hopelessly at variance. He calculates $\grave{a} : \overset{|}{b} : \grave{c}$ = 1·0989 : 1 : 1·5642, $\beta$ = 73° 15′. This ratio for $\grave{a} : \overset{|}{b}$ requires, however, *mm‴* (110 ∧ $1\bar{1}0$) = 92° 55′, not 87° 5′ as stated; also the value 92° 55′ gives the author's angle *cm* = 78° 33′. Furthermore he gives $\bar{1}10$ ∧ $\bar{2}21$ = 24° 45′ and 001 ∧ $\bar{2}21$ = 75° 27′ (76° 26′ meas.), but 001 ∧ $\bar{1}10$ = 101° 27′, hence 001 ∧ $\bar{2}21$ should be 76° 42′. The value of $\grave{c}$ deduced from the author's fundamental angles (using 110 ∧ $1\bar{1}0$ = 92° 55′) is 0·8799, *not* 1·5642; but the measured angles, *ca* = 73° 15′ and *cf* = 56° 27′, give $\grave{c}$ = 1·5748.

ÆNIGMATITE, p. 403.—An amphibole occurring in the "heumite" of Heum, Norway, may belong here, cf. Brögger, Eruptivgesteine d. Krist., 3, 93, 1898. Reported as occurring in Texas, see ægirite.

Investigation of etching-figures, R. A. Daly, Proc. Am. Acad. Sc., **34**, 425, 1899.

AGRICOLITE, p. 448.—From near Schwarzenberg, Saxony, Frenzel, Min. petr. Mitth., **16**, 528, 1896.

AGUILARITE, p. 1025.—Several analyses have been made by Genth on material from the original locality; the purest yielded: Se 13·96, S 5·93, Ag 79·41, Cu 0·50 = 99·80 Dodecahedral crystals gave the composition of argentite, with Se = 3·75 (S : Se = 7 : 1). Other crystals were partially altered to stephanite, etc. Am. J. Sc., **44**, 381, 1892.

ALABANDITE, p. 64.—Occurs at Tombstone, Arizona, in large but rough twinned cubic crystals with tetrahedral faces; G. = 4·031, 4·040; analysis gave (Volckening): S 36·91, Mn 63·03 = 99·94. Moses and Luquer, Sch. Mines Q., **13**, 236, 1892; Moses, Zs. Kr., **22**, 18, 1893.

ALBITE, pp. 327, 1025.—On crystals from Revin, Belgium, see Franck, Bull. Acad. Belg., **21**, 603, 1891.

Crystallographic and optical investigation of a variety free from calcium from Lakous, Crete, Viola, Min. petr. Mitth., **15**, 135, 1895, Zs. Kr., **30**, 423, 436, 1898. Same of varieties from Russian localities, Glinka, Zs. Kr., **22**, 63, 1893; **26**, 509, 1886; Vh. Min. Ges., **31**, 1, 1894.

Cleavage and parting investigated, Penfield, Am. J. Sc., **48**, 115, 1894.

Etching-figures, T. L. Walker, Am. J. Sc., **5**, 182, 1898.

See also *Feldspar*.

**Alexandrolite.** *S. M. Losanitsch*, Ber. Chem. Ges., **28**, 2631, 1895, and Chem. News, **69**, 243, 1894.—See *Avalite*.

**Alexjejevite.** A resin from the Kaluga Govrn., Russia. Composition: C 75·5, H 12·5, O 12·0. Investigated by Alexjejev (Vh. Min. Ges. St. Pet., **29**, 201, 1892) and named by Karnojitsky, Zs. Kr., **24**, 504, 1895.

ALLANITE, p. 522.—Crystals described from Franklin Furnace, N. J., Eakle, Am. J. Sc., **47**, 436, 1892; also from the Harz (*orthite*), Luedecke, Min. d. Harzes, 444, 1896; from Mineville, Essex Co., N. Y., H. Ries, Trans. N. Y. Acad. Sc., **16**, 327, 1897.

Forms about 56 p. c. of a granite on the east shore of Lac à Baude, Champlain Co., Quebec. Hoffmann, Rep. G. Canada, **7**, 12 R, 1894.

**Allingite.** *E. Aweng* [Arch. Pharm., **232**, 1894]. Jb. Min., **2**, 254 ref., 1896. A fossil resin from Switzerland, related to succinite.

ALLOPHANE, p. 693.—Analyses of Italian varieties, G. D'Achiardi, Att. Soc. Tosc., Proc. Verb., March 13, 1898.

ALSTONITE.—See *Bromlite*.

ALTAITE, p. 51.—Occurs near Liddle Creek, West Kootanie, Br. Columbia, Hoffmann, Rep. G. Canada, **6**, 29R, 1893; also on Long lake, Yale district, B. C. (anal. by Johnston), *ibid.*, **8**, 11 R, 1895; at Choukpazat, Upper Burma, Louis, Min. Mag., **11**, 215, 1897.

ALUNITE, p. 974.—Occurs at Tres Cerritos, Mariposa Co., California, in an alunite-quartzite, Turner, Am. J. Sc., **5**, 424, 1898. At Red Mountain, Ouray Co., Colorado, in aggregations of minute crystals with enargite, etc. Analysis; $SO_3$ 38·93, $Al_2O_3$ 39·03, $K_2O$ 4·26, $Na_2O$ 4·41, $H_2O$ 13·35, insol. 0·50 = 100·48. E. B. Hurlburt, Am. J. Sc., **48**, 130, 1894. From Knickerbocker Hill, Custer Co., Colo., anal., Eakins, Bull. U. S. G. Surv., **90**, 62, 1892.

ALURGITE, p. 635.—The deep-red manganese mica from St. Marcel, Piedmont, has been analyzed by Penfield, as follows·

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ | MnO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 53·22 | 21·19 | 1·22 | 0·87 | 0·18 | 6·02 | 11·20 | 0·34 | 5·75 = 99·99 |

For this the formula preferred is $HR_2(AlOH)Al(SiO_3)_4$ with R = MgOH,K chiefly; it is thus distinct from other species of the mica group. It is monoclinic; cleavage basal; laminæ flexible. H. = 3. G. = 2·835–2·849. Not highly pleochroic. $2E_y$ = 56° 5′–57°. Am. J. Sc., **46**, 288, 1893.

AMBER.—See SUCCINITE; also the new names, *Allingite*, *Burmite*, *Cedarite*, etc.

**Amphibole**, pp. 385, 1026.—K. von Kraatz divides the varieties here included into three groups according to prismatic cleavage angle: Tremolite series, cleavage angle 55° 10′ to 55° 25′; common green hornblende, 55° 25′ to 55° 35′; brown basaltic hornblende, 55° 40′ to 55° 50′. Zs. Kr., **30**, 664, 1899.

A discussion of the variation of extinction-angle in the prismatic zone is given by R. A. Daly, Proc. Am. Acad. Sc., **34**, 311, 1899. See also by the same author an exhaustive investigation of etching-figures of different members of the amphibole group, *ibid.*, p. 374 (see *philipstadite* below).

On the composition of certain rock-making amphiboles, from the Sierra Nevada, California, see Turner, Am. J. Sc., **7**, 297, 1899. Analysis (2·72 $H_2O$) of amphibole from the Durbach mica-syenite, Sauer, Beitr. G. Heidelberg, Mitth. Bad. G. Landesanst., **2**, 252. Analyses are given also in many petrographical memoirs, Jahrb. Min., *et al.*

Synthetic experiments leading to the formation of this and other species, Doelter, Jb. Min., **1**, 1, 1897.

An unusual variety (monoclinic-hemihedral or triclinic?) occurs in the trachyte of Montesanto, Italy, Franco, Zs. Kr., **25**, 328, 1895; Rend. Accad. Napoli, May–June, 1895.

An amphibole having the composition of an orthosilicate analogous to garnet, $(\overset{I}{R}_2.\overset{II}{R})_3\overset{III}{R}_2Si_3O_{12}$ (cf. syntagmatite, Min., p. 388), has been called *hastingsite* by Adams and Harrington (Am. J. Sc., **1**, 210, 1896). Occurs in grains in the nephelite-syenite of Dungannon, Hastings Co., Ontario. Optically −. Birefringence low. $\mathfrak{c}$ nearly coincident with $\dot{c}$. Ax. pl. ‖ *b* (010). Ax. angle small, 30° to 45°. Dispersion $\rho > v$. Absorption $\mathfrak{c} = \mathfrak{b} > \mathfrak{a}$. Pleochroism, $\mathfrak{a}$ yw.-green; $\mathfrak{b}$ and $\mathfrak{c}$ deep bluish green. Analysis, Harrington:

| | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| G. = 3·433 | 34·18 | 1·53 | 11·52 | 12·62 | 21·98 | 0·63 | 9·87 | 1·35 | 2·28 | 3·29 | 0·35 = 99·60 |

Another aluminous amphibole, from the gabbro of Pavone, near Ivrea, Piedmont, Italy, investigated by Van Horn is also nearly an orthosilicate. Cleavage-angle 55° 42′. G. = 3·217–3·222. Extinction-angle 14° 30′ to 15° 30′ on *b* (010). Pleochroism strong: $\mathfrak{a}$ light yellow; $\mathfrak{b}$ brown, tinge of red; $\mathfrak{c}$ brown, tinge of yellow. Analysis by Dittrich:

| $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $K_3O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 39·58 | *tr.* | 14·91 | 4·01 | 10·67 | *tr.* | 11·76 | 13·06 | 0·62 | 2·87 | 2·79 = 100·27 |

This corresponds nearly to $\overset{II}{R}_6\overset{III}{R}_2Si_4O_{16}$ or $\overset{II}{R}_3\overset{III}{R}_2Si_3O_{12}$ (syntagmatite) + $\overset{II}{R}_2SiO_4$. Amer. Geol., **21**, 370, 1898.

An amphibole from Philipstad, Sweden, has been called *philipstadite* by R. A. Daly (Proc. Am. Acad. Sc., **34**, 433, 1899). It shows anomalous etching-figures on *m* (110) and *b* (010) (*ibid.*, p. 399); pronounced zonal structure; small optic axial angle (about 50°); also unusual pleochroism and absorption: viz., $\mathfrak{a}$ light brownish green, $\mathfrak{b}$ dark yellow-green, $\mathfrak{c}$ dark blue-green; $\mathfrak{b} > \mathfrak{c} > \mathfrak{a}$. It is optically −, with an extinction-angle on *b* (010) with $\dot{c} = +15° 9′$ (Na). An analysis by Pisani gave:

| $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $Na_2O$ | $K_2O$ | ign. |
|---|---|---|---|---|---|---|---|---|---|---|
| 45·20 | 0·84 | 7·34 | 7·55 | 15·80 | 1·52 | 12·30 | 8·40 | 0·80 | 0·37 | 0·70 = 100·82 |

*Xiphonite* is a name given by G. Platania (Accad. Sc. Acireale, **5**, 1893) to a variety occurring in minute crystals with hematite in cavities of a slag-like rock at Acicatena (Etna), Sicily. Form, angles and cleavage like amphibole, but characterized by light honey-yellow color and by feeble pleochroism. Composition undetermined. Named from Xiphonia, an old town near the locality.

See *Richterite* (astochite); also other species of the group; new names are *Cataphorite* (Kataforite), *Crossite*, *Rhodusite*.

**Analcite**, p. 595.—Crystals described from the Harz, Luedecke, Min. d. Harzes, 576, 1896. Also from Boylestone Quarry, near Barrhead, Renfrewshire, Scotland; doubtful forms *z* (543), *t* (421), also (332). Heddle, Trans. Edinb. G. Soc., **7**, 241, 1897.

Optical structure investigated, Monte Somma, P. Franco, Giorn. Min., **3**, 232, 1892. Same, from Monte Catini, G. D'Achiardi, Att. Soc. Tosc., Pisa, 1897. Discussion of optical structure, with relation to a new artificial silicate, G. Friedel, Bull Soc. Min., **19**, 14, 5, 1896; also with reference to effect produced by loss of water, *ibid.*, pp. 94, 363. Further discussion of optical structure, especially in relation to leucite, Klein, Ber. Ak. Berlin, 290, 1897, and Jb. Min., Beil.-Bd., **11**, 474, 189.

Analysis, from Friedersdorf on the Lahn, Brauns, Jb. Min., **2**, 4, 1892. From the Plauenschen Grund, Dresden, Zschau, Abh. Ges. Isis, p. 94, 1893.

Occurs in a dike-rock at Hamburg, N. J., derived from leucite, Kemp, Am. J. Sc., **45**, 298, 1893. Also in analcite-diabase of San Luis, California, Fairbanks, Bull. Dept. Geol. Univ. California, **1**, 273, 1895.

Present as a primary constituent in certain igneous rocks (monchiquite), Pirsson, J. Geol., **4**, 679, 1896; also in an analcite-basalt near Cripple Creek, Colorado, Cross, J. Geol., **5**, 684, 1897.

**Anatase.**—See *Octahedrite.*

**Andalusite**, p. 496.—Crystals from the Pitzthal, Tyrol, show the new forms, *i* (320), *t* (013), *v* (054), *u* (032), *x* (112). Haefele, Zs. Kr., **23**, 551, 1894.

A variety of chiastolite from the crystalline schists of the region north of Ladoga Lake in eastern Finland is called *maltesite* by J. J. Sederholm. The large nodules show a Maltese cross of wedge-shaped parts of pure material, separated by areas of impure material. G. För. Förh., **18**, 390, 1896.

A variety containing 6·91 p. c. $Mn_2O_3$ is called *Manganandalusite* by H. Bäckström. Occurs in muscovite-quartzite of Vestanå, Sweden, differs from ordinary andalusite in its grass-green color and strong pleochroism: $\mathfrak{c}$ ($\breve{a}$) and $\mathfrak{b}$ ($\bar{b}$) blue-green, $\mathfrak{a}$ ($\acute{c}$) pure yellow and most absorbed.

Investigation of a mineral related to andalusite and dumortierite, from the granite of the Argentine Republic. It is marked by deep-red pleochroism. Romberg, Jb. Min., Beil -Bd., **8**, 340, 1893.

See also *Westanite.*

**Andesine**, p. 333.—Stenzelberg, Siebengebirge, crystals described (new form, $1\bar{2}0$), Busz, Jb. Min., **1**, 36, 1898. See also *Feldspar*.

**Andorite.** *J. A. Krenner* [Math. term. Értesitö, **11**, 119, 1892], Zr. Kr., **23**, 497, 1894; *G. T. Prior* and *L. J. Spencer*, Min. Mag., **11**, 286, 1897; and Zs. Kr., **29**, 346. Sundtite, *W. C. Brogger*, Zs. Kr., **21**, 193, 1893; *Pöhlmann, ibid.*, **24**, 124, 1894. Webnerite, *Stelzner, ibid.*, **24**, 125, 1894.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·6772 : 1 : 0·4458$. $100 \wedge 110 = 34° \ 6\frac{1}{6}'$, $001 \wedge 101 = 33° \ 21\frac{1}{2}'$, $001 \wedge 011 = 24° \ 1\frac{2}{3}'$. Forms: *a* (100), *b* (010), *c* (001); $\phi$ (610), $\psi$ (510), *n* (210), *o* (320), *m* (110), *l* (230), *k* (120); *h* (102), $\theta$ (305), $\sigma$ (203), $\kappa$ (405), *f* (101), *e* (302), $\lambda$ (301), $\mu$ (902); *x* (011), $\nu$ (043), $\pi$ (032), $\gamma$ (021), *y* (031); *v* (112), $\chi$ (223), *p* (111), *z* (332), *q* (221), $\rho$ (331); *s* (211), $\delta$ (364), *r* (121), $\epsilon$ (362); $\omega$ (132); $\beta$ (131); $\alpha$ (162); $\zeta$ (2·21·7). Angles: $mm''' = 68° \ 12'$, $ff' = 66° \ 43'$, $xx' = 48° \ 3'$, $yy' = 106° \ 26'$, $vv' = {}^*35° \ 37\frac{1}{2}'$, $vv''' = {}^*23° \ 54\frac{1}{2}'$.

In aggregates of highly modified prismatic crystals, tabular ∥ *a* (100); faces in prismatic zone vertically striated. Also massive.

Cleavage none. Fracture conchoidal. Brittle. H. = 3–3·5. G. = 5·50. Luster metallic, brilliant. Color steel-gray. Streak black.

Composition, $PbAgSb_3S_6$ or $2PbS.Ag_2S.3Sb_2S_3$. Analyses.—1, Loczka; quoted by Krenner. 2, 3, G. T. Prior. 4, P. J. Mann, quoted by Stelzner (also other anals. on less pure material).

| | G. | S | Sb | Pb | Ag | Cu | Fe |
|---|---|---|---|---|---|---|---|
| 1. Felsöbanya | 5·341 | 23·32 | 41·91 | 22·07 | 11·31 | 0·69 | 0·70 insol. 0·04 = 100·04 |
| 2. " | 5·33 | 22·19 | 41·76 | 21·81 | 11·73 | 0·73 | 1·45 = 99·67 |
| 3. Oruro | 5·377 | 22·06 | 41·31 | 24·10 | 10·94 | 0·68 | 0·30 = 99·39 |
| 4. " | | 23·10 | 40·86 | 24·30 | 10·25 | 0·65 | 0·53 = 99·69 |

First described by Krenner from Felsöbanya, Hungary, where it occurs with stibnite, quartz, and sphalerite, also barite and manganosiderite. Also found at the silver-tin mines of Oruro, Depart. of Oruro, Bolivia, especially the Itos mine (webnerite) with stibnite, pyrite, etc. The name *Andorite* is given for Andor von Semsey; *Sundtite*, for the mining director L. Sundt; *Webnerite*, for the mining engineer, A. Webner.

The identity of andorite, sundtite and webnerite was established by Prior and Spencer. The observed list of forms is that given by them; the position and fundamental angles are those of Brögger (sundtite). It is to be noted that the analysis of "sundtite" by Thesen, quoted by Brögger and which shows only a trace of lead (G = 5·50), it is now stated was not made upon measured crystals, hence it appears to represent another species.

**Anglesite**, p. 907.—Crystals described from the Altai, new form (016), Jeremejev, Vh. Min. Ges., **29**, 174, 1892. Crystals from unknown source show the new form $\Gamma$ (255), L. J. Spencer, Min. Mag., **11**, 197, 1899.

Occurs at the Wellington mine, Bear Lake, West Kootanie, Br. Columbia, Hoffmann, Ref. G. Canada, **6**, 27 R, 1892–93.

A mineral having the form of anglesite, associated with the boléite of Boléo. Lower California, is shown by Genth to have the composition $2PbSO_4.CaSO_4.2H_2O$, and to be a mechanical mixture of anglesite and gypsum. An origin from a possible mineral $2PbSO_4.CaSO_4$ is suggested. Am. J. Sc., **45**, 32, 1893. See also Mallard, Bull. Soc. Min., **16**, 195, 1893. This substance has been called *bouglisite* by Cumenge, after M. de La Bouglise (cf. Lacroix, Bull. Mus. d'Hist. Nat., **42**, 1892).

**Anhydrite**, p. 910.—Molecular properties investigated, also of other species, Mügge, Jb. Min., **1**, 71, 1898.

Refractive indices, Zimanyi, Zs. Kr. **22**, 341, 1893.

Deposits of anhydrite and gypsum of Oulx described by Colomba, Att. Accad. Torino, **33**, 779, 1897–98.

Formation discussed, R. Brauns, Jb. Min. **2**, 257, 1894. Occurs in bluish tabular masses in cavities in trap rock at Larrabee's quarry, Northampton, Mass. Emerson, Bull. U. S. G. Surv., **126**, 26, 1895.

ANORTHITE, p. 337.—Occurs at Buck Creek, Clay Co., N. C., analysis by C. H. Baskerville, quoted by Pratt, Am. J. Sc., **5**, 128, 1898. Occurs with epidote at Phippsburg, Me., Clarke, Am. J. Sc., **48**, 429, 1894. From Raymond, Me., anal., Melville, Bull. U. S. G. Surv., **113**, 110, 1893. See also *Feldspar*.

ANORTHOCLASE, p. 324.—Analysis from acmite-trachyte of the Crazy Mts., Montana, Hillebrand, quoted by Wolff and Tarr, Bull. Mus. Comp. Zool. **16**, 227, 1893.
Brögger proposes the name *soda-microcline* (Natronmikroklin) and discusses relation to other allied feldpars, Eruptivgest. d. Kristianiagebietes, **3**, 11, 1898.

ANTHOPHYLLITE, p. 384.—Occurs at Bakersville, N. C., in dunite; crystals analyzed by Baskerville yielded results identical with those of Penfield (anal. 1, p. 385); it is concluded that the latter's specimens came from this locality, Pratt, Am. J. Sc., **5**, 429, 1898.
*Gedrite* (14 p. c. $Al_2O_3$) occurs as a coarse, granular rock near Harris's Soapstone quarry, Warwick, Mass. Emerson, Bull. U. S. G. Surv., **126**, 86, 1895 (anal., Schneider, Eakins). On gedrite-schist from Vester Silfberg, Sweden, see Weibull, G. För. Förh., **18**, 377. 1896.
Investigation of etching-figures, R. A. Daly, Proc. Am. Acad. Sc., **34**, 424, 1899.
See also *Asbestus* and *Valléite*.

APATITE, pp. 762, 1027.—**Cryst.**—From the granite of Alzo, Lake Orta, Italy, G. Strüver, Riv. Min. Ital., **12**, 52, 1893. From Zöptau, Graber, Min. petr. Mitth., **14**, 269, 1894. From the emerald mines in the Ural, with (80$\bar{8}$7) Jeremejev, Vh. Min. Ges., Prot., **33**, 65, 1895. Elba, Artini, Riv. Min. Ital., **16**, 15, 1896, and Rend. Accad. Linc., **4** (2), 259, 1895. Crystals of manganapatite (5·95 p. c. MnO) from the Vestanå mines, Sweden, gave Weibull *cx* (0001 ∧ 10$\bar{1}$1) = 40° 17′ 20″. G. För. Forh., **20**, 63, 1898.
Twin crystals with tw. pl. *s* (11$\bar{2}$1), inclusions in the andesite of Mt. Stavro, Algeria, are noted by Washington, J. Geol., **3**, 25, 1895.
Discussion of vicinal faces, Karnojitsky, Vh. Min. Ges., **33**, 65, 1895.
**Comp.**—Composition discussed, Rammelsberg, Jb. Min. **2**, 38, 1897. Analyses of many specimens and discussion of variation in composition, Carnot, Bull. Soc. Min., **19**, 135, 1896; Ann. Mines, **10**, 137, 1896, (also other phosphates, *ib.*, **8**, 321, 1895,) and C. R., **122**, 1375, 1896. Montebras, analysis of blue variety, Carnot, Bull. Soc. Min., **19**, 214, 1896. Ceylon, occurring with graphite, Jannasch and Locke, Zs. anorg. Ch., **7**, 154, 1894.

APHTHITALITE, p. 897.—Vesuvius, natural crystals seem to be in part rhombohedral, in part orthorhombic and biaxial, P. Franco, Giorn. Min., **4**, 151, 1893.

APOPHYLLITE, p. 566.—**Cryst.**—Harz Mts., Luedecke, Min. d. Harzes, 572, 1896. Kimberley, S. Africa, new forms, ξ (119), χ (223), *k* (332), Currie, Trans. Edinb. G. Soc., **7**, 252, 1897.
Collo, Constantine, Algeria, crystals described and analysis, Gentil, Bull. Soc. Min., **17**, 11, 1894. No fluorine was found; Friedel also remarks on its absence while he obtains an ammoniacal reaction, *ibid.*, p. 142. A. E. Nordenskiöld found fluorine in the Collo mineral examined by him; he also shows that the presence of ammonia was early established (1805, Rose), G. För. Förh., **16**, 579, 1894.
Discussion of optical properties as influenced by heat and pressure, Klein, Jb. Min., **2**, 165, 1892 (also less complete in Ber. Ak. Berlin, 1892. p. 217).
**Anal.**—Grängesberg, Hallberg, G. För. Förh., **15**, 327, 1893. From the "blue ground" of Koppiesfontein, near Jagersfontein, So. Africa, J. A. Leo Henderson, Min. Mag., **11**, 318, 1897. From the Grand Marais, Minn., Berkey, 23 Ann. Rep. G. Surv. Minnesota, 1894, p. 195. See also above.

ARAGONITE, pp. 281, 1027.—**Cryst.**—Neussargues (Cantal), Gonnard, Bull. Soc. Min., **14**, 183, 1891; **16**, 10, 1893. Framont, new forms (572), (231), (341), (8·11·3), and others doubtful, Stöber [Mitth. G. Landes. Els.-Lothr., **4**, 113, 1894], Zs. Kr , **27**, 531. Monte Ramazzo, Liguria, Italy, new forms (430), (570), (073), (052), (331), (512), (9·2·16), (413), (3·2·12). (431), (24·25·1), (342), (7·10·3), (352), (133), (271), Negri, Riv. Min. Ital., **15**, 65, 1896. Harz Mts., (0·1·12), Luedecke, Min. d. Harzes, 338, 1896. Chaudfontaine, Belgium; G. Cesàro, Mem. Acad. Belg., **53**, 1897. From the amianthus deposits of Val Lanterna, Italy, with doubtful new forms (17·16·0), (11·13·0), (16·22·1), Brugnatelli, Riv. Min. Ital., **18**, 51, 1898, and Rend. Ist. Lombardo, **30**, 1116, 1897 (also Zs. Kr., **31**, 56, 1899).
Crystals from Sicily are referred to the monoclinic system by Viola, Zs. Kr., **28**, 225, 1897.
Determination of the heat of formation, Le Chatelier, C. R., **11**, 390, 1893,
*Tarnowitzite* in crystals from Tarnowitz described with 2·2 to 4·8 p. c. PbO, Traube, Zs. G Ges., **46**, 64, 1894.

**Arfvedsonite**, p. 401.—Investigation of etching-figures, also of other members of the amphibole group, R. A. Daly, Proc. Am. Acad. Sc., **34**, 404, 1899.
See also *Cataphorite.*

**Argyrodite**, p. 150.—Shown by Penfield to be isometric and tetrahedral, not monoclinic in crystallization. The faces *m* and *o* (fig. 1, p. 150) belong to the dodecahedron, *d* (110) ; *f* and *k* to the tetrahedron *o* (111), and *v* to (311). Am. J. Sc., **46**, 107, 1893, and **47**, 451, 1894. Cf. Weisbach, Jb. Min., **1**, 98, 1894. The mineral described by Penfield was from Bolivia, and was first named *canfieldite*, on the supposition that it was a new species, like argyrodite in composition, but isometric ; later this name (see this Appendix, p. 13) was transferred to another sulphostannate of analogous composition also from Bolivia. Penfield shows that the formula of argyrodite is $Ag_6GeS_6$ or $4Ag_2S.GeS_2$ = Sulphur 17·1, germanium 6·4, silver 76·5 = 100. Analyses :

| | | S | Ge | Ag | Fe, Zn | Insol. |
|---|---|---|---|---|---|---|
| 1. Bolivia | G. = 6·26 | ($\frac{2}{2}$) 17·04 | ($\frac{3}{3}$) 6·55 | 76·05 | ($\frac{3}{3}$) 0·13 | 0·29 = 100·06 |
| 2. Freiberg | G. = 6·16 | 16·97 | ($\frac{2}{2}$) 6·64 | ($\frac{2}{2}$) 75·55 | 0·24 | Hg 0·34 = 99·74 |

A stanniferous argyrodite from Aullagas, Bolivia, described by Prior and Spencer (Min. Mag., **12**, 6, 1898) occurs in regular octahedrons, in part spinel-twins ; also in twinned dodecahedrons. G. = 6·19. Composition as given above, but Ge : Sn = 5 : 2. Analysis, Prior : S 16·45, Ge 4·99, Sn 3·36, Ag 74·20, Fe 0·68, Sb *tr.* = 99·68.

**Arsenic**, p. 11.—Occurs at Akadanimura, Ohnogori, Japan, in rhombohedral crystals, Frenzel, Min. petr. Mitth., **16**, 529, 1896.

**Arsenopyrite**, p. 97.—Weibull, after an investigation of the mineral from various Swedish localities (also Freiberg), concludes that the composition and form vary somewhat for different occurrences, but the species (when pure) has the formula Fe(As,S) ; well-formed crystals often enclose impurities. Zs. Kr., **20**, 1, 1891. Scherer has made a still more extended investigation of the form and composition of the mineral from many localities ; he finds crystals often impure, having a zonal structure, but aside from this he concludes that the composition is expressed by $m\mathrm{FeS}_2 + n\mathrm{FeAs}_2$ with $m : n = 1 : 1$ nearly. No simple relation between axial ratio and composition was found. The list of forms (p. 383) contains the following not given in Min., p. 98 : $\delta$ (310), $\zeta$ (0·17·2). $\epsilon$ (054). Zs. Kr., **21**, 354, 1893. See also *idem. ib.*, **22**, 61, 1893, analysis of crystals from Weiler in Elsass.

The composition of this and related species has been also discussed by Rammelsberg, Jb. Min., **2**, 45, 1897 ; by Starke, Shock and Smith, J. Am. Ch. Soc., **19**, 948, 1897.

*Danaite* occurs in Graham township, Algoma, Ontario (analysis by Johnston with 4 p. c. Co, 0·9 Ni), Hoffmann, Rep. G. Canada, **5**, 19 R., 1889–90. Also occurs at the Evening Star mine, Trail creek, West Kootenay, Br. Columbia, *ib.*, **8**, 13 R, 1895.

**Asbestus**, p. 386.—Investigation of various asbestiform minerals, many of which are shown to belong to fibrous anthophyllite, Merrill, Proc. U. S. Nat. Mus., **18**, 281, 1895.

**Ascharite.** *W. Feit* [Ch. Ztg., **15**, 327, 1891], Zs. Kr., **24**, 625, 1894. Found in white lumps with boracite, in kainite and halite at Schmidtmannshall near Aschersleben. The lumps are made up of microscopic grains showing no crystallization. G. = 1·85–1·95. Nearly insoluble in water and more difficultly soluble than stassfurtite in acids. Composition of material freed from other salts by water $3Mg_2B_2O_5.2H_2O$. Analysis : $\frac{3}{3}$ $B_2O_3$ 49·2, MgO 42·8, $H_2O$ 8·0 = 100.

**Astochite**, p. 1027.—The brown variety of this supposed new kind of amphibole is identical with Breithaupt's richterite (p. 391), cf. Hamberg, G. För. Förh., **13**, 801, 1891 ; Sjögren, *ib.*, **14**, 253, 1892. The latter author, however, suggests the name *natronrichterite* for the blue variety, which contains more soda and less potash than the brown. See *Richterite.*

**Astrakanite**, see *Blödite.* **Kalium-astrakanite**, see *Leonite.*

**Atacamite**, p. 172.—Crystals from Sierra Gorda, Chili, examined by G. F. Herbert Smith, are prismatic in habit with the pyramids *r* (111) and *n* (121) prominent ; *e* (011) small ; a new pyramid *h* striated ‖ edge *h/e* in part corresponds to (132). The axial ratio calculated from excellent measurements is $\breve{a} : \bar{b} : \acute{c} = 0·66130 : 1 : 0·75293$. Other more complex crystals, also from Atacama, show $\phi$ (131), $\rho$ (443), $\sigma$ (332) and forms with doubtful indices. Min. Mag., **12**, 15, 1898.

**Augelite**, p. 847.—Crystallized specimens of this hitherto doubtful species examined by Prior and Spencer establish its character, Min. Mag., **11**, 16, 1895.

Monoclinic with the forms *a* (100), *b* (010), *c* (001), *m* (110), *x* ($\bar{1}01$), *r* (011), *n* (112), *o* ($\bar{1}12$), and others doubtful. Axial ratio : $\grave{a} : \bar{b} : \acute{c} = 1·6419 : 1 : 1·2708$, $\beta = 67° \, 33\frac{1}{2}'$. Habit tabular ‖ *c*;

also triangular and tabular ∥ *m* or prismatic with *c* and *x* equally developed. Cleavage: *m* perfect; $x\ (\bar{1}01)$ less perfect. Fracture uneven. Brittle. H. = 4·5 – 5. G. = 2·696. Luster vitreous. Colorless to white. Optically +. Ax. pl. ∥ *b*. $Bx_a \wedge \dot{c} = -34°$. $2E_{a.y} = 84° 42'$. Indices: $\alpha = 1{\cdot}5736$, $\beta = 1{\cdot}5759$, $\gamma = 1{\cdot}5877$.

Composition: $AlPO_4.Al(OH)_3$ or $2Al_2O_3.P_2O_5.3H_2O$. Analyses, Prior:

| | $P_2O_5$ | $Al_2O_3$ | CaO | $H_2O$ |
|---|---|---|---|---|
| 1. | 34·60 | 51·40 | 0·11[a] | 13·77 = 99·88 |
| 2. | 35·33 | 50·28 | 0·90[a] | 13·93 = 100·44 |

[a] Probably foreign to the mineral.

The specimens examined were from Machacamarca, near Potosi, Bolivia, where it occurs with bournonite, octahedral pyrite, zinkenite, etc. The original mineral, described by Blomstrand, was from Westanå, Sweden; his results are here confirmed. Augelite also occurs in Bolivia at the silver mines of Tatasi and Portugalete, province of Sudchichas, dept. of Potosi (Spencer, Min. Mag., 12, 1, 1898).

**Aurichalcite**, p. 298.—Analysis, Torreon, Chihuahua, Mexico, Collins, Min. Mag., **10**, 15, 1892. Campiglia Maritima, also optical examination, G. D'Achiardi, Att. Soc. Tosc., Mem., **16**, 3, 1898.

**Avalite**, p. 617.—An analysis gave Losanitsch (Ber. Ch. Ges., **28**, 2631, 1895, and Ch. News, **69**, 243, 1894) the results below (1). According to the author the so-called *milosin* of Breithaupt (1838) is derived from the alteration of avalite and is a mixture of two minerals, to one of which (2) he limits this name, the other he calls *Alexandrolite*, anal. (3).

| | $SiO_2$ | $Al_2O_3$ | $Cr_2O_3$ | $Fe_2O_3$ | MgO | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. *Avalite* | 54·66 | 20·46 | 10·88 | 1·18 | 2·06 | 4·61 | 5·66 = 99·51 |
| 2. *Milosin* | 46·37 | 30·18 | 9·75 | 0·91 | *tr.* | *tr.* | 13·76 = 100·97 |
| 3. *Alexandrolite* | 52·07 | 20·76 | 13·74 | 2·22 | *tr.* | *tr.* | 10·88 = 99·67 |

Milosin is described as having a bluish-gray color; under the microscope, transparent, crystalline. Insoluble in acids. Analysis (2) made of material dried at 130°. Alexandrolite has a green color, opaque, amorphous. Soluble in hydrochloric acid. Also dried at 130°.

**Axinite**, p. 527.—**Cryst.**—Nordmark, Sweden, new forms $\Xi\ (130)$, $\gamma\ (1\bar{2}0)$, $U\ (061)$, $R\ (081)$, $Z\ (\bar{4}41)$, $Q\ (327)$, $\lambda\ (\bar{2}85)$, Hj. Sjögren, Bull. G. Inst. Upsala, **1**, 1, 1893 and G. För. Förh., **14**, 249, 1892. Bourg d'Oisans, Dauphiné, Gonnard and Offret, Bull. Soc. Min., **16**, 75, 1893. Quenast, Belgium, Franck, Bull. Acad. Belg., **25**, 17, 1893. Harz Mts., Luedecke, Min. d. Harzes, 464, 1896.

Etching-figures investigated, T. L. Walker, Am. J. Sc., **5**, 180, 1898.

Composition discussed, Rheineck, Zs. Kr., **22**, 275, 1893. Analyses by Mauzelius of varieties from Nordmark and Dannemora and discussion of composition, Hj. Sjögren, G. För. Förh., **17**, 279, 1895. Bourg d'Oisans, analysis, Jannasch and Locke, Zs. anorg. Ch., **6**, 57, 1894.

Occurrence in the Pyrenees described, Lacroix, C. R., **115**, 739, 1892.

**Azurite**, p. 295.—**Cryst.**—From Laurion, new forms $I\ (\bar{2}05)$, $T\ (\bar{4}05)$, $W\ (\bar{6}05)$, Zimányi, Zs. Kr., **21**, 86, 1892. Willow's mine, Pretoria, Transvaal, new forms $\Lambda\ (0{\cdot}1{\cdot}10)$, $\Gamma\ (2\bar{6}3)$, $W\ (\bar{1}{\cdot}3{\cdot}15)$. Molengraaf, Zs. Kr., **22**, 156, 1893. Mineral Point, Wis., new forms $\mathfrak{c}\ (307)$, $\mathfrak{b}\ (\bar{2}03)$, $\mathfrak{d}\ (9{\cdot}12{\cdot}8)$, Hobbs, Bull. Univ. Wisconsin, **1**, 145, 1895, and Zs. Kr., **25**, 270, 1895.

**Babingtonite**, pp. 381, 1027.—Occurs in minute crystals on gneiss at Buckland, Mass., Emerson, Bull. U. S. G. Surv., **126**, 32, 1895 (anal. by Schneider).

A pyroxenic mineral from the "mijakite" (augite-andesite) of the island of Mijakeshima is interpreted by Petersen as being a manganiferous babingtonite, Jb. Hamb. Wiss., 8, 49, 53, 1890.

**Baddeckite.** *G. Chr. Hoffmann*, Rep. G. Canada, **9**, 11 R, 1896; Am. J. Sc., **6**, 274, 1898. Occurs in small isolated scales embedded in a plastic clay near Baddeck, Victoria Co., Nova Scotia. G. = 3·252. Luster pearly. Color copper-red. Streak tile-red. Analysis, R. A. A. Johnston:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 48·96 | 13·85 | 25·82 | 1·17 | 2·65 | 3·47 | 0·22 | 3·78 = 99·92 |

Ratio for $RO : R_2O_3 : SiO_2 : H_2O = 1 : 3 : 8 : 2$, or formula $H_4\overset{II}{R}(\overset{III}{R}_2)_3Si_8O_{24}$, the quantivalent ratio for which (3 : 4) approximates to some muscovites, to which it is referred as a ferruginous variety. B. B. fuses at 4·5 to a shiny black slag, becoming magnetic. Decomposed by strong hydrochloric acid with separation of slimy silica.

**Baddeleyite.** *L. Fletcher*, Nature, **46**, 620. 1892; Min. Mag., **10**, 148, 1893. Brazilite, *E. Hussak*, Jb. Min., **2**, 141, 1892; **1**, 89, 1893; Min. petr. Mitth., **14**, 395, 1895.

Monoclinic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·9871 : 1 : 0·5114$; $\beta = {}^{*}81° 14\frac{1}{2}' = 001 \wedge 100$ Hussak. $100 \wedge 110 = {}^{*}44° 17\frac{1}{2}'$, $001 \wedge \bar{1}01 = {}^{*}29° 4\frac{1}{4}'$, $001 \wedge 011 = 26° 48\frac{5}{6}'$. Observed forms: *a* (100), *b* (010), *c* (001); *m* (110), *l* (230), *k* (120), *s* (203), *t* (101), *x* (201) as tw. pl., *r* ($\bar{1}01$), *α* ($\bar{2}01$); *d* (021); *p* (221); *n* ($\bar{1}11$). Angles: $mm''' = 88° 35'$, $a'r = 69° 41'$, $dd' = 90° 37'$, $cm = 83° 44\frac{1}{2}'$.

Crystals usually twins: (1) *a* (100) most common, also as polysynthetic twinning lamellæ: (2) *m* (110) both contact- and penetration-twins, also as thin lamellæ; (3) *x* (201) rather rare. Habit tabular ∥ *a*. Cleavage: *c* rather perfect; *b* much less so; also parting ∥ *m*. H. = 6·5. G. = 5·5 Hussak; 6·025 Fletcher. Luster greasy to vitreous, on opaque crystal nearly submetallic resembling columbite. Color variable, from colorless to yellow, brown and finally black and opaque. Streak white to browish white. Pleochroic. Optically –. Ax. pl. ∥ *b*. $Bx_a$ inclined to $\dot{c}$ about + 13° Fletcher. Dispersion inclined. Ax. angle large, 2E = 70°–75°.

Composition, zircon dioxide, $ZrO_2$. Analysis, C. W. Blomstrand, quoted by Hussak, Jb. Min., **1**, 89, 1893:

| $ZrO_2$ | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | Alk. | ign. |
|---|---|---|---|---|---|---|---|
| 96·52 | 0·70 | 0·43 | 0·41 | 0·55 | 0·10 | 0·42 | 0·39 = 99·52 |

Of the accessory constituents above given, only the iron belongs to the mineral itself; the variation in color is probably due to variation in amount of iron.

B. B. nearly infusible, glows brightly; reacts faintly for iron with borax. When cooled suddenly and pressed flat in the borax bead microlites and microscopic crystals are formed. Insoluble in acids; only slightly attacked by concentrated sulphuric acid if in fine powder. Decomposed by fusion with acid potassium sulphate.

First identified by Fletcher, and described both as regards form and composition, on a single fragment of a crystal (3 grams) from the gem sands of Rakwana, Ceylon; geikielite was obtained from the same source. About the same time discovered by Hussak from Brazil and named *brazilite*, but the composition was only later correctly determined by the analysis of Blomstrand. The Brazilian mineral occurs as an accessory constituent of a decomposed magnetite-pyroxenite (jacupirangite of Derby) of the magnetite deposits of Jacupiranga, on the branch of the same name of the Rio Ribeira, State of São Paulo. It is associated with magnetite, apatite, perovskite, ilmenite, titanite, microlite, zircon, etc. Also identified as an accessory constituent of a rock resembling jacupirangite from the nephelite-syenite region of Alnö, Sweden, cf. Hussak, Jb. Min., **2**, 228, 1898.

Named after Mr. Joseph Baddeley, who brought the specimen from Rakwana.

**Bagotite.**—Green pebbles, identified as lintonite from Bagot, Ontario. See Egleston, Cat. Min., 192, 1889 (1887); Chester, Dict. Names Min., 25, 1896; Spencer, Min. Mag., **11**, 323, 1897.

**Barite**, pp. 899, 1027.—**Cryst.**—Lunkány, Hungary, Zimanyi, Földt. Közl., **22**, 267, 1892. Montevecchio, Sardinia, new forms (1·0·25), (403)?, (123), (157), (2·5·11), (163)?, Negri, Riv. Min. Ital., **12**, 3, 1893. Bergheim, Ober-Elsass, Feurer, Mitth. G. Land. Els.-Loth., **4**, 89, 1893; Zs. Kr., **25**, 623. Caucasus, new form *I* (355), Zimanyi, Földt. Közl., **24**, 404, 1894. From Harz Mts., Luedecke, Min. d. Harzes, 357. 1896. Dobsina, new form 𝔭 (772), Melczer, Földt. Közlöny, **26**, 357, 1896, Zs. Kr., **30**, 183. Vassera, Lombardy, Italy, Artini, Riv. Min. Ital., **16**, 10, 1896. Odenwald, occurrence described, also complex crystals, new form 𝔦 (196), Kraatz-Koschlau, Abh. Hess. G. Land., **3**, No. 2, 55, 1897. From various localities in Belgium, Cesàro, Mem. Acad. Belg., **53**, 1897. Körösmezö, Hungary, G. Moesz, Földt. Közl., **27**, 495, 1897.

Apparent hemimorphism discussed, Beckenkamp, Zs. Kr., **27**, 583, 1896. See also *idem*, *ibid.*, **30**, 55, 1898.

As cementing material in sandstone, F. Clowes, Proc. Roy. Soc., **64**, 374, 1899 (Min., p. 903).

**Barium anorthite.**—See *Celsian*.

**Barium heulandite.**—See *Heulandite*.

**Barkevikite**, p. 405.—Daly's investigation of etching-figures shows it to be more closely related to common hornblende than to arfvedsonite. Proc. Amer. Acad. Sc., **34**, 374, 1899.

A related amphibole occurs in the sodalite-syenite of Montana ($\mathfrak{c} \wedge \dot{c} = 13°$), Lindgren and Melville, Am. J. Sc., **45**, 292, 1893.

See also *Cataphorite*.

**Barracanite.** *R. Schneider*, J. pr. Ch., **52**, 555, 1895.—See *Cubanite*.

**Barytocalcite**, p. 289.—In parallel cryst. growth with barite, Mügge, Jb. Min., **1**, 252, 1895. Optical examination ($\beta = 1·684$) and relation to bromlite, also to calcite, aragonite and witherite, Mallard, Bull. Soc. Min., **18**, 10, 1895.

BARYTOCELESTITE.—See *Celestite.*

**Basiliite.** *Igelström*, G. För. Förh., **14**, 307, 1892 ; Zs. Kr., **22**, 470, 1893.
In foliated forms. Luster metallic or submetallic. Color steel-blue, but in very thin splinters blood-red. Not magnetic. Several partial analyses yielded :

$Sb_2O_5$ 13·09 $Mn_2O_3$ 70·01 $Fe_2O_3$ 1·91 $H_2O$ 15·00

Calculated formula, $11(Mn_2O_3,Fe_2O_3).Sb_2O_5.21H_2O$. Dissolves readily in warm hydrochloric acid with evolution of chlorine. Yields water in the closed tube and turns black and finally red-brown. Occurs with hausmannite and calcite at the Sjö mine, Örebro, Sweden. Named after the alchemist, Basilius Valentinus.

BASTNÄSITE, p. 291.—Colorado, analysis, Hillebrand, Am. J. Sc., **7**, 51, 1899.

**Batavite.** *E. Weinschenk*, Zs. Kr., **28**, 160, 1897. A decomposition-product from the graphite district of Passau, Bavaria. Occurs in aggregates of pearly micaceous scales, hexagonal in outline. G. = 2·183. Approximate composition, $4H_2O.4MgO.Al_2O_3.4SiO_2$. Analysis :

% $SiO_2$ 42·33 $Al_2O_3$ 16·35 MgO 28·17 $H_2O$ 13·19 = 100·04

Named from *Castra Batava*, Roman name for Passau.

BAUXITE, p. 251.—Description of deposits in Arkansas, Branner, Amer. Geol., **7**, 181, 1891, J. Geol., **5**, 263, 1897; in Georgia, Alabama, etc., C. Willard Hayes, 16 Ann. Rept., U. S. G. Surv., Pt. III, pp. 547–597, 1896; also McCalley, Proc. Ala. Ind. Sc. Soc., **2**, 21, 1892; Laur, Trans. Am. Inst. Mng. Eng., **24**, 234, 1894. Analyses, from Calhoun Co., Alabama, Hillebrand, Bull. U. S. G. Surv., **113**, 109, 1893.

A general investigation (with analyses) of material from the Vogelsberg has led Liebrich to the conclusion that bauxite is an alteration-product of a basaltic rock. It is in part amorphous, in part crystalline and having the composition of the aluminium hydrate gibbsite, crystals of which occur in cavities in the mass Ber. Oberhess. Ges., **28**, 57, 1892 (abstr. in Zs. Kr., **23**, 296, 1894); also Zs. prakt. Geol., **5**, 212, 1897. On the relation of bauxite to laterite, see Bauer, Jb. Min., **2**, 208, 1898.

Contains a supposed new element, R. S. Bayer, Ch. News, **71**, 128, 1895.

**Beaconite.**—See *Talc.*

BENTONITE.—Eng. Mng. J., Oct. 22 and Nov. 26, 1898. A Wyoming clay used in making candy, in adulterating candy, etc.

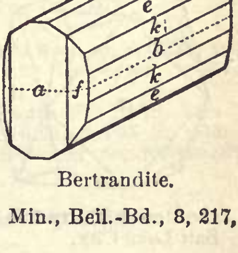
**Beresowite.** Beresovit. Berezovite. *J. Samoilow*, Bull. Soc. Moscou, 290, 1897.
A chromate and carbonate of lead from Berezov in the Ural, associated with galena and cerussite; occurs also altered to crocoite. Crystalline in small lamellæ with one perfect cleavage. G. = 6·69. Color deep red. Birefringent. Composition $6PbO.3CrO_3.CO_2$. Analysis : $CrO_2$ % 17·93, PbO % 79·30, $CO_2$ 2·46.

BERTHIERITE, p. 114.—This or a related mineral occurs on Mt. Gibbs, Tuolumne Co., California, Turner, Am. J. Sc., **5**, 428, 1898.

From Přibram, anal., Hofmann, Ber. Ak. Böhm., Oct. 15, 1897.

BERTRANDITE, pp. 545, 1028.—Occurs with hamlinite in Oxford Co., Me., in twin crystals, prismatic ‖ ă (Fig. 1, $k = 0·12·1$); G. = 2·571. Penfield, Am. J. Sc., **4**, 316, 1897. Crystals, in part twins, are described from Pisek and other localities, by Vrba. Zs. Kr., **24**, 112, 1894.

1.



Bertrandite.

BERYL, pp. 405, 1028.—**Cryst.**—Mursinka, crystals of rhombohedral habit as regards the *s*-faces $(11\bar{2}1)$; etching-prominences show the forms $(43\bar{7}4)$, $(54\bar{9}5)$ $(6·5·\bar{11}·5)$, $(54\bar{9}4)$, $(43\bar{7}3)$, Arzruni, Vh. Min. Ges., **31**, 155, 1894. Mursinka, with $(13·1·\bar{14}·0)$ and $(19·1·\bar{20}·1)$, Jeremejev, *ibid.*, **29**, 230, 1892 ; also Ilmen Mts. $(11\bar{2}6)$, Mursinka $(22\bar{4}3)$, Nerchinsk $(40\bar{4}5)$, *idem.*, *ibid.*, Prot., **33**, 26, 1895. Pisek, with λ $(15·1·\bar{16}·1)$, also supposed twins, with $(5·5·\bar{10}·8)$ as twinning plane ; further, corrosion forms *e* $(60\bar{6}5)$, *r* $(30\bar{3}2)$, *u* $(20\bar{2}1)$, ξ $(11\bar{2}4)$, *o* $(11\bar{2}2)$ and others, Vrba, Zs. Kr., **24**, 104, 1894. On a crystal from New York Island. Ries, Trans. N. Y. Acad. Sc., **16**, 329, 1897. Etching-figures investigated, Traube, Jb. Min., Beil.-Bd., **10**, 464, 1896.

On optical characters as influenced by heat and pressure, Pockels, Jb. Min., Beil.-Bd., **8**, 217, 1893.

A variety from German So. West Africa showed distinct asterism, also cat's-eye effect, Stapff, Zs. prakt. G., **1**, 244, 1893.

Analysis of emerald from Chanteloube, Haute-Vienne, Lebeau, C. R., **121**, 601, 1895.

Occurrence of emerald on Big Crab-Tree Mt., near Bakersville, Mitchell Co., N. C., Kunz, Am. J. Sc., **48**, 429, 1894.

On synthesis, Traube, Jb. Min., **1**, 275, 1894.

BERZELIITE, p. 753.—A *soda-berzeliite* from Långban, Sweden, has been described by Hj. Sjögren (Bull. G. Inst. Upsala, **2**, 92, 1895). Usually massive, also in isometric crystals (110, 211). No cleavage. H. = 4 – 4·5. G. = 4·21. Luster greasy. Color fire-red or orange-yellow. Isotropic. Composition near caryinite (wh. see), but contains soda and differs in crystallization. Analysis, R. Mauzelius:

| $As_2O_5$ | $Sb_2O_5$ | $V_2O_5$ | MnO | CaO | FeO | MgO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| 52·90 | *tr.* | 0·24 | 21·41 | 18·34 | 0·38 | 0·72 | 5·05 | 0·09 | 0·40 = 99·53 |

Sjögren notes the similarity of the above berzeliite to pyrrharsenite (Min., p. 753), and Igelström, giving another analysis of the latter, calls it *mangan-berzeliite*, Zs. Kr., **23**, 592, 1894.

An incomplete analysis of berzeliite is given by Church, Min. Mag., **11**, 10, 1895.

BEYRICHITE, p. 76.—Crystals from Altenkirchen have been investigated by Laspeyres, who finds it in form and composition ((Ni,Co,Fe)S) like millerite, but the sp. gravity = 4·699 (G. = 5·3 –5·9 for millerite); he regards all millerite as formed by paramorphism from beyrichite. Crystals, in part twins, are described with the forms: *m* ($10\bar{1}0$), *a* ($11\bar{2}0$), *i* ($41\bar{5}0$), *r* ($10\bar{1}1$), *e* ($10\bar{1}2$). Axis $\dot{c}$ = 0·3277. Zs. Kr., **20**, 535, 1892; also Vh. Ver. Bonn, **50**, 157, 1893.

BINNITE, p. 118.—Tetrahedral crystals are described by Baumhauer, Zs. Kr., **21**, 202, 1892. Same conclusion reached by Trechmann, who adds many new forms, in part doubtful, Min. Mag., **10**, 220, 1893. Later Baumhauer adds further new forms, Zs. Kr., **28**, 545, 1897.

Announced by Prior and Spencer to be identical with *tennantite*, Min. Soc. Gt. Britain, Jan. 31, in Nature, **54**, 454, 1899.

BIOTITE, p. 627.—Twin crystals (Servian twins) from Dschepa, Servia, formed of two interpenetrating crystals which have the base parallel while one is turned 30° with reference to the other, Uroschewitsch, Zs. Kr., **29**, 278; 1897.

Composition (anal.) of some rock-forming varieties from California, Turner, Am. J. Sc., **7**, 294, 1899.

Discussion of conditions of alteration in a magma (also of amphibole), Washington, J. Geol., **4**, 257, 1896.

On the alteration-products of magnesia mica and the relation between composition and optic axial angle, Z. Schimmer, Inaug. Diss., Jena, 1898, pp. 1–70, and Jenaisch. Zeitschr., **32**, 351, 1898.

See also *Mica*.

**Birmite.**—See *Burmite.*

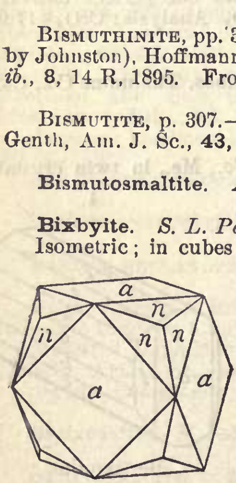
BISMUTHINITE, pp. 38, 1028.—Occurs in Jonquière township, Chicoutimi Co., Quebec (analysis by Johnston), Hoffmann, Rep. G. Canada, **6**, 19 R, 1892–93. Also Lyndoch, Renfrew Co., Ontario, *ib.*, 8, 14 R, 1895. From Sinaloa, Mexico, analysis, Melville, Bull. U. S. G. Surv., **90**, 40, 1892.

BISMUTITE, p. 307.—From Mt. Antero, Chaffee Co., Colorado, analysis of an impure variety, Genth, Am. J. Sc., **43**, 188, 1892.

**Bismutosmaltite.** *A. Frenzel*, Min. petr. Mitth., **16**, 524, 1896.—See *Skutterudite.*

**Bixbyite.** *S. L. Penfield* and *H. W. Foote*, Am. J. Sc., **4**, 105, 1897.

Isometric; in cubes with *n* (211). Cleavage: octahedral in traces. Brittle. H. = 6 – 6·5. G. = 4·945. Luster metallic, brilliant. Color and streak black. Opaque.



Composition, essentially FeO.$MnO_2$, or analogous to perovskite. The analysis may also be interpreted as $R_2O_3$, where R = Fe and Mn in nearly the ratio of 1 : 1. The $SiO_2$ and $Al_2O_3$ of the analysis are due to impurities. Analysis:

| | $TiO_2$ | $Fe_3O_3$ | MnO | MgO | O | $SiO_2$ | $Al_2O_3$ |
|---|---|---|---|---|---|---|---|
| ⅔ | 1·70 | 47·98 | 42·05 | 0·10 | 4·38 | 1·21 | 2·53 = 99·95 |

Fuses B.B. at 4 and becomes magnetic. In very fine powder is dissolved with some difficulty in hydrochloric acid, evolving chlorine.

Occurs with topaz and decomposed garnet in rhyolite on the edge of the desert, thirty-five miles southwest of Simpson, Utah. Named after Mr. Maynard Bixby of Salt Lake City.

BLIABERGSITE.—*L. J. Igelström*, G. För. Förh., **18**, 41, 1896; Zs. Kr., **27**, 603. *M. Weibull*, *ibid.*, **18**, 515, 1896.—See *Ottrelite*.

BLÖDITE, p. 946.—Crystals with *r* (450) described and measured, from the salt seas of the Astrakan Govt., Jeremejev, Zs. Kr., **23**, 268, 1894, and Vh. Min. Ges., **28**, 430, 1891. Punjab Salt Range, crystals described with analysis, F. R. Mallet, Min. Mag., **11**, 311, 1897.

A related potash compound ($K_2Mg(SO_4)_2 + 4H_2O$), called *Kaliastrakanite* or *Kalium-astrachanite*, has been named *Leonite* (wh. see).

**Blueite.** *S. H. Emmens*, J. Am. Chem. Soc., **14**, No. 7, 1892.—See *Pyrite*.

BOLÉITE, p. 1028.—The complex relations of percylite, boléite, pseudoboléite, cumengéite are discussed under *Percylite*.

BORACITE, p. 879.—Etching-figures described, Baumhauer, Die Resultate d. Aetzmethode, etc., 1894.

Specific heat as influenced by the temperature, Kroeker, Jb. Min., **2**, 125, 1892.

Occurrence at Westeregeln, Bücking, Ber. Ak. Berlin, 539, 1895.

Formation of isomorphous chloroborates, Rousseau and Allaire, C. R., **116**, 1195, 1893.

BORNITE, p. 77.—Crystals from Virgen, near Prägratten, Tyrol, described with (533) and (322)?, Heimerl, Bull. Soc. Min., **17**, 289, 1897. See also Klein, Ber. Ak. Berlin, 385, 1898, who describes a crystal from the Frossnitz glacier, Tyrol, with (322) and (211), symmetry tetrahedral.

Occurs as a copper ore in western Idaho, Packard, Am. J. Sc., **50**, 298, 1895.

**Bouglisite.** *E. Cumenge* (*Lacroix*, Bull. Mus. d'Hist. Nat. Paris, 42, 1895).—See *Anglesite*.

BOULANGERITE, p. 129.—Described by Hj. Sjögren (G. För. Förh., **19**, 153, 1897), from the mines of Sala, Sweden. In orthorhombic crystals, prismatic or tabular ∥ *a* (100). Axes $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}5527 : 1 : 0{\cdot}7478$. Forms: *a* (100), *b* (010); *r* (210), *q* (320), *m* (110), *n* (120), *μ* (140), *l* (160), *k* (180), *i* (1·10·0), *h* (1·14·0); *u* (012). Angles: $mm''' = 57° \ 52'$, $b\mu = {*}24° \ 20'$, $bu = {*}69° \ 30'$. The form approximates to that of diaphorite. Composition: $Pb_5Sb_4S_{11}$ or $5PbS.2Sb_2S_3$. Analysis, R. Mauzelius:

| | S | Sb | Pb | Zn | Ag | |
|---|---|---|---|---|---|---|
| G. = 6·185 | 18·91 | 25·54 | 55·22 | 0·06 | *tr.* | insol. 0·23 = 99·96 |

The author concludes that boulangerite has the composition $5PbS.2Sb_2S_3$ like diaphorite, to which it also approximates in form. Further he shows that the earlier analyses do not correspond to $3PbS.Sb_2S_3$, the formula usually accepted. The minerals plumbostib and embrithrite ($10PbS.3Sb_2S_3$ Frenzel) do not belong to boulangerite, but he regards them as independent species.

BOURNONITE, p. 126.—**Cryst.**—Nagybánya, complex crystals described with the new forms, *C* (503), ʒ (021), Schmidt, Zs. Kr., **20**, 151, 1892. Harz Mts., Luedecke, Min. d. Harzes, 150, 1896. Peychagnard, Isère, France, new forms (950), (780)?, (380), (034), (032), (11·3·4), (568), Termier, Bull. Soc. Min., **20**, 101, 1897. Pontgibaud, Puy-de-Dôme, supposed new forms (18·5·0), (5·7·12), (50·66·59), (918), Gonnard, Bull. Soc. Min., **20**, 312, 1897.

Measurements of crystals from different localities show irregularities in angle, but fail to establish monoclinic symmetry, F. B. Peck, Zs. Kr., **27**, 299, 1896. Measurements of heat conductivity, *idem*, *ibid.*, p. 319.

Occurs massive in Bagot township, Renfrew Co., Ontario, Hoffmann, Rep. G. Canada, **7**, 13 R, 1894. Also at the mine Pulacayo, Huanchaca, Bolivia, Penfield and Frenzel, Zs. Kr., **28**, 608, 1897.

BRAUNITE, pp. 232, 1029.—Saint Marcel, analyses, Gorgeu, Bull. Soc. Chim., **9**, 656, 1893.

**Brazilite.** *E. Hussak*, Jb. Min., **2**, 141, 1892; **1**, 89, 1893.—See *Baddeleyite*.

BREISLAKITE, p. 391.—Referred by Wichmann to fayalite, Zs. Kr., **28**, 529, 1897.

BREITHAUPTITE, pp. 72, 1029.—Crystals from Andreasberg show the forms *c*, *m*, *w* ($30\bar{3}1$) and ($70\bar{7}1$); axis $\acute{c} = 0{\cdot}8627$. Busz, Jb. Min., **1**, 119, 1895; also *idem*, quoted by Laspeyres, Zs. Kr., **24**, 496, 1895.

Analysis (by Fasolo) of *arite* from Nieddoris, Sardinia, quoted by Brugnatelli, Rend. Accad. Linc., 3 (1), 86, 1894: As 29·82, Sb 26·57, Bi 0·99, Ni 36·81, Co 3·91, Fe 0·98, S 0·85, Zn *undet.* = 99·93. Analyses are also given of an impure breithauptite; of a mineral near gersdorffite (Sb 3·11 p. c.) corresponding to $(Ni,Fe,Co)_2(S,As,Sb)_3$; also of smaltite.

BREWSTERITE, p. 576.—Occurs in the Harz, Luedecke, Min. d. Harzes, 587, 1896.

Bröggerite, p. 889.—See *Uraninite.*

Bromlite, p. 283.—Optical examination and relation to barytocalcite, etc., Mallard, Bull. Soc. Min., 18, 7, 1895.

Brongniardite, p. 123.—The supposed isometric crystals are shown to belong to the species argyrodite or canfieldite, Prior and Spencer, Min. Mag., **12**, 11, 1898. It is further suggested by Spencer that brongniardite and diaphorite may be identical, Am. J. Sc., **6**, 316, 1898.

Brookite, pp. 243, 1029.—Crystals from Brazil show the new forms *g* (305), *ν* (124), ξ (146), Hussak, Min. petr. Mitth., **12**, 460, 1892. On secondary twin formation, Hussak, Jb. Min., **2**, 99, 1898.

Occurs with octahedrite on quartz at Placerville, Eldorado Co., California, Kunz, Am. J. Sc., **43**, 329, 1892.

Brucite, p. 252.—Analysis of *nemalite* from Afghánistán, Mallet, Min. Mag., **11**, 211, 1897, Rec. G. Surv. India, **30**, 233, 1898.

Nemalite absorbs electric waves vibrating in a certain plane and transmits those vibrating normal to it; so also tourmaline (with planes reversed), but not to so great a degree. J. C. Bose, Nature, **57**, 353, 1898.

Brushite, p. 828.—A calcium phosphate found in human skeletons (1630) unearthed at Paris in 1896 (Lacroix, Bull. Soc. Min., **20**, 112, 1897), has the optical characters of pharmacolite, viz.: optically −; ax. plane and $Bx_o \perp b$; $Bx_a$ inclined 25° forward to trace of *c*; $2V_a = 81°$. It might hence be inferred to belong to brushite; however, G. = 2·31 and the amount of water was too small (loss on ignition = 25·5 p. c.; this is probably too high). For metabrushite from Sombréro, G. = 2·30 was obtained, from the Île des Oiseaux 2·33.

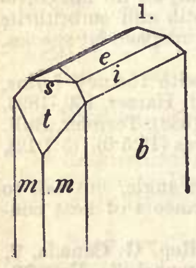
**Burmite.** Birmite. *Otto Helm*, Rec. G. Surv. India, **25**, 180, 1892; **26**, 61, 1893. Schrift. Ges. Danzig, 8, Nos. 3–4, p. 63, 1893. *Fritz Noetling*, Rec. G. Surv. India, **26**, 31, 1893. A fossil resin, resembling amber, but harder and tougher. Occurs abundantly in Upper Burma. An analysis gave Helm: C 80·05, H 11·50, O 8·43, S 0·02 = 100.

Cacoxenite, p. 848.—Partial optical examination, Luquer, Am. J. Sc., **44**, 154, 1893.

Analysis by Church from Hrbek, near St. Benigna, Bohemia (Min. Mag., **11**, 8, 1895), gave: $P_2O_5$ 19·76, $Fe_2O_3$ 48·57, $H_2O$ (ign.) 13·11 (F *tr.*), $H_2O$ (vacuo) 18·69 = 100·13. This corresponds to the complex relation $9Fe_2O_3.4P_2O_5.51H_2O$.

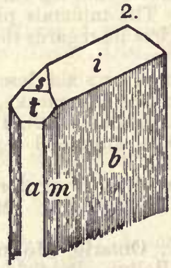
Calamine, p. 546.—**Cryst.**—Radzionkau, Silesia, Traube, also anal. (Breitfeld) showing presence of 2·17 p. c. PbO, Zs. G. Ges., **46**, 65, 1894. Sterling Hill, N. J., and Clear Creek Co., Colorado (Figs. 1, 2), Pratt, Am. J. Sc., **48**, 213, 1894. Gorno, Val Seriana, Italy, new form (503), Artini, Riv. Min. Ital., **16**, 19, 1896. Moresnet, new form (311), Buttgenbach, Ann. Soc. G. Belg., **24**, xl, 1897. Nebida, Sardinia, C. Riva, Rend. Accad. Linc., **6** (1), 421, 1897.

1.



New Jersey.

2.



Colorado.

Analysis of pure variety from Wythe Co., Va., Jones, Am. Ch. J., **14**, 621, 1892.

Occurs in West Kootanie district, Br. Columbia, Hoffmann, Rep. G. Canada, **6**, 28 R, 1893. Also finely crystallized at the Elkhorn mines, Jefferson Co., Montana.

Calaverite, p. 105.—Hillebrand refers here gold tellurides from Cripple Creek, Colorado (Am. J. Sc., **50**, 128, 426, 1895). A crystallized specimen from the Prince Albert mine, which (according to Penfield) seemed to be triclinic, but approximating toward sylvanite in angle, though without its cleavage, gave the results of anal. 1*a* (1*b* deducting impurities). Color pale bronze-yellow. H. = 3. G. (corrected) = 9·00. Two other less pure samples from different mines gave anals. 2, 3 deducting impurities; all correspond to $AuTe_2$. Krennerite also occurs at Cripple Creek, and according to Pearce sylvanite. See Geol. Cripple Creek Dist., Colorado, by Whitman Cross and R. A. F. Penrose, Jr., 16 Ann. Rept. U. S. G. Surv., Part II.

| | Te | Au | Ag |
|---|---|---|---|
| 1*a*. | 57·27 | 38·95 | 3·21 insol. 0·33, $Fe_2O_3$ 0·12 = 99·88 |
| 1*b*. | 57·60 | 39·17 | 3·23 = 100 |
| 2. | 57·40 | 40·83 | 1·77 = 100 |
| 3. | 57·30 | 41·80 | 0·90 = 100 |

See also *Goldschmidtite*, *Kalgoorlite* and *Krennerite.*

**Calcistrontite.** *Von der Marck*, Vh. Ver. Rheinl. Corrbl., **39**, 84, 1882. A mineral substance from near Hamm, Westphalia, supposed to have the composition $3CaCO_3.SrCO_3$. It is shown by Laspeyres and Kaiser to be a mechanical mixture of calcite and strontianite, Zs. Kr., **27**, 41, 1896.

CALCITE, pp. 262, 1026.—**Cryst.**—Landelies, Belgium, Renault, Ann. Soc. G. Belg., **20**, 75, 1892. Nieder-Rabenstein, crystals perhaps to be referred to the dolomite (phenacite) type, Beckenkamp, Zs. Kr., **20**, 163, 1892; cf. also Gaubert, Bul. Mus. d'Hist. Nat., p. 39, 1897. Feldkirch, Gissinger, Zs. Kr., **22**, 359, 1893. Visby, Gotland, crystals of pyramidal habit, Hamberg, G. För. Förh., **16**, 709, 1894. Freiberg, Sansoni, Giorn. Min., **5**, 72, 1894, and Zs. Kr., **23**, 451, 1894. Crystals from the Galena limestone, Wisconsin, Hobbs, Bull. Univ. Wisconsin, **1**, 115, 1895, and Zs. Kr., **25**, 257, 1895. Lake Superior, Palache, Zs. Kr., **24**, 588, 1895. Framont *et al.* in Elsass-Lothringen, Stöber, Zs. Kr., **24**, 629, 1895. Körösmezö, G. Moesz, Földt. Közl., **27**, 495, 1898. Couzon, Rhône, Gonnard, C. R., **122**, 348, 1896, and Bull. Soc. Min., **20**, 18, 330, 1897. Nordmark, Sweden, K. Winge, G. För. Förh., **18**, 527, 1896. Harz Mts., Luedecke, Min. d. Harzes, 285, 1896. Budapest, Melczer, Földt. Közlöny, **26**, 79, 1896; **28**, 257, 1898. From various localities in Belgium, Cesàro, Mem. Acad. Belg., 53, 1897. From the diabase of Neumark, Schnorr (1896), ref. in Zs. Kr., **30**, 660. Auerbach, Hesse, A. Leuze (1896), ref. in Zs. Kr., **30**, 662. Montecatini, G. D'Achiardi, Att. Soc. Tosc., Proc. Verb., May 9, 1897. Jarow near Wran, Bohemia, Polak, Lotos, **17**, 169, 1897.

Selective absorption investigated, Nichols and Snow, Phil. Mag., **33**, 379, 1892.

Refractive indices of Iceland Spar, Dufet, Bull. Soc. Min., **17**, 149, 1894.

Dichroism for infra-red waves, E. Merritt, Wied. Ann., **55**, 49, 1895.

Investigation on the influence of substances in solution upon the crystallization, etc., Vater, Zs. Kr., **21**, 433; **22**, 209, 1893; **24**, 366, 378, 1895; **27**, 477, 1896; **30**, 295, 373, 485, 1898.

Formation of stalactites in caves, G. P. Merrill, Proc. U. S. Nat. Mus., **17**, 77, 1894.

Discussion of origin, composition and uses of *onyx marble* from many localities; with one exception these belong to calcite, *idem*, Rep. U. S. Nat. Mus., **16**, 539, 1893.

Investigation of *hislopite* (Min., p. 266) showing great variation in the amount of glauconite, while other inclusions also occur, Holland, Rec. G. Surv. India, **26**, 166, 1893.

CALEDONITE, p. 924.—Crystals described with $\tau$ (113), $\kappa$ (023) as new forms, Busz, Jb. Min., **1**, 111, 1895.

CALOMEL, p. 153.—Optical characters determined, confirming results of Senarmont (Min., p. 154), who showed its very high birefringence; Dufet obtained (Bull. Soc. Min., **21**, 90, 1898):

| | $\omega$ | $\epsilon$ | $\epsilon - \omega$ |
|---|---|---|---|
| Li | 1·95560 | 2·6006 | 0·6450 |
| Na | 1·97325 | 2·6559 | 0·6827 |
| Tl | 1·99085 | 2·7129 | 0·7220 |

**Canfieldite.** *S. L. Penfield*, Am. J. Sc., **47**, 451, 1894 (not canfieldite, same author, *ib.*, **46**, 107, 1893, = argyrodite).

Isometric, perhaps tetrahedral. In octahedrons *o* (111) with *d* (110). Fracture uneven to small conchoidal. Brittle. H. = 2·5–3. G. = 6·276. Luster metallic, brilliant. Color black with bluish tint.

Composition, $Ag_8(Sn.Ge)S_6$; essentially $Ag_8SnS_6$ or $4Ag_2S.SnS_2$, but with the tin in part replaced by germanium, ratio Sn, Ge = 12 : 5. Analysis:

| S | Sn | Ge | Ag | Fe,Zn |
|---|---|---|---|---|
| 16·22 | 6·94 | 1·82 | 74·10 | 0·21 = 99·29 |

As noted on p. 6, Penfield has shown that argyrodite has the corresponding composition $Ag_8GeS_6$. Franckeite (wh. see) is another new sulpho-stannate.

B. B. fuses at 2 on charcoal, yielding a coating of the mixed oxides of tin and germanium, white or grayish near the assay, tinged with yellow on the edges. By long blowing a globule of silver covered by tin oxide is obtained. In the closed tube sulphur is given off, and at a high temperature a slight deposit of germanium sulphide.

Occurs intimately associated with native silver at La Paz, Bolivia. Named after F. A. Canfield, of Dover, N. J.

CARNALLITE, p. 177.—Discussion of conditions of formation and of alteration, Van't Hoff and Meyerhoffer, Ber. Ak. Berlin, 488, 1897; also later papers by Van't Hoff and others, 1897 and 1898.

**Carnotite.** *C. Friedel* and *E. Cumenge*, C. R., **128**, 532, 1899, and Bull. Soc. Min., **22**, 26, 1899.

Occurs as a yellow crystalline powder, or in loosely cohering masses, easily separated by the fingers; intimately mixed with a quartzose sand.

Composition, perhaps $K_2O.2U_2O_3.V_2O_5.3H_2O$. **Analyses, after the separation of silica, of air-dried material:**

| $V_2O_5$ | $U_2O_3$ | $K_2O$ | $H_2O$ |
|---|---|---|---|
| 20·12 | 63·54 | 10·37 | 5·95 = 99·98 |
| 20·31 | 64·70 | 10·97 | 5·19 $Fe_2O_3$ 0·96 = 102·13 |
| 19·95 | 62·46 | 11·15 | — $Fe_2O_3$ 06·5 |

The radiant power has been investigated by M. and Mde. P. Curie.

Occurs in Montrose Co., Colorado, in cavities or associated with malachite and azurite. Some samples show 60 p. c. of $SiO_2$, the purest 2·6 to 7·2 p. c. Separation is accomplished by nitric acid. Named after M. Adolphe Carnot.

CARYINITE, p. 754.—Further described by Hj. Sjögren. Occurs at Långban, massive, filling fissures in a coarse mixture of schefferite, rhodonite and hedyphane. Anisotropic, without pleochroism. Two cleavages noted parallel to *m* (110) and *b* (010), $bm = 49° 15'$. Extinction-observations on plates ‖ and ⊥ to *b* make the system orthorhombic. Optically +. $Bx_a \perp b$. Ax. pl. ‖ *a* (100). An analysis by R. Mauzelius gave:

|  | $As_2O_5$ | $P_2O_5$ | $V_2O_5$ | PbO | MnO | FeO | CaO | MgO | BaO | $Na_2O$ | $K_2O$ | $H_2O$ | Cl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G. = 4·29 | 49·78 | 0·19 | *tr.* | 9·21 | 18·66 | 0·54 | 12·12 | 3·09 | 1·03 | 5·16 | 0·37 | 0·53 | *tr.* = 100·68 |

This leads to the formula $10RO.3A_2O_5$ or, if the presence of the radical (OH) is assumed, to $R_3As_2O_8$. Nearly the same composition is obtained for the soda-berzeliite (see p. 10). The origin of berzeliite by the alteration of caryinite is confirmed. Bull. G. Inst. Upsala, **2**, 87, 1895.

CASSITERITE, pp. 234, 1030, 1037.—Crystals described with new forms λ (10·9·0), *f* (835), Kohlmann, Zs. Kr., **24**, 350, 1895. On artificial crystals, A. Arzruni, Zs. Kr., **25**, 467, 1895.

Description of occurrence of tin ores in Bolivia, A. W. Stelzner, Zs. G. Ges., **49**, 51, 1897. On the tin deposits of Temescal, So. California, Fairbanks, Am. J. Sc., **4**, 39, 1897.

**Caswellite.** *A. H. Chester*, G. Rep. N. J., 1895. Trans. N. Y. Acad. Sci., **13**, 181, 1894. An altered mica of a light copper-red color and bronze-like luster resembling clintonite. Structure micaceous. Inelastic. H. = 2·5–3. G. = 3·54. Double refraction feeble. Not pleochroic. Analysis:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ | CaO | MgO | Ign. |
|---|---|---|---|---|---|---|
| $\frac{2}{2}$ 38·74 | 6·58 | 6·85 | 15·95 | 22·30 | 5·52 | 4·64 = 100·58 |

Occurs with rhodonite, polyadelphite and a dark-colored biotite, from which it is believed to have been derived at the Trotter mine, Franklin Furnace, N. J. Named after Mr. John H. Caswell.

**Cataphorite.** Kataforit, *W. C. Brögger*, Die Eruptivgest. d. Kristianiagebietes, **1**, 37, 73, 1894; **3**, 169, 1898, *et al.*

An alkali-iron amphibole, intermediate between barkevikite and arfvedsonite, but not yet analyzed. Occurs in the grorudite-tinguaite series of rocks of southern Norway. Cleavage-angle about 56°. Extinction-angle on *b* (010), $\mathfrak{c} \wedge \dot{c} = 30°$ to 60°. Predominating absorption-colors reddish; $\mathfrak{b} > \mathfrak{c} > \mathfrak{a}$. Lacroix gives for a similar amphibole (but nearer barkevikite) from the Haute-Loire. 2E = 60°; $\mathfrak{a}$ yellowish brown; $\mathfrak{b}$ violet; $\mathfrak{c}$ yellow, slightly greenish. Min. France, **1**, 689, 1893. Brögger suggests that the amphibole of pulaskite (J. Fr. Williams, Ign. Rocks Arkansas, p. 64) may also belong between barkevikite and cataphorite. See also *Barkevikite.*

CATAPLEIITE, p. 412.—Occurs at Kangerdluarsuk, Greenland, with neptunite, epididymite, ægirite, etc., in crystals with $(10\bar{1}3)$; G. = 2·743; analysis by Flink: $SiO_2$ 44·08, $ZrO_2$ 31·83, CaO 0·17, $Na_2O$ 14·80, $H_2O$ 9·12 = 100. This corresponds to a pure *natron-catapleiite*, G. För. Förh., **15**, 206, 1893.

**Cedarite.** *R. Klebs* [Jb. preuss. geol. Landesanst. 1896], Jb. Min., **2**, 212 ref., 1898. A fossil resin resembling amber somewhat widely distributed in the alluvium of the Saskatchewan river in Canada. Cold clear yellow, or clouded. Composition: C 78·15, H 9·89, O 11·20, S 0·31, ash 0·45 = 100. Partially soluble in the usual solvents.

CELESTITE, p. 905.—**Cryst.**—List of cryst. forms with references, also optical characters, etc. Grunenberg [Inaug. Diss., Breslau, 1892], Zs. Kr., **24**, 199, 1894. Brousseval, Ville-sur-Saulx, France, new form (1·10·10), Stöber, Zs. Kr., **21**, 339, 1893. From the Romagna with new forms (450), (230), (105), (087)?, (326), (562), Artini, Rend. Ist. Lomb. Sc., **26**, 323, 1893. Westeregln, Bücking, Ber. Ak. Berlin, 536, 1895. Giershagen Stadtberge, new forms *N* (705), *Q* (332), *R* (1·19·19), also discussion of variation in axial ratio, physical characters, etc., Arzruni and Thaddéeff, Zs. Kr., **25**, 38, 1895. Bessarabia, Prendel, Vh. Min. Ges., **34**, 185, 1896.

Occurs in Lansdowne township, Leeds Co., Ontario (anal. by Johnston, BaO *tr.*), Hoffmann, Rep. G. Canada, **7**, 9 R, 1894; cf. also *ib.*, **5**, 25 R, 1889–90.

A fibrous radiated variety from the Silurian crystallized limestone of Eastern Ontario gave C. W. Volney: $SrSO_4$ 70·01, $BaSO_4$ 30·85, $Al_2O_3,Fe_2O_3$ 0·005 = 100·865. G. = 4·123. J. Am. Ch. Soc., **21**, 386, 1899. Another specimen from Lansdowne, Ontario, gave, $SrSO_4$ 58·20, $BaSO_4$ 39·85 = 98 05. G. = 4·188. Still another celestite showed over 3 p. c. $BaSO_4$; G. = 4·41. *Ibid.*, **13**, 290, 1891. Cf. Hoffmann, above.

**Celsian.** *Hj. Sjögren.* G. För. Förh., **17**, 578, 1895.

Triclinic. Massive. Cleavage: *c* (001) perfect; *b* (010) distinct; *m* (110) and *M* ($1\bar{1}0$) less distinct. Angles: *bc* = 89° 34′–89° 37′, *cm* = 68° 30′–68° 45′, *bm* = 59° 18′. H. = 6 to 6·5. G. = 3·37. Luster vitreous. Colorless. Extinction on *c* inclined 3° 10′, and on *b*, 26° 45′ to edge b/c. Optic axis seen obliquely in sections ‖ *c*.

Composition analogous to that of anorthite, $BaAl_2Si_2O_8$ or $BaO.Al_2O_3.2SiO_2$. Analysis R. Mauzelius:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | BaO | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ | F |
|---|---|---|---|---|---|---|---|---|---|
| 32·43 | 26·55 | 0·12 | 39·72 | 0·23 | 0·11 | 0·22 | 0·16 | 0·64 | 0·64 = 100·82 |

B. B. scarcely fusible even on thin splinters.

From the manganese mines of Jakobsberg, Sweden, with schefferite and manganophyllite. Named after Anders Celsius, the Swedish naturalist.

Celyphite.—Same as *Kelyphite*, p. 447.

Cenosite, p. 698.—Described by Hj. Sjögren, from the Ko mines, Nordmark, Sweden; occurs with diopside, clinochlore, magnetite and apatite. Crystallization orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·9517 : 1 : 0·8832, or near those of cerite. Forms: *b* (010), *c* (001); *m* (110), *h* (230); *g* (201); *f* (023), *d* (011), *e* (021). Habit short prismatic. Angles: *mm‴* = 87° 10′, *mm′* = *92° 50′, *bd* = *48° 33′ (see below). Cleavage not observed. G. = 3·38. Luster greasy. Color yellow-brown to dark chestnut-brown. Analysis (on 0·067 gr.), R. Mauzelius:

| $SiO_2$ | $Y_2O_3$, etc. | $Fe_2O_3$ | CaO | MgO | Alk. | $H_2O$ | $CO_2$ |
|---|---|---|---|---|---|---|---|
| 31·7 | 35·9 | 2·9 | 16 5 | 1·4 | 3·6 | 2·9 | [5·1] = 100 |

The author gives *bd* = 41° 33′, which is obviously an error; 48° 33′ agrees with his axial ratio. G. För. För., **19**, 54, 1897.

Cerussite, pp. 286, 1030.—**Cryst.**—Pacaudière, Loire, and Roure, (Pontgibaud), France, Gonnard, Bull. Soc. Min., **15**, 35, 41, 1892. Norberg, twins, Johansson, G. För. Förh., **14**, 49, 1892 Black Hawk, Montana, Pratt, Am. J. Sc., **48**, 212, 1894. Cabo de Gata, Osann, Zs. Kr., **23**, 264, 1894. Tarnowitz, Silesia, new forms $\mathfrak{a}$ (441), $\mathfrak{f}$ (170), $\mathfrak{e}$ (025), $\mathfrak{g}$ (171); also on *iglesiasite*, from Radzionkau (3·4 ZnO), $\mathfrak{i}$ (210), Traube, Zs. G. Ges., **46**, 60, 1894. From the Galena limestone, Wisconsin, with the new form $\lambda$ (0·25·4), Hobbs, Zs. Kr., **25**, 265, 1895, and Bull. Univ. Wisconsin, **1**, 128, 1895: also from Missoula, with $\mathfrak{d}$ (380), *id.*, Am. J. Sc., **50**, 121, 1895. Gorno, Val Seriana, Italy, crystals described, with new form (0·13·1), Artini, Riv. Min. Ital., **16**, 21, 1896, and Rend. Ist. Lombardo, **30**, 1529, 1897. Nebida, Sardinia, Riva, Riv. Min. Ital., **18**, 54, 1898, and Rend. Accad. Linc., **6** (1), 421, 1897.

Chabazite, p. 589.—Tulferthal, Tyrol; crystals described (twins), Habert, Zs. Kr., **28**, 243, 1897. Investigation of the absorption of gases after having been partially deprived of water, G. Friedel (also other zeolites), Bull. Soc. Min., **19**, 102, 1896; **22**, 5, 1899. Also Rinne, Jb. Min., **2**, 28, 1897.

Chalcanthite, p. 944.—Etching-figures investigated, T. L. Walker, Am. J. Sc., **5**, 176, 1898. Occurs at the Avoca claim, Bonaparte river, Lillooet district, Br. Columbia, Hoffmann, Rep. G. Canada, **9**, 12 R, 1896.

Chalcocite, p. 55.—Crystals from Bristol, Conn., with (130) as tw.-plane, Kaiser, Zs. Kr., **24**, 498, 1895. From Montecatini, with new form (052), Boeris, Zs. Kr., **23**, 235, 1894, and Riv. Min. Ital., **14**, 26, 1895.

Chalcophanite, p. 256.—*Hydrofranklinite* of Roepper (Min., p. 259) is shown by Penfield and Kreider (Am. J. Sc., **48**, 141, 1894) to be identical with chalcophanite. The form is not octahedral, but rhombohedral, a combination of *c* and *r*. Analysis: FeO 10·00, MnO 48·27, ZnO 18·25, O 11·21, $H_2O$ 11·85, insol. 0·25 = 99·83; G. = 4·012.

Chalcopyrite, pp. 80, 1030.—**Cryst.**—Westphalia, new form, *s* ($5\bar{2}5$), Cesàro, Bull. Ac. Belg., **28**, 182, 1894. Victoria mine, near Burgholdingshausen, Siegen, new forms (312), (534), Sonheur, Zs. Kr., **23**, 545, 1894. Kis-Almás, Hungary, new forms $\tau$ (605), $\zeta$ (907), $\chi$ (704), Zimanyi, Zs. Kr., **27**, 95, 1896. Harz Mts., Luedecke, Min. d. Harzes, 123, 1896.

Occurs at Müsen, in capillary forms, Laspeyres, Zs. Kr., **20**, 529, 1892.

CHALCOSTIBITE, pp. 113, 1030.—Penfield and Frenzel have shown (Am. J. Sc., **4**, 27, 1897, and Zs. Kr, **28**, 598) that the guejarite of Cumenge (Min., pp. 110, 1030) is identical with chalcostibite (wolfsbergite*). Referred to the axial ratio $\breve{a} : \bar{b} : \dot{c} = 0·5283 : 1 : 0·6364$, which is that of Laspeyres (p. 1030, Wolfsberg cryst.) modified to correspond with the symbol 6·12·7 of *p* (not 7·14·8 Lasp.), the forms are : *b* (010), *c* (001), *h* (203), *d* (101), *i* (302), *g* (201), *t* (021), *u* (061). Analyses (Frenzel) 1, 2, below. G. = 4·959 Pfd.

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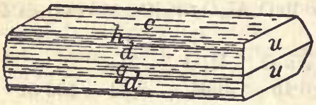
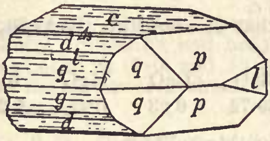


Guéjar.

2.



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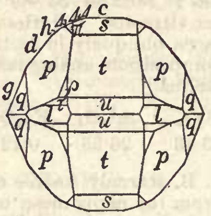

Huanchaca, Bolivia.

Crystals of chalcostibite from the Pulacayo mine, Huanchaca, Bolivia, showed (l. c.) the new forms *l* (130), $\Delta$ (209), $\Delta_1$ (207), $\Delta_3$ (205), *s* (065), $\mu$ (136), $\nu$ (133), $\pi$ (265), $\rho$ (263), $\sigma$ (4·12·5), $\tau$ (261). The axial ratio deduced is $\breve{a} : \bar{b} : \dot{c} = 0·5312 : 1 : 0·63955$. Other crystals from the same locality examined by L. J. Spencer (quoted above) showed the additional forms: $\alpha$ (233), $\beta$ (354), $\gamma$ (474), $\delta$ (475), $\epsilon$ (476). The crystals are prismatic ∥ *b* and striated in this direction. Cleavage : basal, perfect ; *a* and *b* also observed.

Analyses, Frenzel : 1 of chalcostibite from Guéjar, G. = 4·96 ; 2 of the original guejarite ; 3 of chalcostibite from Bolivia :

| | S | Sb | Cu | Pb | Fe | |
|---|---|---|---|---|---|---|
| 1. Guéjar | 26·28 | 48·86 | 24·44 | 0·58 | 0.42 | = 100·58 |
| 2. " | 26·12 | 48·44 | 25·23 | 0·32 | 0·49 Zn 0·18 | = 100·78 |
| 3. Huanchaca | 26·20 | 48·45 | 24·72 | — | — | = 99·37 |

CHLORASTROLITE, p. 610.—Examined by N. H. Winchell, who concludes that, while the material may be somewhat impure (delessite, etc.), it has constant and distinguishing optical characters. Occurs in small round pebbles with fine fibrous, stellate structure. H. = 5·5. G. = 3·155. Color light and dark green. Fibers elongated ∥ 𝔟. Extinction oblique, to 20°. Refractive index higher than for thomsonite. Pleochroism: distinct, colorless and light green. From Isle Royale, Lake Superior. Remarks are also made on the possible relation of "zonochlorite" to chlorastrolite and mesolite. Amer. Geol., **23**, 116, 1899.

CHLORITES, pp. 643–664.—Discussion of composition and analyses, F. W. Clarke and Schneider, Am. J. Sc., **43**, 378, 1892. Also Bull. U. S. G. Surv., **113**, 11, 27, 1893.

See also *Clinochlore*, *Penninite*, etc.

CHLORITOID, pp. 640, 1031.—Occurs in blocks on the south shore of Michigamme lake, Mich., W. H. Hobbs (anal. Kahlenberg), Am. J. Sc., **50**, 121, 1895 ; **2**, 87, 1896 ; cf. Lane and Kellar, Min., p. 1031, also Rominger, Geol. Surv. Michigan, vol. **5**, p. 31.

From Lainicium, Carpathian Mts., anal., Duparc and Mrazek, C. R., **116**, 601, 1893. Also in Kincardineshire described (anal.) by G. Barrow, Q. J. G. Soc., **54**, 149, 1898.

See also *Ottrelite.*

**Chloroarsenian.** *L. J. Igelström*, G. För. Förh, **15**, 471, 1893 ; Zs. Kr., **22**, 468. An imperfectly described mineral occurring with basiliite (p. 9) at the Sjö mine, Örebro, Sweden. In crystals, showing one cleavage and having a vitreous luster and yellowish green color. Contains MnO and $As_2O_5$ (or $As_2O_3$), but no $Sb_2O_5$ nor $H_2O$. It is to be regretted in the case of this and other supposed new minerals from the same locality that the name was not withheld until they could be adequately described according to scientific methods.

CHONDRODITE, p. 535.—See *Humite.*

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* The probable identity of chalcostibite and guejarite was urged by L. J. Spencer in 1896. See Min. Mag., **11**, pp. x and 188, 1897.

**Chondrostibian.** *L. J. Igelström*, G. För. Förh., 15, 343, 1893; Zs. Kr., **22, 43, 1893**. In grains and perhaps also in octahedral crystals (?) embedded in barite at the Sjö mine, Örebro, Sweden. Color dark brownish red to yellowish red in small grains. Feebly magnetic. An analysis on very impure material gave after the deduction of 51 p. c. of foreign substances (calcite, tephroite, barite, etc.): $Sb_2O_5$ 30·66, $As_2O_5$ 2·10, $Mn_2O_3$ 33·13, $Fe_2O_3$ 15·10, $H_2O$ 19·01 = **100.** The result thus obtained has obviously little claim to accuracy.

CHROMITE, pp. 228, 1031.—Crystals from the Bendegó meteoric iron show the forms (111), (110), (311), (221); (001) rare; also faces of (510), (310), (210), (211), (553), (774)?, (552)?, (331), (441). Hussak, quoted by Derby, Arch. Mus. Nacional de Rio de Janeiro, p. 165, 1896.

A variety (*magnochromite*) from Tampadel, Zobtengebirge, Lower Silesia, gave Laszczyński (quoted by Traube, Zs. G. Ges., **46**, 52, 1894): $Cr_2O_3$ 41·23, $Al_2O_3$ 24·58, FeO 19·04, MnO 0·58, MgO 14·77 = 100·20; the iron may be partly $Fe_2O_3$. G. = 4·21.

J. H. Pratt, discussing the occurrence and origin of chromite (Am. J. Sc., **7**, 281, 1899), has proposed the name *mitchellite*, after Prof. Elisha Mitchell of North Carolina (1793–1857), for a magnesian variety represented by the mineral from Webster, N. C. An analysis by H. W. Foote gave:

| $Cr_2O_3$ | $Al_2O_3$ | FeO | MgO |
|---|---|---|---|
| 39·95 | 29·28 | 13·90 | 17·31 = 100·44. |

The calculated formula is $2MgAl_2O_4.MgCr_2O_4.FeCr_2O_4$. This corresponds closely to the magnochromite of Bock (Min., p. 228) and to the similar mineral from Tampadel, Silesia, noted above.

CHRYSOLITE, pp. 441, 1031.—Crystals from Monte delle Croce, near Montefiascone, described and measured. Fantappié, Riv. Min. Ital., **17**, 3, 1897.

A minute discussion of the form, composition, etc., of minerals of the Chrysolite Group is given by Thaddéeff, Zs. Kr., **26**, 28, 1896.

Crystals altered to serpentine from Middlefield, Mass., Emerson, Bull. Amer. G. Soc., **6**, 473; Bull. U. S. G. Surv., **126**, 152, 1895.

An alteration-product from the north shore of L. Superior is referred to bowlingite (Min., p. 682) by Winchell, Amer. Geol., **23**, 43, 1899. See also *Iddingsite.*

A lead-zink chrysolite (*Bleizinkchrysolith*) from a slag is noted by Heberdey, Zs. Kr., **21**, 61, 1892.

CINNABAR, pp. 66, 1031.—Occurs in fine crystals at Ouen-Shan-Tchiang, central China, Termier, Bull. Soc. Min., **20**, 204, 1897.

On occurrences in Canada, see Hoffmann, Rep. G. Canada, **5**, 66 R, 1889–90; **6**, 31 R, 1892–93. The occurrence in Southern Texas near the Rio Grande (Long. 27° W., Lat. 29° 30′ N.) is described by W. P. Blake (Trans. Am. Inst. Mng. Eng., March, 1895); in grains and small rhombohedral crystals.

On synthesis, Ippen, Min. petr. Mitth., **14**, 114, 1894.

CLEVEITE, p. 889.—See *Uraninite.*

CLINOCHLORE, p. 644.—Crystals from the Ural described, Jeremejev, Vh. Min. Ges., **31**, 417, 1894.

A discussion of optical characters specially with reference to the relations of clinochlore and penninite is given by Klein, Jb. Min., **2**, 119–132, 1895. Clinochlore is found to be always optically *positive*, even when it becomes uniaxial on heating; penninite, however, is *negative.*

Analyses of specimens from Zlatoust (also leuchtenbergite), Clarke and Schneider, Am. J. Sc., **43**, 378, 1892.

From Buckingham, Ottawa Co., Quebec, and Bagot township, Renfrew Co., Ontario (analyses by Johnston), Hoffmann, Rep. G. Canada, **6**, 17 R, 1892–93.

CLINOCLASITE, p. 795.—Analysis by Church, Min. Mag., **11**, 4, 1895.

**Clinohedrite**, *S. L. Penfield* and *H. W. Foote*, Am. J. Sc., **5**, 289, 1898.

Monoclinic-clinohedral. Axes $\dot{a} : \bar{b} : \dot{c}$ = 0·68245 : 1 : 0·3226; $\beta = 76° \ 2\tfrac{1}{2}'$ = 100 ∧ 001. Angles 100 ∧ 100 = 33° 31′, 001 ∧ 011 = 17° 23′, 001 ∧ 101 = 22° 22·9′. $bm$ = * 56° 29′, $pp'$ = * 29° 8′, $mp$ = * 51° 54′. Observed forms: *b* (010), *h* (320), *m* (110), $m_1$ $(\bar{1}10)$, *n* (120), *l* (130); *e* $(\bar{1}01)$, $e_1$ $(\bar{1}0\bar{1})$, *p* (111), $p_1$ $(\bar{1}1\bar{1})$, *q* $(\bar{1}11)$, $q_1$ $(11\bar{1})$, *r* $(\bar{3}31)$, *s* $(\bar{5}51)$, *t* $(\bar{7}71)$, *u* $(\bar{5}31)$, *o* (131), $o_1$ $(13\bar{1})$, *x* $(\bar{1}3\bar{1})$, *y* $(\bar{1}2\bar{1})$. Habit of crystals varied as shown in figures, but conforming to the group under the monoclinic system (clinohedral or domatic group) which has a plane of symmetry, but no axis of symmetry.

Cleavage: *b* (010) perfect. Brittle. H. = 5·5. G. = 3·33. Luster vitreous. Colorless to white and amethystine. Transparent. Optically −. Birefringence not high. Ax. pl. and $Bx_o \perp b$. $\mathfrak{b} \wedge \dot{c} = -28°$. Strongly pyroelectric.

Composition analogous to calamine, $H_2ZnCaSiO_4$ or $(ZnOH)(CaOH)SiO_3$; this requires: Silica 27·92, zinc protoxide 37·67, lime 26·04, water 8·37 = 100. Analysis (Foote):

| | $SiO_2$ | ZnO | MnO | CaO | MgO | $H_2O$ | $(Fe,Al)_2O_3$ |
|---|---|---|---|---|---|---|---|
| $\frac{3}{2}$ | 27·22 | 37·44 | 0·50 | 26·25 | 0·07 | 8·56 | 0·28 = 100 32 |

B.B. exfoliates and then fuses at 4 to a yellowish enamel; the water is expelled at a faint red heat. Yields a coating of zinc oxide on charcoal. Dissolves readily when powdered in hydrochloric acid, yielding gelatinous silica on evaporation.

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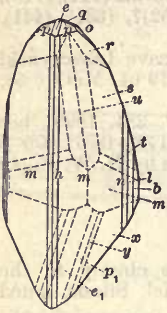

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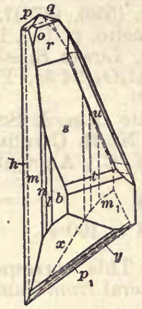

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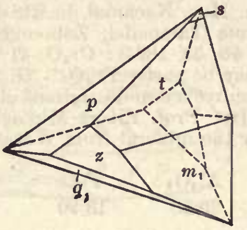

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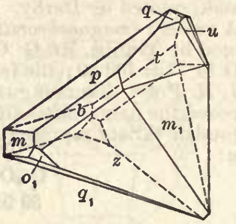


From the Trotter mine, Franklin Furnace, N. J., associated with willemite, brown garnet, axinite, datolite, phlogopite. This name had previously been used for a variety of tetrahedrite supposed (Breithaupt) to differ from others in form.

**Clinozoisite.** Klinozoisit. *E. Weinschenk*, Zs. Kr., **26**, 161, 433, 1896. A name proposed for those members of the zoisite-epidote group, which are near zoisite in composition but monoclinic in crystallization; they are further optically + and of feebler refringence and birefringence than typical epidote; zoisite is regarded as dimorphous with epidote. To clinozoisite belong crystals, like epidote in habit, from rolled pebbles at the foot of the Goslerwand, Prägratten, Tyrol. Color pale rose-red, transparent. Optically +. $Bx_a \wedge \dot{c} = 2°$. $\beta = 1·7195$. $\gamma - \alpha = 0·0056$. $2V_y = 81° 40'$. Analysis gave:

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|
| G. = 3·372 | 39·06 | 32·57 | 1·68 | 0·29 | *tr.* | 24·53 | 0·01 = 100·14 |

An epidote from the Rothenkopf, Zillerthal, with only 3·52 $Fe_2O_3$, was optically *negative*, with $\gamma - \alpha = 0·0105$. See also *Fouquéite* (Min., p. 1035) and *Zoisite.*

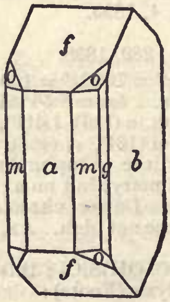
COBALTITE, p. 89.—From Siegen, twins with *o* (111) as tw.-plane, Laspeyres, Zs. Kr., **20**, 550, 1892.

COHENITE, pp. 31, 1038.—Noted in the Bendegó, Brazil, meteoric iron, in dendritic aggregates, also in isolated isometric crystals with the forms *a* (100), *o* (111), *d* (110), *p* (221), $\beta$ (322), (944)? Hussak, quoted by Derby, Arch. Mus. Rio de Janeiro, p. 160, 1896. Also described from other meteoric irons (Cohen) and in the terrestrial iron of Niakornak, Greenland. Analyses by Cohen, Medd. om Grönland, **15**, 293, 1897.

COLEMANITE, p. 882.—Anomalous etching-figures examined, Baumhauer, Zs. Kr., **30**, 97, 1898.

COLUMBITE, p. 731.—Crystals of a mangano-columbite from Rumford, Me., are described by H. W. Foote (Figs. 1, 2). G. = 6·44, color dark reddish brown, Am. J. Sc., **1**, 460, 1896.

1.



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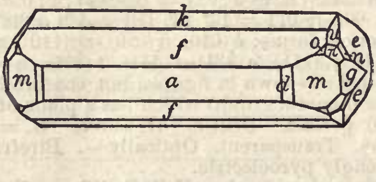

Analysis from North Carolina, Khrushchov, Vh. Min. Ges., 31, 412, 1894.

Occurs (G. = 5·36) in the township of Sebastopol, Renfrew Co., Ontario, W. G. Miller, Rep't Bureau of Mines, 7, Part III, p. 234, Toronto, 1898.

See also *Tantalite* and *Tapiolite*.

Cookeite, p. 625.—From Hebron, Me., analyzed by Penfield, Am. J. Sc., 45, 393, 1893, and shown to have the formula $Li[Al(OH)]_3[SiO_3]_2$. Crystallization monoclinic, the crystals often formed of wedge-shaped cleavage-plates grouped as in figures 1–3; the center *a* of 3 uniaxial. Analysis:

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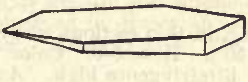

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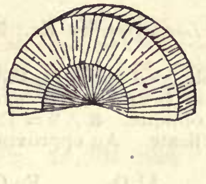

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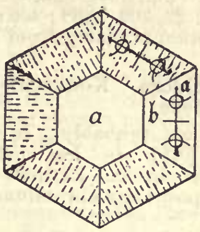

| | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | $K_2O$ | $Na_2O$ | $Li_2O$ | $H_2O$ | F |
|---|---|---|---|---|---|---|---|---|---|---|
| G. = 2·675 | ⅔ | 34·00 | 45·06 | 0·45 | 0·04 | 0·14 | 0·19 | 4·02 | 14·96 | 0·46 = 99·32 |

A mineral referred here by Hoffmann occurs in the sericite-schist of Wait-a-bit creek, Columbia river, British Columbia (analysis by Johnston), Rep. G. Canada, 6, 22 R, 1892–93.

Copper, p. 20.—Crystals in aventurine glass described, Washington, Am. J. Sc., 48, 411, 1894.

Crystals from Burra-Burra, S. Australia, are covered with an incrustation of minute crystals of cuprite in parallel position with it, Mügge, Jb. Min., 2, 151, 1898.

Occurs at Franklin Furnace, N. J., J. E. Wolff, Proc. Am. Acad., 33, 429, 1898.

Cordierite.—See *Iolite*.

Corundum, pp. 210, 1031.—Description of twin crystal (showing the new form $(5\cdot5\cdot\overline{10}\cdot4)$) with *r* $(10\bar{1}1)$ as tw.-plane; also a similar contact-trilling, etc., H. Barvíř, Ann. Mus. Wien, 2, 135, 1892.

Discussion of planes of parting, viz., parallel to *c* (0001), *a* $(11\bar{2}0)$, both normal "solution-planes"; also *r* $(10\bar{1}1)$, a gliding plane and sometimes a secondary solution-plane, Judd, Min. Mag., 11, 49, 1895.

Pratt has described crystals of sapphire (Figs. 1–3) from Yogo Gulch, Montana, with *x* $(30\bar{3}2)$; also showing natural etching-figures, Am. J. Sc., 4, 424, 1897. See also below. Bauer notes the new form **r** $(01\bar{1}2)$ on Burma rubies, Jb. Min., 2, 197, 1896.

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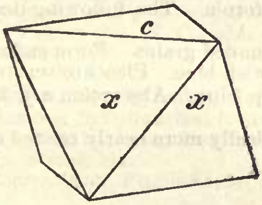

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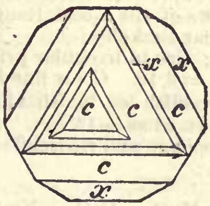

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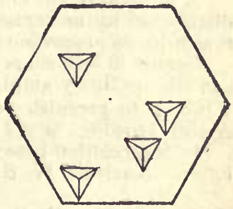


Investigations of hardness of minerals in the scale of Mohs compared with corundum, Rosiwal, Vh. G. Reichs., 475, 1896. See also Auerbach, Wied. Ann., 58, 357, 1896; Jaggar (microsclerometer), Am. J. Sc., 4, 399, 1897.

In regard to the *occurrence* of corundum, recent investigations show that it is often associated with igneous rocks and is itself of igneous origin, though also of secondary origin in crystalline limestone and, further, the result of contact-metamorphism. These subjects have been discussed by the following authors:

On the occurrence and origin of the rubies of Burma (and associated minerals), C. Barrington Brown and J. W. Judd, Phil. Trans., 187 (A), 151–228, 1896. See also Bauer, l. c.; on the rubies of Siam, Louis, Min. Mag., 10, 267, 1894.

On the corundum of India, T. H. Holland, Geol. India, 2d Ed., Part I, pp. 1–79, Calcutta, 1898. See also Judd, Min. Mag., 11, 56, 1895.

Corundum deposits of Georgia, F. P. King, Geol. Surv. Georgia, Bull. 2, 1894. Associated with peridotite of N. Carolina, igneous origin discussed, Pratt, Am. J. Sc., 6, 49, 1898.

Sapphire of Yogo Gulch, Fergus Co., and elsewhere, Montana, Kunz, Am. J. Sc., 4, 417, 1897; Pirsson, *ibid.*, p. 421.

Corundum of Eastern Ontario, W. G. Miller, Rep. Bureau of Mines, Vol. 7, Pt. III, Toronto, 1898.

Produced by contact-metamorphism on the border of the Dartmoor granite, Devonshire, Busz, Geol. Mag., 3, 492, 1896.

Experimental investigation of conditions of formation in a magma, Morozewicz, Min. petr. Mitth., 18, 22, 202, 1898; see also Zs. Kr., 24, 281, 1894.

Description of emery from Naxos, Tschermak, Min. petr. Mitth., 14, 311, 1894.

**Cosmochlore.** Kosmochlor, *Laspeyres*, Zs. Kr., **27**, 592, 1896. Kosmochromit, Groth, Tab. Ueb., 132, 1898.

Monoclinic, probably. In embedded splinters, showing, in thin sections, cleavages parallel to *a* (100), *b* (010), also less distinct prismatic (30° and 150°). H. = 5–6. Color emerald-green, strongly pleochroic. Extinction oblique. $\mathfrak{a} \wedge \dot{c} = 12°$. Birefringence high. Ax. pl. ‖ *b* (010).

In composition a chromium silicate. An approximate analysis (on 0·003 gr.) gave:

| $SiO_2$ | $Cr_2O_3$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO |
|---|---|---|---|---|---|
| 31·82 | 39·39 | 9·09 | 9·09 | 6·06 | 4·55 = 100. |

Identified in minute amount in the stony portion of the Toluca meteoric iron. The author found also orthoclase, plagioclase, pyroxene, quartz, zircon, chromite, and others not fully determined, perhaps new.

COTUNNITE, p. 165.—Study of artificial crystals, Stöber, Bull. Ac. Belg., **30**, 345, 1895.

**Courtzilite.** 17th Ann. Rep. U. S .G. Surv., Part III., p. 752, 1895–96. A form of asphaltum allied to uintahite (gilsonite), etc.

COVELLITE, p. 68. Occurs in fine indigo-blue masses at the East Gray Rock mine, Butte, Montana; analysis by Hillebrand, Am. J. Sc., 7, 56, 1899. Also massive from La Sal mine, La Sal distr., Utah; in plates from Rio Grande Co., Colo. (Pfd.).

CROCOITE, p. 913.—Crystals from Penchalonga, Mashonaland, described (new form 403), Redlich. Zs. Kr., **27**, 607, 1896. See also Alford, Q. J. G. Soc., **50**, 8, 1894.

Occurs finely crystallized at the Adelaide mine, Mt. Dundas, Tasmania, new forms *S* (10·3·0), *T* (530), Palache, Am. J. Sc., 1, 389, 1896. On the occurrence in Tasmania, see also Petterd, Min. Tasmania, p. 24, 1893, p. 30, 1896; further, Liversidge (anal.), Proc. R. Soc. N. S. W., **29**, 318, 1895.

Obtained in minute crystals by exposing for several months to the air a solution of lead chromate in caustic potash, Ludeking, Am. J. Sc., **44**, 57, 1892.

**Crossite.** *Charles Palache*, Bull. G. Univ. California, 1, 181, 1894.

A mineral of the amphibole group, characterized by its blue color, occurring somewhat widely distributed in the crystalline schists of the Coast Ranges of California. The following description belongs to specimens from near Berkeley:

Occurs in lath-shaped crystals; also in irregular prisms and rounded grains. Form and cleavage like ordinary amphibole. G. = 3·16. Color fine blue, yellowish blue. Pleochroism strong: $\mathfrak{c}$ brown to greenish yellow; $\mathfrak{b}$ reddish or bluish violet; $\mathfrak{a}$ deep blue. Absorption $\mathfrak{a} \geqq \mathfrak{b} > \mathfrak{c}$. Ax. pl. ‖ *b* (010). $\mathfrak{a} \wedge \dot{c} = 13°$ (assumed as + 13°)..

In composition between glaucophane and riebeckite, being optically more nearly related to the latter. Analysis, W. S. T. Smith:

| SiO | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $Na_2O$ | $K_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 55 02 | 4·75 | 10·91 | 9·46 | 9·30 | 2·38 | 7·62 | 0·27 | MnO *tr.*, $H_2O$ *undet.* = 99·76 |

Named after Mr. Whitman Cross of the U. S. Geol. Survey.

A blue amphibole of like optical characters occurs as a secondary growth on brown hornblende and on pyroxene in Custer Co., Colorado, (cf. Min., p. 402, where it is provisionally placed under arfvedsonite).

CRYOLITE, pp. 166, 1032.—Description of twin crystals, Baumhauer, Zs. Kr., **24**, 87, 1894.

CRYSTALLITES.—Discussion of various forms with introduction of new names: clavalite, spiculite, bacillite, scopulite, arculite, rotulite, furculite, crenulite, Rutley, Min. Mag., **9**, 261, 1891.

**Cubaite.**—See *Quartz.*

**Cubanite**, p. 79.—Analyses of a mineral having the external characters of **Breithaupt's** species gave Schneider:

| | | | |
|---|---|---|---|
| 1. | S 34·37 | Cu 24·32 | Fe 41·15 = 98·84 |
| 2. | 34·01 | 23·00 | 42·51 = 99·52 |

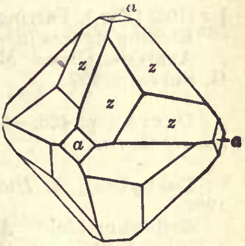
This leads to the formula $CuFe_2S_3$, agreeing with the analysis of Scheidauer (anal. 4, Min., p. 79). For the mineral analyzed by Eastwick and others (anals. 1–3, *ibid.*) which corresponds to $CuFe_2S_4$, the author proposes the name *barracanite* or *cupropyrite.* J. pr. Ch., 52, 555, 1895.

**Cubeïte.** Kubeit, *L. Darapsky*, Jb. Min., 1, 163, 1898. This name was earlier suggested for an imperfectly known iron sulphate from the neighborhood of the Loa river, desert of Atacama. Now obtained in druses of elongated rhombic or monoclinic double pyramids. Brittle, of vitreous luster. Analysis gave: $SO_3$ 36·4, $Fe_2O_3$ 19·3, MgO 7·8, $H_2O$ 33·7, CaO [0·1], insol. 2·7 = 100.

**Cumengéite.** *E. Mallard*, Bull. Soc. Min., **16**, 184, 1893. **Cumengite.—See *Percylite.***

**Cuprite**, p. 206.—Etching-figures do not show the trapezohedral **symmetry** sometimes exhibited in the distribution of the faces Traube, Jb. Min., Beil.-Bd., **10**, 455, 1896. Fig. shows a crystal from Cornwall, drawn by J. H. **Pratt** (priv. contr.), in which the trapezohedral symmetry is marked.

See also *Copper*.



Cuprite.

**Cuprocassiterite.** *Titus Ulke*, Trans. Am. Inst. Mng. Eng., **21**, 240, Feb. 1892.—See *Stannite.*

**Cuproiodargyrite.** *H. Schulze* [Ch. Ztg., **16**, 1952, 1892], Zs. Kr., **24**, 626, 1895.

Occurs as an incrustation or filling crevices in limestone. Somewhat harder and less sectile than iodyrite. Color sulphur-yellow. Translucent. Composition CuI.AgI. Analysis: I 57·75, Ag 25·58, Cu 15·91 = 99·24. Occurs at the mine San Agustin, Huantajaya, near Iquique, Chili, as a decomposition-product of stromeyerite.

**Cuproplumbite**, p. 51.—From Butte City, Montana, analysis by J. T. De Bell: S 17·77, **Cu** 61·32, Pb 18·97, quartz 1·58 = 99·64. This gives $5Cu_2S.PbS$. The corrected specific gravity (5·39) is shown to correspond with that called for (5·45) on the supposition that it is to be classed with isometric galena. Am. Ch. J., 14, 620, 1892.

From Semipalatinsk, anal. by Antipov, Vh. Min. Ges., 28, 527, 1891, and Zs. Kr., 23, 275, 1894.

**Cyanite**, p. 500.—Etching-figures investigated, Traube, Jb. Min., Beil.-Bd., **10**, 459, 1896; same by T. L. Walker, Am. J. Sc., **5**, 181, 1898.

Occurs in rich grass-green crystals with *t* (520), often perfectly transparent, on North Toe river, Yancey Co., N. C.; also pale green cyanite elsewhere in the state, Pratt, Am. J. Sc., **5**, 126, 1898.

**Cylindrite.** Kylindrit, *A. Frenzel*, Jb. Min., **2**, 125, 1893.

Massive; in cylindrical forms separating under pressure into distinct shells or folia, difficult to pulverize, like graphite. Soft; H. = 2·5–3. G. = 5·42. Luster metallic. Color blackish lead-gray. Streak black.

Composition, $Pb_6Sb_2Sn_6S_{21}$ or $3PbS.Sb_2S_3 + 3(PbS.2SnS_2)$. Analysis:

| S | Sn | Sb | Pb | Ag | Fe |
|---|---|---|---|---|---|
| 24·50 | 26·37 | 8·73 | 35·41 | 0·62 | 3·00 = 98·63 |

Obtained from the Mine Santa Cruz, at Poopó, Bolivia. The same country has also afforded the allied minerals plumbostannite, Min., p. 108; franckeite, this App., p. 26; also canfieldite, *ib.*, p. 13.

**Cyrtolite**, p. 487.—See *Zircon.*

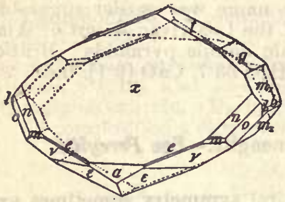
**Dahllite**, p. 866.—Shown by Hamberg to be an alteration-product of apatite somewhat analogous to staffelite (Min., p. 764). G. För. Förh., 13, 802, 1891.

DANALITE, pp. 435, 1032.—Occurs at Redruth, Cornwall, in large rough tetrahedral crystals, of a columbine-red; H. = 5·5; G. = 3·350. Analysis: $SiO_2$ 29·48, FeO 37·53, MnO 11·53, ZnO 4·87, BeO 14·17, CaO *tr.*, S 5·04 = 102·62. Calculated ratio, $SiO_2$ : RO : RS = 3 : 7 : 1 nearly. Miers and Prior, Min. Mag., **10**, 10, 1892.

DANBURITE, p. 490 —Occurs in crystals in the Cimina region, Rome, Italy; in erratic blocks with davyne, tourmaline, etc., Fantappié, Riv. Min. Ital., **16**, 82, 1896; **18**, 7, 1898; also Rend. Accad. Linc., **5** (2), 108, 1896.

DARAPSKITE, p. 873. — Shown by Osann to be monoclinic. Axial ratio $\grave{a} : \bar{b} : \dot{c}$ = 1·5258 : 1 : 0·7514. $\beta$ = 77° 5′ = 001 ∧ 100. 100 ∧ 110 = 56° 5′. 001 ∧ 101 = 23° 23′, 001 ∧ 011 = 36° 13′. Observed forms: *a* (100), *b* (010), *c* (001); *m* (110); *r* (101), *e* (302); *n* ($\bar{1}$01), *d* ($\bar{2}$01); *q* (011); *o* (111), *s* ($\bar{1}$11), *v* (121). Angles: *ac* = *77° 5′, *am* = *56° 5′, *ar* = *53° 42′, *cr* = 23° 23′. Crystals tabular ∥ *a*; often twins, tw. pl. *a*. Cleavage: *a* perfect. Ax. pl. ⊥ *b*, *b* = $\bar{a}$. Axial angle large. H. = 2–3. G. = 2·203. Zs. Kr., **23**, 584, 1894.

Artificial formation, A. de Schulten, Bull. Soc. Min., **19**, 161, 1896.



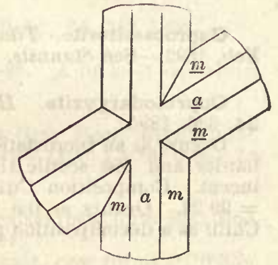
Datolite.

DATOLITE, p. 502.—**Cryst.**—Loughboro, Ontario, description of large crystals, prismatic ∥ $\grave{a}$, Pirsson, Am. J. Sc., **45**, 100, 1893. Lake Superior, Osann, Zs. Kr., **24**, 543, 1895. Harz Mts., Luedecke, Min. Harzes, 418, 1896. Guanajuato, Mexico, crystals, tabular ∥ *x* (102) (Fig.), Farrington, Am. J. Sc., **5**, 285, 1898.

Etching-figures investigated and figured, Baumhauer, Die Resultate d. Aetzmethode, 1894.

Analysis, Grand Marais, Minn., Berkey, 23 Ann. Rept. Minn. G. Surv., p. 197.

DAVYNE, p. 428.—Occurrence in the Cimina region near Rome, see *Danburite*.



Derbylite.

**Derbylite.** *E. Hussak* and *G. T. Prior*, Min. Mag., **11**, 85, 176, 1897.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·9661 : 1 : 0·5502. Forms: *a* (100), *c* (001), *m* (110); also (011) as tw. pl. Angles: *am* = *44° 0¾′, *c* ∧ 011 = 28° 49¼′, *mm* = 39° 8½′ Hussak. In slender prismatic crystals, 2 to 3 mm. long; often in cruciform twins crossing at an angle of 57° 39′; rarely in trillings.

Fracture conchoidal. Very brittle. H. = 5. G. = 4·512–4·530. Luster resinous. Color pitch-black, dark brown and translucent in thin splinters.

Composition perhaps $FeO.Sb_2O_5 + 5FeO.TiO_2$. Analysis on material not entirely pure (hence $SiO_2$, etc.), Prior:

| $Sb_2O_5$ | $TiO_2$ | FeO | CaO | $SiO_2$ | $Al_2O_3$ | $Na_2O$ | $K_2O$ | ign |
|---|---|---|---|---|---|---|---|---|
| 24·19 | 34·56 | 32·10 | 0·32 | 3·50 | 3·17 | 0·76 | 0·28 | 0·50 = 99·38 |

B.B. in salt of phosphorus gives a bead (R.F.) yellow when hot, violet when cold. Insoluble in acid, but decomposed by acid potassium sulphate.

Occurs in the cinnabar-bearing gravel of Tres Cruzes, Tripuhy near Ouro Preto, Mina Geraes, Brazil; lewisite, xenotime, monazite, zircon, rutile, etc., are associated. Named after Dr. O. A. Derby, Director of the Geological Survey of Brazil.

DESCLOIZITE, p. 787.—Analyses, from Obir, Carinthia, Brunlechner, Zs. Kr., **24**, 626, 1895.

DIAMOND, pp. 3, 1033.—Crystals from the Ural described with (971), (432), Jeremejev, Vh. Min. Ges., **34**, 59, 1896.

Artificial corrosion-figures, Luzi, Ber. Ch. Ges., **25**, 2470, 1892.

Refractive indices measured, Wülfing, Min. petr. Mitth., **15**, 61, 1895. Investigation of variation of refractive indices with the temperature, A. Sella, Riv. Min. Ital., **10**, 65, 1892. Thermal expansion, J. Joly, Nature, **49**, 480, 1894.

Shown to be transparent to X-rays (while paste is opaque), also investigation of behavior of many species toward *X-rays*, Doelter, Jb. Min., **2**, 87, 1896; **1**, 256, 1897. (See further on the general subject, Zs. Kr., **30**, 610, 1899.)

Found in the glacial drift of Wisconsin, at Plum Creek, Pierce Co.; Oregon, Dane Co.; Kohlsville, Washington Co. (21¼ carats); Eagle, Waukesha Co. (16 carats), cf. Kunz, Bull. G. Soc. Am., **2**, 638, 1891, and Min. Res. U. S.; Hobbs, Amer. Geol., **14**, 31, 1894; Bull. Univ. Wisconsin, **1**, 152, 1895.

Occurrence and origin in California, Turner, Amer. Geol., **23**, 182, 1899. Also in South Africa, Stone, Bonney and Raisin, Geol. Mag., 2, 492, 1895; Moissan, C. R., **116**, 292, 458, 460; **117**, 423, 1893. Description of the Kimberley mines, Stelzner, Isis, p. 71, 1893. Discussion of origin as illustrated in Brazil, Derby, J. Geol., **6**, 121, 1898.

See also the works of L. de Launay and H. Carvill Lewis noted in the bibliography.

In the meteoric iron of Cañon Diablo, Arizona, A. E. Foote, Am. J. Sc., **42**, 413, 1891; Kunz and Huntington, Am. J. Sc., **46**, 470, 1893. Also C. Friedel, Bull. Soc. Min., **15**, 258, 1892 (C. R., **115**, 1037, 1892); **116**, 290, 1893. Also Moissan, C. R., **116**, 288, 1893 (Bull. Soc. Chim., **9**, 967, 1893). Occurrence in meteorites in general, Huntington, Proc. Amer. Acad., **29**, 204, 1894.

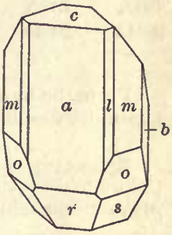
Formed artificially, Moissan, C. R., **116**, 218, 1893; Friedel, *ibid*, p. 224; Rousseau, *ib.*, **117**, 164; further, Moissan, *ib.*, **118**, 320, 1894; **123**, 206, 210, 1896. Also J. Friedländer, Berlin, 1898, Jb. Min., **1**, 202, 1899. Reproduction, Q. Majorana, Riv. Min. Ital., **19**, 22, 1898.

DIAPHORITE, p. 124.—Identified by L. J. Spencer (Am. J. Sc., **6**, 316, 1898) with pyrargyrite, galena, dolomite on a specimen of stephanite from the Lake Chelan distr., Okanogan Co., Washington; also with miargyrite, etc., from Santa Maria de Catorze, San Luis Potosi, Mexico

**Dicksbergite.** *L. J. Igelström*, G. För. Förh., **18**, 231, 1896. A supposed new species occurring with cyanite at Dicksberg, Ransät parish, Wermland, Sweden. Shown by Weibull and Upmark (*ibid.*, p. 523) to be *rutile.*

**Dietzeite.** *A. Osann*, Zs. Kr., **23**, 588, 1894.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 1{\cdot}3826 : 1 : 0{\cdot}9515$; $\beta = {}^*73° 28' = 001 \wedge 100$. $100 \wedge 110 = {}^*52° 58'$, $001 \wedge \bar{1}01 = 39° 2\frac{1}{2}'$, $001 \wedge 0\bar{1}1 = 42° 22\frac{1}{4}'$. Observed forms: *a* (100), *b* (010), *c* (001); *l* (210), *m* (110); *r* ($\bar{1}$01), *s* ($\bar{2}$23), *o* ($\bar{2}$21). Angles: $mm''' = 105° 56'$, $a'r = {}^*67° 10'$, $cm = 80° 8'$. Crystals prismatic, tabular ‖ *a* and elongated ‖ $\grave{c}$. Commonly fibrous to columnar.



Cleavage: *a* imperfect. Fracture conchoidal. H. = 3–4. G. = 3·698. Luster vitreous. Color dark gold-yellow. Optically +. Ax. pl. ⊥ *b*. $Bx_o \perp a$ in obtuse angle $\grave{c}\,\grave{a}$; extinction on *b* (010) 5° to 7° with $\grave{c}$. $2G_{a.y} = 87°$ to 88°. Dispersion horizontal and $v > \rho$, both strongly marked.

Composition, $7Ca(IO_3)_2.8CaCrO_4$. Soluble in hot water; from the solution the colorless calcium iodate ($Ca(IO_3)_2 + 6H_2O$) separates on cooling, leaving the calcium chromate in solution.

Obtained from the same region which furnished the calcium iodate lautarite (Min., p. 1040). The occurrence of this salt was earlier described by Dietze (after whom it is named), see Min., l. c.

DIOPSIDE.—See *Pyroxene.*

DIOPTASE, pp. 463, 1033.—Occurs in crystals in the neighborhood of Mindouli, east of Comba, on the road to Brazzaville, French Congo; also at other points in the Congo region. Lacroix, C. R., **114**, 1384, 1892. See also A. Le Chatelier, C. R., **116**, 894, 1893.

Etching-figures investigated, Traube, Jb. Min., Beil.-Bd., **10**, 462, 1896.

DIPYRE.—See *Wernerite.*

DOLOMITE, pp. 271, 1033.—From Raibl, containing traces of thallium and lithium, Heberdey, Zs. Kr., **21**, 71, 1892.

Origin discussed, Klement, Min. petr. Mitth., **14**, 526, 1895; Pfaff, Jb. Min., Beil.-Bd., 9, 485, 1894.

The black crystals from Teruel, Spain, occurring embedded in gypsum have been long called *teruelite.*

DUFRENOYSITE, p. 120.—Description by Baumhauer of crystals (anal., König) with the new forms (223), (441), (207), (103), (205), (407), (027), (013), (025), (049), (047), Zs. Kr., **24**, 85, 1894; **28**, 551, 1897.

**Dundasite.** *W. F. Petterd*, Catalogue of Minerals of Tasmania, p. 26, 1893. Inferred from qualitative tests to be a hydrated carbono-phosphate of lead and aluminium. Occurs as an incrustation on a ferro-manganese gossan with crocoite; consists of small spherical aggregates with radiated structure; color within white and silky, externally yellow-brown. H. = 2. From the Adelaide Proprietory mine, Dundas, Tasmania.

DURDENITE, p. 980.—F. C. Knight has noted an oxidation-product of the tellurides of Cripple Creek, Colo. The soluble (HCl) portion of the mixture analyzed was perhaps $2Fe_2O_3.2TeO_2.H_2O$, the insoluble calaverite. Proc. Colo. Soc., Oct. 1, 1894.

Dyscrasite, p. 42.—Crystals from the Harz described, Luedecke, Min. d. Harzes, 48, 1896.

Edingtonite, p. 599.—Occurs in large crystals (to 3 cm. in length) at the mines of Bôhl, Sweden Habit prismatic, tabular ‖ one pair of *m*-faces ; twins, pseudo-tetragonal. These are referred to the orthorhombic system (hemihedral) with the forms: *c* (001), *m* (110), *p* (111), *p*, (1$\bar{1}$1), *r*, (121), *r*, (1$\bar{2}$1). Axes $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}9873 : 1 : 0{\cdot}6733$. Angles: *mm'''* = 89° 16', *cp* = 43° 47'. G. = 2·776. $2E_y$ = 87° 17'. O. Nordenskiöld. Bull. Soc. Min., **18**, 396, 1895, and G. För. Förh., **17**, 597, 1895. An analysis is given by G. Lindström, Öfv. Ak. Stockh., **53**, 469, 1896.

**Elfstorpite.** *L. J. Igelström*, G. För. Förh., **15**, 472, 1893; Zs. Kr., **22**, 468. An imperfectly described mineral from the Sjö mine, Orebro, Sweden. Occurs in crystals and crystalline particles with one cleavage. H. = 4. Brittle. Color and streak whitish gray. Inferred, on the basis of a partial qualitative analysis, to be a hydrated arsenate of manganese (MnO).

**Elpidite.** G. Lindström, G. För. Förh., **16**, 330, 1894. *G. Nordenskiöld, ibid.*, p. 343.

Orthorhombic. Axes: $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}5117 : 1 : 0{\cdot}9781$. 100 ∧ 110 = 27° 6', 001 ∧ 101 = 62° 23', 001 ∧ 011 = 44° 22'. Forms *a* (100), *b* (010), *c* (001), *m* (110), *n* (120), *e* (013), *d* (011); also doubtful *u* (540), *t* (580), *s* (5·12·0). Angles: *mm'''* = *54° 12', *cd* = *44° 22'. Crystals prismatic, rarely distinct (described by G. Nordenskiöld). Usually massive, fine fibrous or columnar; also as a felt-like mass.

Cleavage: *m* (110). H. nearly 7. G. = 2·524 white, 2·594 red. Luster silky. Color white to brick-red. Extinction parallel to prismatic direction, which corresponds to *a*.

Composition, essentially, $H_6Na_2ZrSi_6O_{18}$ or $Na_2O.ZrO_2.6SiO_2.3H_2O$. Analysis, Lindström:

| $SiO_2$ | $ZrO_2$ | FeO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ (ign.) | $H_2O$ (100°) | Cl | |
|---|---|---|---|---|---|---|---|---|---|
| 59·44 | 20·48 | 0·14 | 0·17 | 10·41[a] | 0·13 | 5·72 | 3·89 | 0·15 | $TiO_2$,CuO *tr.* = 100·53. |

[a] Another determination gave: $Na_2O$ 10·29, $K_2O$ 0·21.

From the locality in southern Greenland (probably Nagssarsuk near Igaliko) which has afforded neptunite (see this App., p. 49) and epididymite, p. 25. Named from ἐλπις, hope.

Enargite, pp. 147, 1033.—Occurs at the Ida mine, also at Red Mountain, Summit distr., Colorado; crystals from the latter locality show the new forms *v* (210), *e* (012), *z* (134); habit prismatic or tabular (figs. 1–5, Red Mountain). Pirsson, Am. J. Sc., **47**, 212, 1894.

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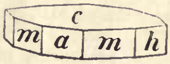

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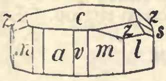

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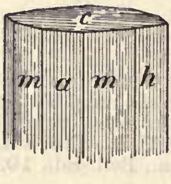

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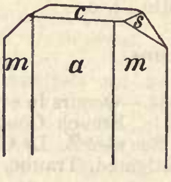

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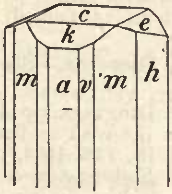


Monograph on the crystallization, L. J. Spencer; new forms noted are: *y* (610), *f* (520), *i* (540), *N* (230), *t* (108), *A* (207), *w* (709), *u* (301). The author concludes that clarite (Min., p. 148) is identical with enargite. Min. Mag., **11**, 69, 1895. Crystals from Peru show the new forms *π* (031), *φ* (132), $\phi_1$ (394), $\phi_2$ (131), $\phi_3$ (392), *idem*, Min. Mag., **11**, 196, 1897.

Occurs in large crystals at the Bell Stow mine, Missoula Co., Montana, Moses, School Mines Q., **16**, 230, 1895. Analysis, from Butte, Montana, Hillebrand, Am. J. Sc., **7**, 56, 1899.

Enstatite, p. 346.—From Corundum Hill, N. C., also Webster, Jackson Co., N. C., analyses quoted by Pratt, Am. J. Sc., **5**, 430, 431, 1898.

Investigation of alteration-products, Johansson, Ak. H. Stockh., Bihang, **17** (2), No. 4, 1891. (Ref. in Zs. Kr., **23**, 152.)

**Epididymite.** *G. Flink*, G. För. Förh., **15**, 201, 1893; Zs. Kr., **23**, 353, 1894. *G. Nordenskiöld*, G. För. Förh., **16**, 345, 1894.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0{\cdot}5758 : 1 : 0{\cdot}5340$ or $1 : 1{\cdot}7367 : 0{\cdot}9274$. 100 ∧ 110 = 29° 56', 001 ∧ 101 = 42° 50½', 001 ∧ 011 = 28° 6⅛'. Observed forms: *a* (100), *b* (010), *c* (001); *m* (110), *l* (120), *n* (130); *i* (023), *h* (034), *g* (011), *e* (043), *d* (021), *f* (041), *λ* (061), *χ* (081); *p* (221). Angles: *mm'''* = 59° 52', *nn'* = 119° 52', *bn* = *30° 4', *cd* = *46° 53'.

Crystals usually tabular ‖ *c* and elongated by extension of the faces in the brachydome zone; these faces horizontally striated. In part in hexagonal tables, *b* and *m* being equally developed; these also twinned, having *c* in common but revolved 60° about the vertical axis, and as tw. lamellæ.

Cleavage: *b* and *c* perfect. H. = 5·5. G. = 3·548. Luster vitreous, on *b* and *c* pearly.

Colorless. Optically —. Ax. pl ‖ *c*. Bx$_a$ ⊥ *b*. Indices: For Na, $\alpha = 1{\cdot}5645$, $\beta = 1{\cdot}5685$, $\gamma = 1{\cdot}5688$. ∴ $2V_{a \cdot y} = 31° 4'$.

Composition $HNaBeSi_3O_8$ like eudidymite (Min., p. 313). Analysis, G. Flink:

| $SiO_2$ | BeO | $Na_2O$ | $H_2O$ |
|---|---|---|---|
| 73·74 | 10·56 | 12·88 | 3·73 = 100·91 |

B.B. fuses easily to a colorless glass, but yields water only at a high temperature. Not attacked by acids.

From Greenland, exact locality uncertain, probably Narsasik (or Nagssarsuk, Lindström) near Igaliko, cf. *neptunite* and *elpidite*.

Epidote, p. 516.—Crystals from Quenast described, Stöber, Bull. Ac. Belg., **29**, 403, 1895. Also from the Comba di Compare Robert, Avigliana, G. Boeris, Atti Accad. Sc. Torino, **32**, April 25, 1897, and Riv. Min. Ital., **20**, 65, 1898.

Optical examination of isomorphous layers of crystals, Ramsay, Jb. Min., **1**, 111, 1893.

Occurrence as a primary constituent of igneous rocks, Keyes, Bull. G. Soc. Amer., **4**, 305, 1893.

The relation of epidote to zoisite is discussed by Weinschenk, Zs. Kr., **26**, 166, 1896. See also *Clinozoisite*.

Epsomite, p. 938.—Description of natural crystals from Stassfurt (new form *g* (210)), also optical determination, Milch, Zs. Kr., **20**, 221, 1892.

**Erionite.** *A. S. Eakle*, Am. J. Sc., **6**, 66, 1898, and Zs. Kr., **30**, 176, 1898.

Orthorhombic. In aggregates of very slender fibers, resembling woolly hairs. G. = 1·997. Luster pearly. Color white. Optically biaxial, positive. Extinction and Bx$_a$ (c) parallel to fibers. Birefringence high.

Composition, $H_2CaK_2Na_2Al_2Si_6O_{17} + 5H_2O$ or $CaO.K_2O.Na_2O.Al_2O_3.6SiO_2.6H_2O$. Analysis:

| $SiO_2$ | $Al_2O_3$ | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|
| 57·16 | 16·08 | 3·50 | 0·60 | 3·51 | 2·47 | 17·30 = 100·68 |

Fuses B.B. easily and quietly to a clear, colorless glass. Easily soluble in hydrochloric acid. Occurs with milky opal in cavities in a rhyolite tuff at Durkee, Oregon. Named from *ἔριον*, wool.

Erythrite, p. 817.—Occurs on the west shore of Rabbit Lake, Nipissing, Ontario, Ferrier, Ottawa Naturalist, **9**, 193.

Ettringite, p. 976.—From Tombstone, Arizona, analyzed by Moses (after deducting 1·91, $SiO_2$): $SO_3$ 18·54, $Al_2O_3$ 9·72, CaO 26·31, $H_2O$ (red heat) 10·88, $H_2O$ (115°) 34·53 = 99·98. Formula deduced $10CaO.2Al_2O_3.5SO_3.54H_2O$; 14 parts of $H_2O$ go off at a red heat, the formula then reduces to $2R_2O_3.SO_3 + 8H_2O$. Occurs in bunches of white, silky fibers. H. = 2. G. = 1·55. Shows double refraction with parallel extinction. Am. J. Sc., **45**, 489, 1893; Zs. Kr., **22**, 16, 1893.

**Euchlorine.** *A. Scacchi*, 1869; *E. Scacchi*, Rend. Accad. Napoli, **23**, 158, 1884. A thin emerald-green incrustation on the lava at Vesuvius. The analysis by Pisani (quoted by Scacchi) made it a compound of copper sulphate and cuprous chloride. According to a later investigation, however (E. Scacchi), it is made up of an insoluble and a soluble portion. The proper euchlorine yielded: $SO_3$ 43·98, CuO 41·50, $K_2O$ 8·04, $Na_2O$ 6·48 = 100. The crystallization is orthorhombic. Observed forms: *b* (010), *c* (001), *e* (011), *d* (103), *o* (101); measured angles: *ce* = 61° 56′, *co* = 67° 54′. An analysis by Rammelsberg (Min. Ch., Erg.-Heft, 87, 1886) gave: $SO_3$ 42·96, CuO 37·87, $Na_2O$ 5·48, $K_2O$ 10·34, $H_2O$ [3·35] = 100.

Euchroite, p. 838.—Libethen, crystals with the new forms, *f* (102), *d* (101), Gissinger, Zs. Kr., **22**, 367, 1892. An analysis by A. H. Church shows 1·48 p. c. $P_2O_5$, Min. Mag., **11**, 1, 1895.

Euclase, p. 508.—Bahia, Brazil, crystals described, Hussak, Min. petr. Mitth., **12**, 473, 1892.

Eudialite, pp. 409, 1034.—Kola peninsula, optical investigation of crystals, confirming and extending earlier results (Min., p. 410), Ramsay, Jb. Min., Beil.-Bd., **8**, 722, 1893.

Evansite, p. 846.—Occurs at a mine in the Zeehan district, Tasmania. G. = 1·939. Analysis: $P_2O_5$ 18·11, $Al_2O_3$ 40·19, $H_2O$ = 41·27 = 99·57. H. G. Smith, Proc. R. Soc. N. S. W., **27**, 382, 1893.

FAYALITE, pp. 456, 1034.—From Rockport, Mass., analysis (nearly pure $Fe_2SiO_4$, G. = 4·318) and optical properties with discussion of the relation of the latter to composition in the species of the Chrysolite Group; also analysis of hortonolite. Penfield and Forbes, Am. J. Sc., **1**, 129, 1896. Analysis of crystals from slag, G. O. Smith, Johns Hopkins Univ. Circ., 112, May 1894.

See also *Neochrysolite* and *Breislakite.*

**Fedorovite.** Fedorowit, *C. Viola,* Jb. Min., **1**, 121, 1899.—See *Pyroxene.*

FELDSPARS, pp. 314, 1034.—Much work has been done recently upon the optical characters of the feldspars, and chiefly those of the plagioclase series; this has to a large extent had as its object the determination of the different species under the microscope, as, for example, in the form they appear in thin-sections of rocks. Prominent contributions are the following:

Michel-Lévy, an important work entitled "Étude sur la détermination des feldspaths dans les plaques minces." Paris (two parts), 1894 and 1896 (see Bull. Soc. Min., **18**, 79, 1895). A summary of this (and other papers) is given by N. H. Winchell in Amer. Geol., **21**, 12, 1898; see also G. F. Becker, Am. J. Sc., **5**, 349, 1898.

Fedorow, feldspar studies, Zs. Kr., **22**, 248, 1893; **26**, 225, 1896; **27**, 337, 1896; **29**, 604, 1898. Viola, Zs. Kr., **30**, 23, 232, 1898.

Fr. Becke, determination of refractive indices, Ber. Ak. Wien, **102** (1), 358, 1893; also determination by interference-figures, etc., Min. petr. Mitth., **14**, 415, 1895.

Bertrand, Bull. Soc. Min., **20**, 219, 1897. Wallerant, rapid determination in rocks, *ibid.*, **21**, 268, 1898.

Many optical determinations with analyses are given by Fouqué, Bull. Soc. Min., **17**, 283–611, 1894. See also Brögger, Eruptivgesteine d. Kristianiagebietes, 1894–98; also many memoirs on petrography (Jb. Min., Min. petr. Mitth., *et al.*).

Discussion of composition of plagioclase feldspars, Rammelsberg, Jb. Min., **2**, 165, 1896.

See also the species *Albite, Anorthite, Anorthoclase, Celsian, Microcline, Orthoclase.*

FERGUSONITE, p. 729.—From Ceylon, analysis. Prior, Min. Mag., **10**, 234, 1893.

Examination of gases yielded (helium, etc.), Ramsay, Proc. Roy. Soc., **59**, 325, 1896; Ramsay and Travers, *ib.*, **60**, 443, 1897. Investigation of endothermic properties, Ramsay, *ib.*, **62**, 325, 1898.

FIEDLERITE, p. 172.—Description of crystals from Laurion, Greece, Lacroix, C. R., **123**, 955, 1896. Also G. F. Herbert Smith, Min. Mag., **12**, 107, 1899.

FLUOCERITE, pp. 175, 1034.—Weibull has described a fragment of an hexagonal crystal from Österby (cf. anal., Min., p. 175) with $m$ $(10\bar{1}0)$ and $p$ $(11\bar{2}2)$; $mp = 51°$, whence $a : \dot{c} = 1 : 1{\cdot}06$. Optically uniaxial, positive; $\epsilon - \omega = 0{\cdot}002$ approx. G. För. Förh., **20**, 54, 1898.

**Fluor-adelite.**—See *Tilasite.*

FLUORITE, pp. 161, 1034.—Sarnthal, Tyrol, crystals described with the form (27·12·5) developed by corrosion, Höfer, Min. petr. Mitth., **12**, 500, 1892. On crystals from the Harz Mts., Luedecke, Min. d. Harzes, 252, 1896.

Tenacity investigated, Sella and Voigt, Wied. Ann., **48**, 663, 1893.

Anomalous optical characters, Wallerant, Bull. Soc. Min., **21**, 44, 1898.

Phosphorescent under the action of X-rays, this is also true of calcite and other species, Burbank, Am. J. Sc., **5**, 53, 1898.

Refractive indices for long waves, Carvallo, C. R., **116**, 1189, 1893; Rubens and Snow, Wied. Ann., **46**, 529, 1892.

Dispersion in the infra-red, Paschen, Wied. Ann., **53**, 301, 1894.

Photoelectrical properties, Schmidt, Wied. Ann., **62**, 407, 1897.

From Quincié, containing free fluorine (anal., G. = 3·117), to which the odor on fracture is due, Becquerel and Moissan, Bull. Soc. Chim., **5**, 154, 1891.

On the fluorite deposits of southern Illinois, see S. F. Emmons, Trans. Am. Inst. Mng. Eng., **21**, 31, 1892.

Occurs on a large scale at San Roque, Cordoba, Argentina, Valentin, Zs. prakt. Geol., **4**, 104, 1896.

**Folgerite.** *S. H. Emmens,* J. Am. Chem. Soc., **14**, No. 1, 1892.—See *Pentlandite.*

FOSTERITE, p. 450.—Colorless transparent crystals from Monte Somma have been measured by Jolles and analyzed by Thaddéeff, see Arzruni (Zs. Kr., **25**, 471, 1895); the latter also gives the optic-axial angles and notes twins with (031) as tw. pl.

Analysis, from the crystalline limestone of the Passau graphite region, Weinschenk, Zs. Kr., **28**, 145, 1897.

**Franckeite.** *A. W. Stelzner,* Jb. Min., **2**, 114, 1893.

Massive, with imperfect radiated and foliated structure; in part in spherules aggregated in reniform shape. Cleavage perfect in one direction. Somewhat malleable, making a mark on paper. H = 2·75. G. = 5·55. Luster metallic Color blackish gray to black. Opaque.

Composition, $Pb_5Sn_2Sb_2S_{12}$ or $2PbSnS_3.Pb_3Sb_2S_6$. Analysis by C. Winkler:

| S | Sb | Sn | Pb | Fe | Zn | Gangue |
|---|---|---|---|---|---|---|
| 21·04 | 10·51 | 12·34 | 50·57 | 2·48 | 1·22 | 0·71 = 98·87 |

Germanium is present in small amount (0·1 p. c.); also about 1 p. c. silver.

B.B. on charcoal gives a yellow coating of lead oxide, and farther from the assay one of oxide of antimony. In the open tube yields sulphurous and antimonial fumes. In the closed tube, a slight coating of germanium sulphide if no air is present. Dissolved by nitric acid with the separation of a white powder (oxides of antimony, tin and germanium); also readily in aqua regia with separation of sulphur.

From the silver-mining region of Las Animas, southeast of Chocaya, Bolivia; it is locally known as *llicteria;* wurtzite is closely associated. Named after the mining engineers, Carl and Ernst Francke.

FRIEDELITE, pp. 465, 1035.—From the Sjö mine, Wermland, Sweden, analysis, Igelström: $SiO_2$ 34·36, MnO 45·88, FeO 1·35, CaO 1·50, MgO 1·50, Mn 2·79, Cl 3·00, $H_2O$ 9·00, $P_2O_5$ *tr.* = 99·38. G. För. Förh., **14**, 505, 1892; Zs. Kr., **21**, 92, 1892.

**Fuggerite.** *E. Weinschenk,* Zs. Kr., **27**, 577, 1896.

In thick four-sided tabular crystals, probably tetragonal. Cleavage: basal, perfect. H. = 6·5. G. = 3·18. Color light apple-green; also white and dull. Birefringence very low, for yellow (Na) sensibly isotropic; $\omega_{na} = \epsilon_{na} = 1·691$.

Corresponds in composition to a member of the gehlenite-åkermanite series (3 Åk : 10 Gehl), but deviates in physical characters. Analysis, E. Mayr:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $Na_2O$ | MnO,$K_2O$ | insol. |
|---|---|---|---|---|---|---|---|
| 34·04 | 17·97 | 3·49 | 37·65 | 4·89 | 2·04 | *tr.* | 0·12 = 100·20 |

Occurs on the contact-zone adjoining the monzonite of the Monzonithal; in part as a microscopic constituent, in part in nests of crystals, also as a coarse-granular aggregate with calcite.

GADOLINITE, pp. 509, 1035.—Crystals from the Harz described by Luedecke, Min. d. Harzes, 438, 1896.

GAHNITE, pp. 223, 1035.—Occurs in Raglan township, Renfrew Co., Ontario, Hoffmann, Rep. G. Canada, **9**, 15R, 1896.

GALENA, p. 48.—**Cryst.**—From Neudorf with the new form (551), Cesàro, Zs. Kr., **20**, 468, 1892. From the Harz, Luedecke, Min. d. Harzes, 16, 1896. On the octahedral cleavage of a variety from Nil-St.-Vincent containing tellurium, Cesàro, Ann. Soc. G. Belg., **19**, Bull., 76, 1892. Freiberg, new form (447), Cesàro, Ann. Soc. G. Belg., **24**, lxxix, 1898.

From Broken Hill, N. S. W., containing 15·5 p. c. Zn, Liversidge, Proc. Roy. Soc., N. S. W., **29**, 320, 1895. Cubic crystals stated to be from Bingham, Utah, gave Hartley 4·97 p. c. Zn, Miers, Min. Mag., **12**, 112, 1899.

GARNET, pp. 437, 1035.—Pyrope of cubic form occurs in the diamond sands of Agua Suja, Minas Geraes, Brazil, Hussak, Ann. Mus. Wien, **6**, 113 (not.), 1891.

Optical investigation of crystals from many localities with references to the recent literature (since 1882, cf. Min., p. 439), etc., Klein, Jb. Min., **2**, 68, 1895, also Ber. Ak. Berlin, 723, 1895; 676, 1898. See also Brauns, Opt. Anom., 1891, p. 133; Karnojitsky, Vh. Min. Ges., **34**, 1, 1896; Fedorow, Zs. Kr., **28**, 276, 1897.

Optical character of *pyrenéite* corresponding to that of an orthorhombic crystal, Mallard, Bull. Soc. Min., **14**, 293, 1891. Same of *melanite* from Algeria, Gentil, Bull. Soc. Min., **17**, 269, 1894; of crystals from Affaccata, Elba, G. D'Achiardi, Annal. Univ. Tosc. **20**, 1896.

*Grossularite,* analysis of an apple-green variety resembling jade, found as a water-worn pebble near Eltoro, California, F. W. Clarke, Am. J. Sc., **50**, 76, 1895. Analyses, Rothenkopf, Zillerthal, Schnerr, Zs. Kr., **27**, 431, 1896.

*Almandite,* analysis, Sydney, N. S. W., H. G. Smith, Proc. Roy. Soc., N. S. W., **28**, 47, 1894.

*Andradite* from nephelite-syenite of Dungannon, Hastings Co., Ont., with 1·08 p. c. $TiO_2$, Adams and Harrington, Am. J. Sc., **1**, 217, 1896. Italian Peak, Gunnison Co., Colo., Eakins, Bull. U. S. G. Surv., **113**, 112, 1893.

*Topazolite, Melanite,* analyses, Piners, Zs. Kr., **22**, 479, 1894.

*Pyrope,* etc., chemical composition discussed with analysis, C. v. John, Jb. G. Reichs., **42**, 53, 1892.

*Spessartite,* analyses from Llano Co., Texas, W. H. Melville, Bull. U. S. G. Surv., **90**, 40, 1892. Silberberg near Bodenmais, analysis, Weinschenk, Zs. Kr., **25**, 357, 1895. Aschaffenburg (analysis by Wehr and Schröder), Weinschenk, Zs. Kr., **28**, 162, 1897. Caprera, Sardinia, Lovisato, Rend. Accad. Linc., **5** (1), 56, 1896.

Analyses by Wait of varieties from Canada, Hoffmann, Rep. G. Canada, **6**, 16R, 1892–93.

Discussion of composition with analyses, K. H. Schnerr, Inaug. Diss. Munich, 1894, abstract in Jb. Min., **1**, 432 ref., 1897.

Occurrence in the dune sands of Holland (analysis), Retgers, Jb. Min., **1**, 16, 1895.

Discussion of relation of subspecies, Weinschenk, Zs. Kr., **25**, 365, 1895.

Hrubschitz, altered to diopside, hornblende, and plagioclase, Barviř, Ber. Böhm. Ges., May 19, 1893.

Artificial formation of *melanite*, Michel, C. R., **115**, 830, 1892.

*Rhodolite* is a variety from Mason's Branch, Macon Co., N. C., described by Hidden and Pratt (Am. J. Sc., **5**, 294, 1898). Characterized by its rose-like color and brilliant luster by reflected light. Occurs in rolled pieces and etched fragments. G. = 3·838. Composition corresponds to 2 molecules of pyrope, $Mg_3Al_2[SiO_4]_3$, and 1 of almandite, $Fe_3Al_2[SiO_4]_3$. Analysis, Pratt:

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO |
|---|---|---|---|---|---|---|
| $(\frac{2}{2})$ | 41·59 | 23·13 | 1·90 | 15·55 | 17·23 | 0·92 = 100·32 |

*Lagoriolite* (Lagoriolith) is an artificial compound obtained by Morozewicz, corresponding in composition to a soda-variety of grossular garnet; formula $(Na_2,Ca)_3Al_2[SiO_4]_3$, with $Na_2 : Ca = 3 : 2$. An analysis (deducting 14·8 p. c. insol.) gave: $SiO_2$ 39·6, $Al_2O_3$ 21·4, CaO 14·2, $Na_2O$ 23·6, $SO_3$ 1·2 = 100. The crystals obtained seemed to be isometric in form (100 and 110), but showed optical anomalies, twinning, etc., analogous to some garnet, also particularly to noselite and haüynite. Named after Professor A. Lagorio. Min. petr. Mitth., **18**, 147, 1898.

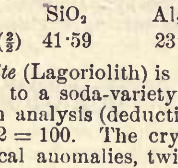
*Schneebergite* of Brezina is shown by Eakle and Muthmann to be a garnet of the topazolite type in octahedral form. Am. J. Sc, **50**, 244, 1895; Zs. Kr., **24**, 583, 1895.

*Ransätite* is a supposed new mineral from the damourite of Bliaberg, Ransät, Wermland, Sweden, described by Igelström (G. För. Förh., **18**, 41, 1896). It is shown by Weibull (*ibid.*, **20**, 53, 1898) to be an impure manganesian garnet.

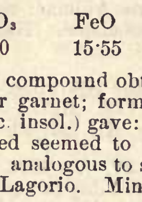
GARNIERITE, p. 676.—N. Caledonia, analysis of a related silicate, Pisani, Bull. Soc. Min., **15**, 48, 1892. Various nickel silicates have been examined by H. v. Foullon, Jb. G. Reichs., **42**, 223, 1892.

GAY-LUSSITE, p. 301.—Crystals described from Borax Lake, San Bernardino Co., Cal. (Figs. 1–3). G. = 1·992. J. H. Pratt, Am. J. Sc., **2**, 130, 1896.

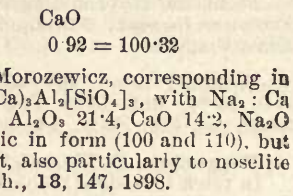
1.



2.



3.



Occurs in a confused crystalline mass at the borax locality in San Bernardino Co., Cal., Hanks, Am. J. Sc., **43**, 540, 1892, Mng. Sc. Press, March 26, 1892.

On the artificial formation, A. de Schulten, C. R., **123**, 1023, 1896.

GEHLENITE, p. 476.—Occurs in limestone of the Kaiserstuhl, Brauns, Jb. Min., **1**, 81, 1899. See also *Fuggerite*.

**Geikielite.** *L. Fletcher*, Nature, **46**, 620, Oct. 27, 1892. *A. Dick*, Min. Mag., **10**, 145, 1893.

Massive; in rolled pebbles. Cleavage: in one direction perfect; also imperfect in another, nearly normal to it. Brittle. H. = 6. G. = 3·98–4. Luster metallic-adamantine on the cleavage-face. Color bluish or brownish black; microscopic fragments transmit a purplish-red light. Optically uniaxial, negative. Birefringence high.

Composition, essentially magnesium titanite, $MgTiO_3$. Analysis, Dick:

$TiO_2$ 67·74 MgO 28·73 FeO 3·71 = 100·38

B.B. infusible; reacts for titanium with salt of phosphorus. Slowly decomposed by hot hydrochloric acid if in fine powder.

Obtained from the gem mines of Rakwana, Ceylon, a locality which has also furnished baddeleyite. Named after Sir Archibald Geikie, Director of the Geological Survey of Great Britain.

**Gersbyite.** *L. J. Igelström*, Zs. Kr., **28**, 310, 1897. Occurs in pale-blue to deep-blue grains embedded in quartzose damourite-schist at Dicksberg, Wermland, Sweden. Closely resembles lazulite and is near it in composition. One of several analyses gave: $P_2O_5$ 32·26, $Al_2O_3$ 46·68, CaO,FeO,MnO 6·66, MgO 5·33, $H_2O$ 9·07 = 100.

GERSDORFFITE, p. 90.—Occurs in octahedral crystals in Denison township, Algoma district, Ontario (analysis by Johnston), Hoffmann, Rep. G. Canada, **5**, 22R. Also on Kootenay Mountain, near Rossland, British Columbia, *ibid.*, **9**, 15R, 1896. Analysis from Goslar in the Harz, Klockmann, Zs. prakt. Geol., **1**, 387, 1893.

GIBBSITE, p. 254 —Artificial formation of crystals, A. de Schulten, Bull. Soc. Min., **19**, 157, 189

GILSONITE.—See *Uintaite.*

GISMONDITE, p. 586.—Occurrence in basalt, St.-Agrève, Ardèche, France, Gonnard, C. R., **117**, 590, 1893.

GLAUBERITE, p. 898.—Description and measurements of crystals from Westeregeln, W. von Schulz, Vh. Min. Ges., **30**, 75, 1893.

**Glaucochroite.** *S. L. Penfield* and *C. H. Warren*, priv. contr.

Orthorhombic. In embedded prismatic crystals without distinct terminations. Prismatic angle $m \wedge m$ 47° 30′. Twins with the brachydome (011) as tw. plane, the vertical axes crossing at an angle of 58°30′ (microscope). Axes $\breve{a} : \bar{b} : \dot{c} = 0·44 : 1 : 0·56$. H. about 6. G. = 3·407. Color a delicate bluish-green like some beryl.

Composition, $CaMnSiO_4$, analogous to the Chrysolite Group; corresponds to a manganese monticellite. Analysis, Warren:

| $SiO_2$ | MnO | CaO | PbO |
|---|---|---|---|
| 31·48 | 38·00 | 28·95 | 1·74 = 100·17 |

B.B fuses quietly at 3·5. Easily soluble in hydrochloric acid and yields gelatinous silica upon evaporation. Reacts for manganese with borax.

Occurs at Franklin Furnace, N. J., with nasonite, brown garnet, axinite and a little franklinite. Named from γλαυκός, *blue-green*, and χροα, *color*, in allusion to its color.

GLAUCONITE, p. 683.—Extensive beds occur in Spottsylvania and Stafford Cos., Va., analysis, Corse and Baskerville, Am. Ch. J., **14**, 627, 1892.

In Woodburn, Antrim, Ireland, analysis, Hoskins, Geol. Mag., **2**, 317, 1895.

General discussion of composition, origin, etc., Gümbel, Ber. Ak. München, **26**, 545, 1896; also Glinka, Zs. Kr., **30**, 390, 1898.

GLAUCOPHANE, p. 399.—Investigation of etching-figures, R. A. Daly, Proc. Am. Acad. Sc., **34**, 404, 1899.

Analysis, Beaume, Dora Riparia, Colomba, Att. Accad. Torino, **29**, 404, 1893.

*Rhodusite* is a variety of glaucophane described by Foullon as occurring in the Eocene Flysch rocks of the island Rhodus. It is characterized by a fibrous asbestus-like structure. Color lavender-blue. Analysis of purified material gave:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MgO | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 55·03 | 0·49 | 15·47 | 7·39 | 11·48 | 0·98 | 6·38 | 0·80 | 1·98 = 100 |

This corresponds to a glaucophane, in which $Fe_2O_3$ has taken the place of $Al_2O_3$. Ber. Ak. Wien, **100** (1), 176, 1891

See also *Crossite.*

GLOCKERITE, p. 970.—An orange-yellow ocherous basic ferric sulphate from Parys Mount, Anglesea, analyzed by Church, corresponds nearly to $2Fe_2O_3.SO_3.8H_2O$. Loss of $H_2O$ at 100° 13·51 p. c., on moderate ignition 12·85. Glockerite is $2Fe_2O_3.SO_3.6H_2O$. Min. Mag., **11**, 13, 1895.

GMELINITE, p. 593.—Crystals from Montecchio Maggiore, described with new forms $(21\bar{3}0)$, $(21\bar{3}3)$, $(12\bar{3}3)$, Artini, Giorn. Min., **2**, 262, 1891.

GOLD, p. 14.—Crystals from the Ural, described, new form (811), Jeremejev, Vh. Min. Ges., Prot., **33**, 60, 1895.

Crystalline structure of nuggets investigated by Liversidge, Proc. R. Soc. N. S. W., **31**, 70, 1897 (read Oct. 3, 1894). Discussion as to the origin of moss gold and of gold nuggets, Liversidge, Proc. R. Soc. N. S. W., **27**, 287, 303, Sept. 6, 1893.

Gold containing palladium occurs in the Caucasus, Th. Wilm, Zs. anorg. Chem., **4**, 300, 1893. Occurs in California with albite, barite, calcite, etc., Turner, Am. J. Sc., **47**, 467, 1894.

On the gold fields of the Southern Appalachians, G. F. Becker, 16th Ann. Rept. U. S. G. Surv., Part II, 1894. Of Transvaal, the same, 18th Ann. Rept. U. S G. Surv., Part V, 1896. Of Alaska, the same, 18th Ann. Rept. U. S. G. Surv., Part III (also Map of Alaska, etc., S. F. Emmons, U. S. G. Surv., 1898). Of Georgia, Geol. Surv. Georgia, Bulletin 4A, Yeates, McCallie and King, 1896. On the mining region of Cripple Creek, Colorado, Cross and Penrose, 16th Ann. Rept. U. S. G. Surv., Part II.

The world's production of gold has increased at a very remarkable rate during the past decade. In 1890 the value of the total amount produced (see Min., p. 19) was less than 120 million dollars; in 1896 it was about 200 millions, in 1897 237 millions, and the amount estimated for 1898 is upwards of 280 millions. Of this increase, South Africa has contributed relatively the largest amount. For the United States the amount for 1898 is nearly 66 millions, or double that of 1890; for Colorado the amount has increased from 4 millions in 1890 to more than 24 millions for 1898, chiefly through the productivity of the Cripple Creek mines. Canada's amount for 1898 is 14½ millions, of which it is estimated that the Klondike region on the tributaries of the Yukon river has yielded 12 millions.

**Goldschmidtite.** *W. H. Hobbs*, Am. J. Sc., **7**, 357, 1899.

Monoclinic. Axes $\breve{a} : \bar{b} : \acute{c} = 1{\cdot}8561 : 1 : 1{\cdot}2980$; $\beta = 89° 11' = 100 \wedge 001$. Forms *a* (100), *b* (010), *c* (001); *g* (310), *f* (210), *m* (110), *t* (370), *l* (130); *y* (508), *s* (101), *n* (201), *r* (703), *w* (401), *q* (801), *x* (10·0·1), *v* (35·0·1), *S* ($\bar{1}$01), *N* ($\bar{2}$01), *W* ($\bar{4}$01), *X* ($\overline{10}$ 0·1), *Z* ($\overline{14}$·0·1); *k* (032). Angles: *am* = *61° 41′, *mm‴* = 123° 22′, *as* = 54° 29′, *a′S* = *55° 35′, *an* = 35° 17′, *a′N* = 35° 50′, *ac* = 89° 11′ (mean derived (following Hobbs) from the measured angles: *as* = 54° 57′, *a′S* = 55° 35′ and *an* = 34° 13′, *a′N* = 34° 58). In form related to calaverite).

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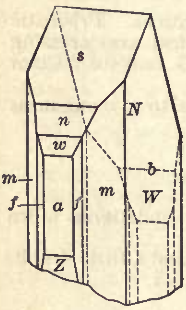

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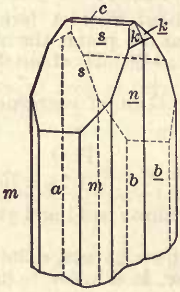

Crystals prismatic ∥ $\acute{c}$. Twins common, tw. plane *a* (100) (Fig. 2).

Cleavage, *b* (010) perfect. Brittle. H. = 2. G. = 8·6 (estimated). Luster metallic. Color silver-white. Streak dull grayish black. Opaque.

Composition, $Au_2AgTe_6$. Analysis (on 0·1 gram):

Te [59·64] Au 31·41 Ag 8·95 = 100

B.B. fuses easily on charcoal, giving a bluish-green flame (Te) and yielding a white sublimate of tellurium oxide with a yellowish-white button of gold and silver.

Occurs sparingly at the Gold Dollar mine in Arequa Gulch, Cripple Creek district, Colorado. Named after Professor Victor Goldschmidt of Heidelberg.

See also *Calaverite* and *Krennerite.*

**Gonnardite.** *A. Lacroix*, Bull. Soc. Min., **19**, 426, 1896. Min. France, **2**, 279, 1896.

Orthorhombic ? In spherules with fibrous structure. H. = 4·5–5. G. = 2·246–2·26; 2·357 Gonnard. Color white. Luster silky. Translucent. Optically biaxial, positive. $Bx_a$ and ax. pl. parallel to the fibers. Ax. angle very small.

Composition, $(Ca,Na_2)_2Al_2Si_5O_{15} + 5\frac{1}{2}H_2O$ with Ca : $Na_2$ = 5 : 3. Analysis, Pisani, quoted by F. Gonnard, C. R., **73**, 1448, 1871:

| $SiO_2$ | $Al_2O_3$ | CaO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|
| 42·3 | 28·1 | 10·0 | 6·7 | *tr.* | 14·1 = 101·2 |

From cavities in the doloritic basalt of Gignat, Puy-de-Dôme and elsewhere in the same region; early analyzed by Pisani, l. c.; in Dana's Min. (p. 606) provisionally referred to mesolite. Named after M. Gonnard of Lyons, France.

**Goslarite**, p. 939.—Occurs in white silky fibrous masses at Altenberg (anal.). Gräff, Jb. Min., **1**, 76, 1899.

**Göthite**, pp. 247, 1036.—Optical investigation of crystals from Ouro Preto, Brazil, giving results differing from those of Palla. Ax. pl. ∥ *a* (100) for red, ∥ (001) for green (and yellow); optically negative for both colors. $2E_r = 58° 31'$, $2E_{gr} = 67° 42'$. $\beta = 2{\cdot}5$. Pelikan, Min. petr. Mitth., **14**, 1, 1894.

The ocherous variety abundant at Mesabi, Minnesota, has been called *mesabite* by H. V. Winchell, Trans. Am. Inst. Mng. Eng., **21**, 661, 1893.

Grahamite, p. 1020.—A related mineral substance occurs at various points in Texas, cf. Dumble, Trans. Amer. Inst. Mng. Eng., **21**, 602, 1892.

Origin discussed (derived like albertite, uintahite, etc., from the oxidation of petroleum), I. C. White, Bull. G. Soc. Amer., **10**, 277, 1897.

**Graphite**, pp. 7, 1036.—The relations of the different forms of carbon are discussed by Moissan, Ann. Ch. Phys., 8, 289, 306, 466, 1896, and C. R., 121, 538, 540, 1895. Also by Luzi, Ber. Ch. Ges., **24**, 4085, 1891, **25**, 214, 1378, 1892, **26**, 890, 1893; Zs. Nat. Halle, **64**, 224; B.-H. Ztg., **52**, 12, 1893 (cf. Jb. Min., **2**, 241 ref., 1893). Finally by Weinschenk, Zs. Kr., **28**, 291, 1897. *Graphitite* of Luzi (l. c.), a supposed new form of amorphous carbon (cf. Zs. Kr., **24**, 639), is shown by Weinschenk to have no real distinctive characters.

On the graphite and associated minerals of the Passau region in Bavaria, see Weinschenk, Zs. Kr., **28**, 135, 1897.

**Graphitite.**—See *Graphite.*

**Greenockite**, pp. 69, 1036.—Occurs with wurtzite and smithsonite at the Lüderich mine, near Bensberg, Sonheur, Zs. Kr., **23**, 549, 1894. Also at Laurion, Greece, (analysis,) as a yellow pulverulent incrustation on an amber-colored smithsonite (with 2·70 CdO), A. C. Christomanos, Min. petr. Mitth., **16**, 360, 1896; C. R., **123**, 62, 1896.

**Grünlingite.** *W. Muthmann* and *E. Schröder*, Zs. Kr., **29**, 144, 1897.

Rhombohedral? Massive, with one distinct cleavage; resembling tetradymite. G. = 7·321. Color gray, tarnishing black.

Composition, $Bi_4TeS_3$ or Bi(Te,S) with Te : S = 1 : 3; this requires, tellurium 12·0, sulphur 9·1, bismuth 78·9 = 100. Analyses:

| | | |
|---|---|---|
| Te 12·82 | S 9·31 | Bi 79·31 = 101·44 |
| 12·66 | 9·40 | 78·82 = 100·88 |

From Cumberland, England; an approximate analysis was earlier made by Rammelsberg (Min. Ch., p. 5, 1875).

**Guanabacoite, Guanabaquite.**—See *Quartz.*

**Guarinite**, p. 717.—The absence of titanium, early shown by Mauro, is confirmed by **O. Rebuffat**. Analysis gave:

| $SiO_2$ | $Y_2O_3$(?) | $Fe_2O_3$ | $Al_2O_3$ | $Ce_2O_3$ | CaO | $Na_2O$ | $K_2O$ |
|---|---|---|---|---|---|---|---|
| 34·84 | 1·23 | 1·69 | 25·37 | 3·45 | 25·20 | 6·57 | 1·56 = 99·91 |

Calculated formula: $2(Na,K)_2O.8CaO.5(Al,Fe,Ce)_2O_3.10SiO_2$. Lab. Chim. Napoli, 1894; abstract in Zs. Kr., **26**, 219, 1896.

**Gummite** (Eliasite), p. 892.—Investigations of gases yielded, Lockyer, Proc. Roy. Soc., **59**, **1**, 1895.

**Gunnarite.** *G. Landström*, G. För. Förh., **9**, 368, 1887. A briefly described nickel-iron sulphide containing S 45 p. c., Ni 22, Fe 33; formula suggested $3FeS_2.2NiS$. Color tin-white with tinge of yellow, tarnishing yellowish brown. G. = 4·4. Not magnetic. Dissolves with difficulty in hydrochloric acid; more easily in aqua regia with separation of sulphur. Occurs embedded in pyrrhotite at Rud, parish of Skedevi, Östergötland.

**Gypsum**, p. 933.—**Cryst.**—Discussion of symbols of doubtful forms, Cesàro, Bull. Ac. Belg., **29**, 385, 1895. Crystals from Girgenti with (350), Kraatz, Zs. Kr., **27**, 604, 1896. Harz, forms (510), (350), etc., Luedecke, Min. d. Harzes, 377, 1896. From the environs of Paris, forms $(\bar{2}03)$, (011), (031), $(\bar{2}11)$, $(\bar{5}49)$, (15·21·26), Lacroix, Bull. Soc. Min., **21**, 39, 1898, and N. Arch. Mus. Paris, **9**, 201.

On cleavage-planes, Cesàro, Ann. Soc. G. Belg., Mem., **22**, 23, 1895.

On gliding-planes, Nies, Zs. Kr., **30**, 662, 1899

On etching-figures, Viola, Zs. Kr., **28**, 573, 1897; also K. von Kraatz, Zs. Kr., **30**, 662, 1899. Corrosion-figures due to loss of water, Sohncke, Zs. Kr., **30**, 1, 1898.

Analysis of saline water contained in cavities in crystals from Sicily, Hj. Sjögren, Bull. G. Inst. Upsala, **1**, 277, 1893.

On the formation of incrustations in caves, G. P. Merrill, Proc. U. S. Nat. Mus., **17**, 77, 1894.

Gigantic crystals have been obtained from a cave at South Wash, Wayne Co., Utah, see Talmage, Science, **21**, p. 85, Feb. 17, 1893. On the occurring forms including (450) or (340) and (013), see Moses, School Mines Q., **14**, 325, 1893; also G. O. Smith, Johns Hopkins Univ., 112, May, 1894.

Crystals containing fine sand, about 50 p. c., occur at Carcote, Bolivia, Pohlmann, Vh. Ver. Santiago, **2**, 238, 1892. Also others similar from the Astrakan steppes described by Doss, Zs. G. Ges., **49**, 143, 1897.

**Hainite.** *Jos. Blumrich*, Min. petr. Mitth., **13**, 472, 1893.

Triclinic. In slender needles and plates. Twins tw. pl. *a* (100). Angles *ab* = 78° 14′, $b \wedge hko$, = 31½°. Cleavage: *b* (010) rather perfect: *a* (100) faintly indicated. Brittle. H. = 5. G.

$= 3{\cdot}184$. Luster vitreous to adamantine. Color wine-yellow, honey-yellow, colorless. Optically $+$. Ax. pl. $\perp b$ and oblique to $a$. Ax. angle large. Dispersion strong; $\rho > v$. Birefringence low; $\gamma - \alpha = 0{\cdot}012$. Pleochroism not marked; $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$.

Qualitative trials make it a silicate of sodium, calcium, titanium and zirconium; probably allied to wöhlerite, mosandrite, låvenite, etc.

Occurs in crystals in cavitities, and in embedded needles or plates of the groundmass of the phonolite of the Hohe Hain, near Mildenau in northern Bohemia.

HALITE, pp. 154, 1036.—Description of crystals (artif.) with *h* (410), *n* (211). *p* (221), *r* (332). Traube, Jb. Min., **2**, 163, 1892. Starunia, crystals with the rare form (210), Pelikan, Min. petr. Mitth., **12**, 483, 1892.

Capillary relations of crystal faces with reference to the mother liquor (also of sylvite), Berent, Zs. Kr., **26**, 529, 1896.

Investigation of tenacity, Sella and Voigt, Wied. Ann., **48**, 636, 1893.

Refractive indices for long waves, Rubens and Snow, Wied. Ann., **46**, 529, 1892. Dispersion in the infra-red, Paschen, Wied. Ann., **53**, 337, 1894. Dispersion and absorption, Rubens and Trowbridge, Wied. Ann., **60**, 724, 1897: Am. J. Sc., **5**, 33, 1898.

The skeleton crystals of calcite (resembling chiastolite) embedded in black slate at West Springfield, Mass. (and at other points), and variously interpreted (see Min., p. 222), are shown to be pseudomorphs after salt by Emerson, Bull. U. S. G. Surv., **126**, 145, 1895.

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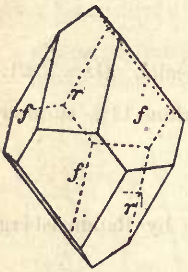

Hamlinite.

HAMLINITE, p. 762.—Occurs in crystals (Fig. 1) with the forms *r* $(10\bar{1}1)$, *f* $(02\bar{2}1)$ associated with bertrandite in Oxford Co., Maine; these (G. $= 3{\cdot}159$–$3{\cdot}283$) have been analyzed by Penfield (Am. J. Sc., **4**, 313, 1897) and the unknown composition of the mineral thus determined, viz.: $Al_3Sr(OH)_7P_2O_7$ or $[Al(OH)_2]_3[SrOH]P_2O_7$. In 2, the $SiO_2$, $Fe_2O_3$, $K_2O$, $Na_2O$ have been deducted as impurities.

| | $P_2O_5$ | $Al_2O_3$ | SrO | BaO | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|
| 1. | $\frac{2}{2}$ 28·92 | 32·30 | 18·43 | 4·00 | 12·00 | 1·93 | $SiO_2$ 0·96, $K_2O$ 0·34, $Na_2O$ 0·40, $Fe_2O_3$ 0·90 = 100·18<br>[(less O 0·81) = 99·37 |
| 2. | 30·20 | 32·67 | 19·25 | 4·18 | 12·53 | 2·01 | = 100·84 (less O 0·84) = 100 |

**Hancockite.** *S. L. Penfield* and *C. H. Warren*, priv. contr.

Monoclinic. In very small, lath-shaped crystals and crystal aggregates. Habit like that of epidote. Forms *a* (100), *c* (001), *e* (101), *r* $(\bar{1}01)$ and *n* $(\bar{1}11)$. Approximate measurements of the angles gave values near those of epidote. Color of the mass brownish red: of an isolated crystal under the microscope, golden-brown for rays vibrating parallel to the axis of symmetry and somewhat variable for the direction at right angles to this. A crystal shows a delicate greenish-brown color near the termination and a pale rose at the attached end. Ax. pl. $\parallel b$ (010). 2V = 50° approximately. Cleavage basal. H. = 6–7. G = 4·03.

Analysis (Warren) as yet incomplete, but shown to be a silicate of aluminum, ferric iron, lead, calcium and strontium. Yields a small amount of water and may be expected to conform to the general formula of the epidote group. Fusible B.B. with intumescence at 3 to a black globule. Alone on charcoal becomes magnetic. With soda on charcoal gives a coating of lead oxide. Insoluble in hydrochloric acid, but after fusion dissolves and yields gelatinous silica upon evaporation.

Occurs at Franklin, N. J., with clinohedrite, axinite, garnet, phlogopite, willemite, rœblingite, native lead and copper. Named after Mr. E. P. Hancock of Burlington, N. J.

HANKSITE, p. 920.—Borax Lake, San Bernardino Co., Cal., analyses (deducting insol., 0·19, 0·121 p. c.), J. H. Pratt:

| | $SO_3$ | $CO_2$ | $Na_2O$ | Cl | K |
|---|---|---|---|---|---|
| *Tabular cryst.* | 46·11 | 5·66 | 43·53 | 2·215 | 2·485 = 100 |
| *Prismatic cryst.*, Fig. 1 | 45·92 | 5·65 | 43·74 | 2·29 | 2·40 = 100 |

The chlorine is shown to be essential, and the following formula is obtained: $9Na_2SO_4.2Na_2CO_3.KCl$. Indices (Na): $\omega = 1{\cdot}4807$. $\epsilon = 1{\cdot}4614$. Am. J. Sc., **2**, 133, 1896.

On the formation of artificial crystals, A de Schulten, C. R., **123**, 1325, 1896.

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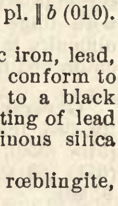


Hanksite.

**Hardystonite.** *J. E. Wolff*, Proc. Amer. Acad. Sc., **34**, 479, 1899.

Tetragonal. In granular masses showing good cleavages $\parallel c$ (001), also secondary cleavages $\parallel a$ (100) and *m* (110). H. = 3–4. G. = 3·396. Luster vitreous. Color white. Optically uniaxial, negative. Birefringence high.

Composition essentially $Ca_2ZnSi_2O_7$ or $2CaO.ZnO.2SiO_2$; perhaps related to ganomalite (Min., p. 422). Manganese replaces part of the zinc and magnesium of the calcium. Analysis (also others less complete):

| $SiO_2$ | ZnO | MnO | CaO | MgO | $Fe_2O_3$ | Ign. |
|---|---|---|---|---|---|---|
| 38·10 | 24·30 | 1·50 | 33·85 | 1·62 | 0·57 | 0·52 = 100·46. |

B B. fuses with difficulty to a cloudy glass, giving a red calcium flame; on charcoal glows and yields a sublimate of zinc oxide. Gelatinizes easily with hydrochloric acid.

Obtained from the North Hill mine at Franklin Furnace, N. J. Occurs in a fine granular banded ore associated with willemite, rhodonite and franklinite. Named from the township in which the locality is situated.

HARMOTOME, p. 581.—Analysis from the Beaver mine, Thunder Bay district, Ontario, Hoffmann, Rep. G. Canada, **5**, 16R, 1889–90.

**Hastingsite.** *F. D. Adams* and *J. B. Harrington*, Am. J. Sc., **1**, 210, 1896.—See *Amphibole.*

**Hauchecornite.** *Scheibe*, Zs. G. Ges., **40**, 611, 1888; Jb. preuss. G. Land., 1891, p. 91.

Tetragonal. Axis $\dot{c} = 1·05215$; $001 \wedge 101$ (*ce*) $= 46° 27\frac{1}{3}'$. Forms: *a* (100), *c* (001), *m* (110), *e* (101), *s* (112), *p* (111). Angles: *cp* = 56° 6′, *me* = *59° 10′. In tabular crystals, pyramidal or short prismatic. H. = 5. G. = 6·4. Luster metallic. Color light bronze-yellow.

Composition, $(Ni,Co)_7(S,Sb,Bi)_8$. Analyses, 1, R. Fischer; 2, 3, Hesse; 4, Fraatz:

| S | Bi | Sb | As | Ni | Co | Fe | Zn | Pb | |
|---|---|---|---|---|---|---|---|---|---|
| 22·71 | 24·06 | 5·69 | 1·96 | 41·08 | 2·83 | 0·89 | 0·12 | 0·64 | = 99·98 |
| 22·88 | 24·51 | 6·74 | 0·90 | 45·05 | 0·70 | 0·27 | — | 0·03 | = 101·08 |
| 22·62 | 23·72 | 6·23 | 0·45 | 45·88 | 0·82 | 0·17 | — | — | = 99·88 |
| 22·71 | 24·74 | 3·14 | 3·04 | 45·26 | — | *tr.* | — | Cu 0·09 | = 98·98 |

Occurs with millerite, bismuthinite, etc., in cavities in siderite at the Friedrich mine, near Hamm a. d. Sieg, Prussia.

HAUSMANNITE, pp. 230, 1036.—Ilmenau, analyses, Gorgeu, Bull. Soc. Chim., **9**, 653, 1893.

**Hautefeuillite.** *Michel*, Bull. Soc. Min., **16**, 38, 1893, and C. R., **116**, 600, 1893.

Monoclinic. In lamellar masses with radiated structure: these are made up of minute prismatic crystals with the forms *a* (100), *b* (010), *m* (110).

Cleavage: *b* perfect. H. = 2·5. G. = 2·435. Colorless. Transparent. Optically +. Ax. pl. ∥ *b*. $Bx_a$ inclined 45° to *a*. $2E_y = 88°$. $n_y = 1·52$. Dispersion $\rho < v$; inclined strong.

Composition, $(Mg,Ca)_3P_2O_8 + 8H_2O$. This is like bobierrite except in the calcium present. The two minerals also differ optically. Analysis:

| $P_2O_5$ | MgO | CaO | $H_2O$ |
|---|---|---|---|
| 34·52 | 25·12 | 5·71 | 34·27 = 99·62 |

B.B. exfoliates and fuses to a greenish-white globule. Dissolves with difficulty in acids.

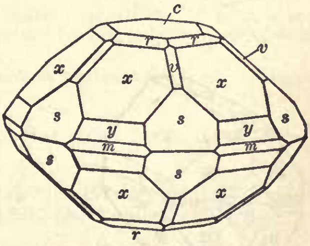
Occurs with apatite, monazite and pyrite at the mines of Ödegaarden, Bamle, Norway. Named after M. Hautefeuille.

HAÜYNITE, p. 431.—A variety from the Kaiserstuhl exhibits phosphorescence, Brauns, Jb. Min., **1**, 84, 1899.

**Heazlewoodite.** *W. F. Petterd*, Catalogue of Minerals of Tasmania, p. 47, 1896. A sulphide of nickel and iron related to pentlandite, occurring in narrow bands in the serpentine of Heazlewood, Tasmania. Color light yellow-bronze; streak light bronze. Highly magnetic. H. = 5. G. = 4·61. Rich in nickel, up to 38 p. c., but not analyzed.

HEDENBERGITE.—See *Pyroxene.*

HEDYPHANE, p. 775.—Occurs in distinct crystals at the Harstig mine, Norway, with tephroite in calcite. Hexagonal; forms: *m*, *c*, *r*, *x*, *α*(30$\bar{3}$2), *y*, *v*, *s*; axis $\dot{c} = 0·7063$, or near that of apatite. Cleavage *x* (10$\bar{1}$1). Hj. Sjögren, G. För. Förh., **14**, 250, 1892; Bull. G. Inst. Upsala, **1**, 11, 1893.



Hedyphane.

HEINTZITE, p. 885.—Crystals from Westeregeln examined by Bücking, Ber. Ak. Berlin, 58, 1895.

Luedecke remarks on the identity of heintzite, hintzeite and kaliborite (Min., p. 885), Zs. Ges. Nat. Halle, **64**, 423, 1892.

**Helvite**, p. 434.—Schwarzenberg, associated with fluorite, scheelite, etc. Analysis after deducting fluorite (corresponding to 3·16 p. c. CaO): $SiO_2$ 39·33, FeO 4·45, MnO 44·43, BeO 14·92, $Al_2O_3$ 0·77, S 5·03 = 102·93. G. = 3·202. Miers and Prior, Min. Mag., **10**, 13, 1892.

Discussion of composition with the conclusion that the ratio Be : Mn + Fe + Zn is constant, = 1 : 1; hence the formula $3Be(Mn,Fe,Zn)SiO_4 + (Mn,Fe,Zn)S$, Retgers, Zs. phys. Ch., **20**, 488, 1896.

**Hematite**, pp. 213, 1037.—Cryst. study, Framont, Schweitzer [Inaug. Diss., Strassburg, 1892], Zs. Kr., **24**, 627, 1895. Crystals from Puy de la Tache, Mont Dore, with new forms, F. Gonnard, C. R., **126**, 1048, 1898. Artificial crystals with $\mu$ (01$\bar{1}$5), etc., Doss, Zs. Kr., **20**, 567, 1892.

Refractive indices measured, mean value for *A* 2·834, for *C* 2·964, Wülfing, Min. petr. Mitth., **15**, 68, 1895.

Occurrence of hematite and martite ores in Mexico, Hill, Am. J. Sc., **45**, 111, 1893.

On the action of a powerful magnet upon minerals containing iron, as hematite, limonite, siderite, franklinite, etc., see Wilkens and Nitze, Trans. Am. Inst. Mng. Eng., **26**, 351, Feb., 1896.

**Hercynite**, p. 223.—From the Veltlin forming a granular aggregate with corundum, sillimanite, etc., analysis by Linck, after deducting 2·8 p. c. pyrrhotite: $Al_2O_3$ 61·21, $Fe_2O_3$ 3·18, FeO 25·98, MgO 9·63 = 100. Ber. Ak. Berlin, 47, 1893.

**Herderite**, p. 760.—Shown by Penfield (Am. J. Sc., **47**, 329, 1894) to be monoclinic in crystallization. Axes $\breve{a} : \bar{b} : \dot{c} = 0·63075 : 1 : 0·42742$; $\beta = {}^*89° 54'$ for crystals from Paris, Me. Forms: *a* (100), *b* (010), *c* (001); *m* (110), *l* (120), $\mu$ (130); *d* (101), $\underline{e}$ (302), $\mathfrak{e}$ ($\bar{3}$02), $\mathfrak{d}$ ($\bar{3}$01); *u* (011), *t* (032), *v* (031), *s* (061); *r* (112), *p* (111), *q* (332), $\underline{n}$ (331), *o* (441), $\mathfrak{q}$ ($\bar{3}$32), $\mathfrak{n}$ ($\bar{3}$31); *k* (122), *w* (3·12·4), $\mathfrak{r}$ ($\bar{1}$21), *x* ($\bar{3}$62), *z* ($\bar{3}$94), $\mathfrak{p}$ ($\bar{3}$91). Also *y* (131 or $\bar{1}$31). Angles $mm''' = 64° 29'$, $ct = {}^*45° 25'$, $bv = {}^*37° 57'$.

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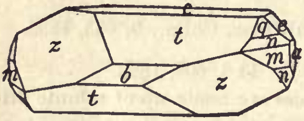

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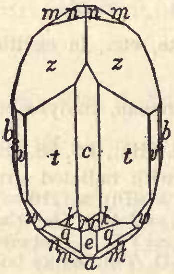
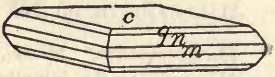


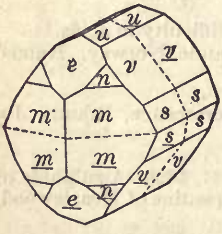
Paris.

3.

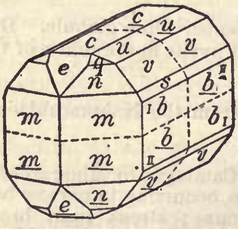


Hebron.

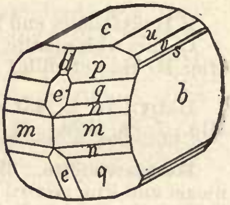
4.



5.

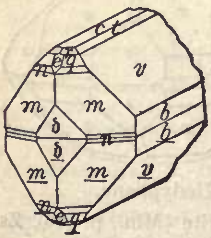


6.



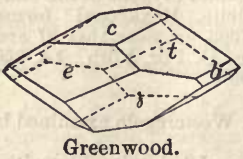
Figs. 4–6, Stoneham.

7.



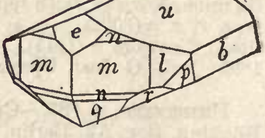
Auburn.

8.



Greenwood.

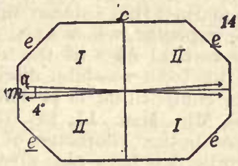
9.



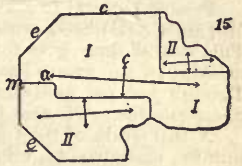
Greenwood.

Crystals sometimes monoclinic in habit (Paris), but commonly penetration-twins with *c* (001) as tw. pl. and then pseudo-orthorhombic, analogous to stilbite (Figs. 4, 5). Sections ‖ *b* (010) show inclined extinction; $\mathfrak{c} \wedge \acute{c} = Bx_o \wedge \acute{c} = -2\frac{1}{2}°$ for Na. Dispersion inclined, distinct. $\beta = 1·632$, $2H_a = 70° 44'$ and $\therefore 2V_a = 71° 59'$ for Na, Paris. Also $\beta = 1·612$, $2H_a = 66° 0'$, $\therefore 2V_a = 68° 7'$, again $2E_a = 128° 25'$ for Na, Stoneham. Sections of twins show monoclinic character (Figs. 10, 11 (cf. Fig. 5)).

10.



11.



Stoneham.

The composition is shown to vary according to the relative amounts of fluorine and hydroxyl present, the general formula being $Ca[Be(F,OH)]PO_4$. The pure *fluor-herderite* has not been noted as yet, but the Stoneham mineral is a *hydro-fluor-herderite*, while that from Paris (new local.) and Hebron is *hydro-herderite* as shown below. Greenwood is another new locality affording both kinds. Analyses, 1, 2, H. L. Wells, quoted by Penfield, also Am. J. Sc., **44**, 114, 1892. Anal. 2 after deducting 5·27 insol.

| | G. | $P_2O_5$ | BeO | CaO | $H_2O$ | F | |
|---|---|---|---|---|---|---|---|
| Paris | 2·952 | 44·05 | 16·13 | 34·04 | 5·85 | – | insol. 0·44 = 100·51 |
| Hebron | 2·975 | 43·08 | 16·18 | [34·35] | 6·15 | 0·42 | = 100·18 |

Hessite, pp. 47, 1037.—San Sebastian distr., Jalisco, Mexico, analysis by J. S. de Benneville, quoted by Genth and Penfield, Am. J. Sc., **43**, 187, 1892.

Occurs in Yale district, Br. Columbia, Hoffmann, Rep. G. Canada, **8**, 11R, 1895.

Heteromorphite, p. 122.—See *Plagionite.*

Heulandite, p. 574. — Crystals described from Tulferthal, Tyrol, Habert, Zs. Kr., **28**, 250, 1897.

Relation in physical characters and composition to brewsterite, stilbite, etc., discussed by Rinne, Jb. Min., **1**, 12, 1892.

Analysis from the granite on the Struth, Thuringia, Fomme, Ber. phys.-med. Soc. Erlangen, **25**, 1893. Also from Anthracite Creek, Gunnison Co., Colo., Eakins, Bull. U. S. G. Surv., **90**, 62, 1892. From Pula, Sardinia (anal., 2·55 p. c. BaO), Lovisato, Rend. Accad. Linc., **6** (1), 260, 1897; Riv. Min. Ital., **18**, 33, 1898.

Results of treatment with sulphuric acid and hydrochloric acid, Rinne, Jb. Min., **1**, 139, 1896.

Hislopite, p. 266.—See *Calcite.*

**Hoeferite.** Höferite, *F. Katzer*, Min. petr. Mitth., **14**, 519, 1895.

Amorphous; earthy, granular or scaly. H. = 1–3. G. = 2·34 (air-dried). Luster glimmery to greasy. Color siskin-green, also apple- to grass-green. Streak slightly lighter. Adheres to the tongue.

Composition, $2Fe_2O_3.4SiO_2.7H_2O$; or $Fe_2O_3.SiO_2.H_2O$ if the water lost at 120° is neglected = Silica 35·2, iron sesquioxide 46·5, water 18·3 = 100. Hence closely related to chloropal (nontronite). Analyses:

| $SiO_2$ | $Fe_2O_3$* | $Al_2O_3$ | Ign. |
|---|---|---|---|
| 36·14 | 45·26 | 1·11 | 18·15 = 100·66 |
| 35·88 | 46·64 | | 18·20 = 100·72 |

*Includes a little FeO.

B.B. becomes reddish brown, then dark grayish black, and fuses with difficulty to a black magnetic slag. Insoluble in dilute acids, and only in part decomposed by hot sulphuric acid with separation of pulverulent silica.

Occurs at Křitz, near Rakonitz, Bohemia, at the formerly worked antimony mines. Named after Professor H. Hoefer of Leoben.

Hopeite, p. 808.—Crystals described from Moresnet, Belgium, G. Cesàro, Mem. Acad. Belg., **53**, 1897.

Humite Group, p. 535.—Analyses on carefully selected material, identified by crystallographic study, have enabled Penfield and Howe (Am. J. Sc., **47**, 188, 1894) to establish the following formulas for the three species of the group:

Chondrodite, $Mg_3[Mg(F,OH)]_2[SiO_4]_2$
Humite, $Mg_5[Mg(F,OH)]_2[SiO_4]_3$
Clinohumite, $Mg_7[Mg(F,OH)]_2[SiO_4]_4$

These formulas vary progressively by an increase of one molecule of ($Mg_2SiO_4$), and this variation is closely connected with the crystallization (see Min., p. 534). The vertical axes are in the ratio of 5 : 7 : 9, that is, of the total number of magnesium atoms present. The same result was reached at nearly the same time by Hj. Sjögren, Bull. G. Inst. Upsala, **2**, 39–54, 1894.

Penfield and Howe also remarked that another member of the series, having the composition $Mg[Mg(F,OH)]SiO_4$, was to be expected, whose axial ratio should be about 1·086 : 1 : 1·887, $\beta = 90°$. This would then give for the vertical axes of the four compounds the ratio of 3 : 5 : 7 : 9 A member of the group having this form was later discovered by Hj. Sjögren and called *Prolectite.* Though not yet analyzed, its composition is probably expressed by the formula given above. See *Prolectite.* Cf. also Lewis, Min. Mag., **11**, 137, 1896.

A full study of the form and optical characters of crystals of the three members of the group, humite, chondrodite, clinohumite, has been also given by Sjögren, G. För. Förh., **14**, 423, 1892; Bull. G. Inst. Upsala, **1**, 16–40, 1892.

A humite, occurring in serpentine in the Allalin region, Valais, Switzerland, contains no fluorine, having the composition $Mg_5(MgOH)_2(SiO_4)_3$, see analyses by Jannasch and Locke, Zs. anorg. Ch., **7**, 92, 1894; occurrence described by Schäfer, Min. Mitth., **15**, 126, 1895.

HURONITE, p. 340.—Investigation, chemical and microscopic, showing it to be a basic plagioclase, more or less altered to saussurite. Barlow, Ottawa Naturalist, **9**, 25; Jb. Min., **1**, 430 ref., 1897.

**Hydrocalcite.** *K. Kosmann*, B.-H. Ztg., No. 38, 1892; Zs. G. Ges., **44**, 155, 1892; Jb. Min., **1**, 260 ref., 1894. A soft white pulpy substance occurring in a limestone cave at Wolmsdorf, Glatz, Silesia. Dried over sulphuric acid, it yields the composition $CaCO(OH)_4$ or $CaCO_3.2H_2O$. When free from water it forms a "Bergmilch," containing needle-like crystals with strong double refraction. The author would regard the "Bergmilch" as a third form of calcium carbonate.

HYDROFRANKLINITE, p. 259.—See *Chalcophanite.*

HYDROGIOBERTITE, p. 305.—A mineral provisionally referred here, but perhaps new, has been noted by Brugnatelli at the amianthus deposits of Val Brutta. In loose aggregates of prismatic (orthorhombic) crystals, biaxial with parallel extinction. G. = 2·013. Analysis: $CO_2$ 21·85, MgO 43·32, $H_2O$ 34·32 = 99·49. Rend. Ist. Lombardo, **30**, 1109, 1897, and Riv. Min. Ital., **18**, 44, 1898; also Zs. Kr., **31**, 54, 1899.

HYDROHERDERITE.—See *Herderite.*

HYDROZINCITE, p. 299.—Analysis from Bleyberg, Belgium, G. Cesàro, Mem. Acad. Belg., **53**, 1897.

ICE, p. 205.—Photographs of snow-crystals, G. Nordenskiöld, Bull. Soc. Min., **16**, 59, 1893, and G För. Förh., **20**, 163, 1898. Also by W. A. Bentley, noted by J. E. Wolff, Proc. Am. Acad., **33**, 431, 1898 and Bentley and Perkins, Pop. Sci. Monthly, May, 1898.

Resemblance of spherical crystals to chondrules in meteorites, Rinne, Jb. Min., **1**, 259, 1897.

Plasticity of crystals measured, Mügge, Jb. Min., **2**, 211, 1895.

Observed in hollow, hopper-like, hexagonal crystals, Grossmann, Proc. Roy. Soc., **54**, 113, 1894.

Density determined, E. L. Nichols, Phys. Rev., **8**, 21, 1899. The final results for 0° reached are: 0·9181 for natural ice, 0·9161 for artificial ice (obtained with $CO_2$ and ether).

**Iddingsite.** *A. C. Lawson*, Bull. G. Univ. Cal., **1**, 31, 1893. A mineral substance occurring in the carmeloite (augite-andesite) of Carmelo Bay, California, probably an alteration-product of chrysolite. Structure lamellar. Cleavage easy ‖ *a* (100); also parallel to a brachydome of 80°. H. = 2·5. G. variable, 2·839 a maximum. Luster on *a* (cleavage) bronze-like. Color brown. Optically biaxial. Ax. plane ‖ 010 and ⊥ *a* (cleavage). Pleochroism on *a* chestnut- and lemon-yellow. Absorption $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$. A silicate of iron, calcium and magnesium. B. B. infusible. Finally decomposed by hydrochloric acid. Named after Prof. J. P Iddings of Chicago.

**Idrizite.** *A. Schrauf*, Jb. G. Reichs., **41**, 379, 1892. A sulphate related to botryogen from the Idria mercury mines in Carniola. Compact to cystalline. Color yellow-gray. H. = 3. G. = 1·829. Analysis gave: $SO_3$ 33·94, $Al_2O_3$ 8·59, $Fe_2O_3$ 8·70, Fe(Mn)O 3·10, MgO 4·51, $H_2O$ 40·80 = 99·64. The formula $(Mg,Fe)(Fe,Al)_2Si_3O_{13} + 16H_2O$ is deduced. Insoluble in hot or cold water, but soluble in dilute hydrochloric acid.

ILMENITE, p. 217.—Discussion of composition leading to formula $FeTiO_3$, Th. Koenig and O. von der Pfordten, Ber. Chem. Ges., **22**, 1488, 2070, 1889. This subject has been also treated by Penfield and Foote. A new analysis (Foote) of the crystallized mineral (G. = 4·345) from Layton's Farm, Warwick, N. Y., gave: ($\frac{2}{2}$) $TiO_2$ 57·29, $SiO_2$ 0·37, FeO 24·15, MgO 15·97, MnO 1·10, $Fe_2O_3$ 1·87 = 100·75. This (which confirms the analysis of Rammelsberg) yields the formula $RO.TiO_2$, where R = Mg and Fe. Hence it is inferred that the composition should be regarded as an isomorphous mixture of $MgO.TiO_2$ and $FeO.TiO_2$. Am. J. Sc., **4**, 108, 1897.

Variety containing 11·9 ($\frac{2}{2}$) p. c. MgO, from the Magnolia district, Colorado, analyzed by Whitaker (G. = 4·44), Colorado Sc. Soc., Feb. 5, 1898.

Analysis from Bedford Co., Va., Peck, Am. Ch. J., **19**, 232, 1897.

**Ilvaite**, pp. 541, 1037.—Occurs in crystals with rhodonite (bustamite) at Cap Bon-Garonne, Algeria, Gentil, Bull. Soc. Min., **18**, 410, 1895. Also occurs near the head of Barclay Sound, Vancouver Is., Br. Columbia (analysis), Hoffmann, Rep. G. Canada, **5**, 12R, 1889–90.

**Inesite**, p. 564.—Crystals from Jakobsberg, Nordmark, Sweden, described by Hamberg, show the forms: *a* (100), *b* (010), *c* (001), *d* (011), *g* (201), and *f* ($\bar{3}01$) new; analysis, G. Lundell: $SiO_2$ 42·92, MnO 36·31, PbO 0·73, CaO 8·68, MgO 0·37, $H_2O$ 10·48 (0·62 over $H_2SO_4$) = 99·49. G. För. Förh., **16**, 323, 1894.

**Iolite**, p. 419.—Crystals from Selrain, Montavon and the Pitzthal in the Alps, described by Gemböck (new forms 350, 120, 160, 501, 351, 261, 281), Zs. Kr., **29**, 305, 1898.

Occurrence in an eruptive rock from S. Africa, Molengraaf, Jb. Min., **1**, 79, 1894.

Experimental investigation of conditions of formation in a magma, Morozewicz, Min. petr. Mitth., **18**, 22, 1898.

**Iron**, pp. 28, 1037.—Discussion of twinning structure, Linck, Zs. Kr., **20**, 209, 1892; Ann. Mus. Wien, **8**, 113, 1893. See also papers by Cohen on the investigation of meteoric iron, Ann. Mus. Wien, **7**, 143, 1892; **9**, 97, 1894; **12**, 42, 119, 1897.

Many papers on meteoric irons have been published (Am. J. Sc., Ann. Mus. Wien, Ber. Ak. Berlin, etc.) See also the classification of meteorites and catalogue of Vienna collection, Brezina, Ann. Mus. Wien, **10**, 231, 1895.

Terrestrial native iron occurs in minute spherules in feldspar in Cameron township, Nipissing district, Ontario, Hoffmann, Rep. G. Canada, **6**, 23R, 1895. Noted also in connection with the coal measures of Missouri, E. T. Allen, Am. J. Sc., **4**, 99, 1897.

The Coahuila and Toluca irons yield minute quantities of platinum, also iridium, Davison, Am. J. Sc., **7**, 4, 1899.

**Jacksonite**, p. 531.—Examined by N. H. Winchell, who concludes that it is optically distinct from prehnite and thomsonite, but may perhaps be the same as lintonite (wh. see). Amer. Geol., **23**, 250, 1899.

**Jadeite**, p. 369.—Analyses of chloromelanite, Damour, Bull. Soc. Min., **16**, 57, 1893. From Mogoung, Burma, analysis, Farrington, Proc. U. S. Nat. Mus., **17**, 29, 1894.

Occurrence in Upper Burma described, Noetling, Jb. Min., **1**, 1, 1896 (Rec. G. Surv. India, **26**, 26, 1893); Bauer, *ib.*, p. 18; from "Thibet," Bauer, *ib.*, p. 85.

A soda-pyroxene, allied to jadeite, occurring with allurgite, at St. Marcel, Piedmont, has been investigated by Penfield. Tough, forming an interwoven aggregate of coarse prismatic crystals. Color ash-gray. G. = 3·26–3·38. Analysis ($\frac{2}{2}$): $SiO_2$ 54·59, $Al_2O_3$ 9·74, $Fe_2O_3$ 11·99, $Mn_2O_3$ 1·06, MnO 0·58, MgO 5·03, CaO 7·24, $Na_2O$ 9·32, $K_2O$ 0·24, $H_2O$ 0·37 = 100·16. Am. J. Sc., **46**, 291, 1893.

**Jamesonite**, p. 122.—Occurs in East Kootanie, Br. Columbia, Hoffmann, Rep. G. Canada, **5**, 65R. Also from Barrie township, Frontenac Co., Ontario, *ib*, **6**, 30R, 1892–93.

On the historical relations of jamesonite and heteromorphite, see L. J. Spencer, Min. Mag., **12**, 58, 1899. The crystallized jamesonite from Bolivia is stated *not* to conform to $2PbS.Sb_2S_3$ (Rose's original formula was $3PbS.Sb_2S_3$).

**Jarosite**, p. 974.—Occurs in auriferous quartzite at the Buxton mine, Lawrence Co., So. Dakota, W. P. Headden (analysis), Am. J. Sc., **46**, 24, 1892. Also at the Jarilla Mts., Doña Ana Co., N. M., Hidden, Am. J. Sc., **44**, 255, 1893. At Pisek, Bohemia, in crystals with *c*, *r*, *s* ($02\bar{2}1$), Krejči, Ber. Ak. Böhm., Feb. 21, 1896.

**Jarrowite.**—A local name for pseudomorphs of calcite, perhaps after celestite, from the Jarrow Docks, Durham, England (= pseudo-gaylussite, this Appendix, also Min., p. 907). See Miers, Min. Mag., **11**, 264, 897.

**Jeffersonite.**—See *Pyroxene.*

JORDANITE, pp. 141, 1039.—Further description of Binnenthal crystals, monoclinic in symmetry, with new forms, Baumhauer, Zs. Kr., **24**, 78, 1894.

**Josephinite.** *W. H. Melville*, Am. J. Sc., **43**, 509, 1892.

Massive, granular, forming the metallic portion of ellipsoidal pebbles whose sp. gravity is 6·204. Their complex composition is noted below; the metallic part has the following characters: Malleable and sectile. H. = 5. Luster metallic. Color gray. Opaque. Magnetic. Composition $Fe_2Ni_5$. Analysis gave $(\frac{2}{2})$: Fe 23·23, Ni 30·45. A little cobalt, copper and arsenic were also present; phosphorus was absent.

The pebbles consist of 13·38 p. c. of silicates, of which 12·88 p. c., soluble in HCl. is serpentine; the remainder, insoluble, is perhaps bronzite. A very small amount of chromite, magnetite, pyrrhotite are also present, further a trace of chlorine (0·04 p. c.) of uncertain relations. Occur in the placer gravel of a stream in Josephine and Jackson counties, Oregon, which it is inferred probably came from an eruptive dike in the vicinity. Deposits of nickel silicate occur in Douglas Co. to the south of the locality here noted (see Min., p. 677; also awaruite, Min., p. 29).

KAINITE, p. 918.—Analyses of kainite and other salts from Kalusz and Aussee, C. v. John, Jb. G. Reichs., **42**, 341, 1892.

KAINOSITE.—See *Cenosite*.

**Kalgoorlite.** *E. F. Pittman*, Rec. G. S. New South Wales, vol. **5** (separate).

Massive. Fracture subconchoidal. Color iron-black. G. = 8·791. Composition, $HgAu_2Ag_6Te_6$. Analysis by J. C. H. Mingaye:

| Te | S | Au | Ag | Hg | Cu |
|---|---|---|---|---|---|
| [37·26] | 0·13 | 20·72 | 30·98 | 10·86 | 0·05 = 100 |

Occurs at the telluride deposits at Kalgoorlie, West Australia. A yellow gold telluride (G. = 9·377) referred to calaverite is associated; this gave Te 56·65, Au 41·76, Ag 0·80 = 99·21.

**Kaliastrakanite.** Kalium-astrakanite, *J. K. van Heide*, Ber. Ch. Ges., **26**, 414, 1893; *Naupert* and *Wense*, *ibid.*, p. 873.—See *Leonite*.

**Kaliblödite.** *C. A. Tenne*, Zs. G. Ges., **48**, 632, 1896.—See *Leonite*.

**Kamarezite.** *K. Busz*, Ber. Ges. Bonn, **50**, 83, 1893; Jb. Min., **1**, 115, 1895.

Orthorhombic? In minute crystals, tabular ‖ *b* and vertically striated; terminations formed by two domes (assumed as 101 and 201 (*d*)); crystals in cavities of a crystalline mass. Cleavage: perfect ⊥ *b*. H. = 3. G. = 3·98. Color grass-green. Ax. pl. ‖ *b*. $Bx_a$ ⊥ cleavage. Ax. angle large.

Composition, $(CuOH)_2SO_4.Cu(OH)_2 + 6H_2O$, thus related to langite and arnimite. Analysis:

| $SO_3$ | CuO | FeO | $H_2O$ |
|---|---|---|---|
| $(\frac{4}{4})$ 17·52 | $(\frac{3}{3})$ 51·50 | 0·69 | [30·29] = 100 |

B.B. in the closed glass tube decrepitates strongly and gives off first water and then sulphuric acid. Insoluble in water, but readily soluble in ammonia and acids.

From Laurion, Greece; named from Kamareza in Greece.

**Katoforite.** *W. C. Brögger*, Die Eruptivgesteine d. Kristianiagebietes, **1**, 37, 73 (*et al.*), 1894; **3** 169, 1898.—See *Cataphorite*.

**Kauaiite.** *Goldsmith*, Proc. Acad. Nat. Sc., Philad., 1894, 105. Occurs on the island Kauai, Hawaiian Is., as a soft, amorphous chalk-like mass. G. = 2·566. Analysis: $Al_2(SO_4)_3$ 7·18, $Al_2O_3$ 33·40, $K_2SO_4$ 17·00, $Na_2SO_4$ 4·91, $H_2O$ 31·57, X [5·94] = 100.

**Kehoeite.** *W. P. Headden*, Am. J. Sc., **46**, 22, 1893.

Massive, amorphous, forming seams and bunches in the ore (argentiferous galena with sphalerite and pyrite) of the Merritt mine, Galena, So. Dakota. G. = 2·34. Insoluble in water, soluble in dilute acids; becomes insoluble after ignition. Infusible. Analysis gave, after deducting 1·76 insoluble:

| $P_2O_5$ | $Al_2O_3$ | $Fe_2O_3$ | ZnO | CaO | MgO | $H_2O$ | $SO_3$ |
|---|---|---|---|---|---|---|---|
| 27·13 | 25·29 | 0·79 | 11·74 | 2·75 | 0·08 | 31·60 | 0·51 = 99·89 |

This corresponds to $4R_2O_3.RO.5P_2O_5.9H_2O$. Of the water 14·2 per cent are lost between 105° and 110°, 3·34 between 115° and 120°; the remainder is expelled only at a red heat.

KENTROLITE, pp. 544, 1039.—Described by Flink as occurring in crystals at Långban, Sweden, with barite and calcite, as noted in Min., p. 1039.

Crystals from Jakobsberg have been examined by G. Nordenskiöld, G. För. Förh., **16**, 153, 1894. Forms: *e* (102), *v* (115), *u* (114), *o* (111), *s* (221), *z* (3·15·10)? Habit usually pyramidal, *o*, *n*, with *m* and *e* small; rarely prismatic, *m*, *o*. Angles $pp^{\text{iv}}$ (111 ∧ 11$\bar{1}$) = 62° 31·7′, $pp'$ (111 ∧ $\bar{1}$11) = 92° 34′. Ax. pl. (on Långban sections) ∥ *b*; also $\mathfrak{a} = \check{a}$, $\mathfrak{b} = \bar{b}$, $\mathfrak{c} = \dot{c}$. Birefringence high. Occurs with inesite.—See also *Melanotekite*.

KERMESITE, p. 106.—Revision of crystallographic data with new forms, in part doubtful, Pjanitsky, Zs. Kr., **20**, 417, 1892; cf. also Goldschmidt, Kryst. Winkeltabellen, 389, 1897.
Discussion of composition, Baubigny, C. R., **119**, 737, 1894.

KIESERITE, p. 932.—Occurs in crystals at Westeregeln with carnallite, etc.; new forms *c* (001), *y* (335), Bücking, Ber. Ak. Berlin, 533, 1895.

**Klinozoisite.** *E. Weinschenk*, Zs. Kr., **26**, 161, 433, 1896.—See *Clinozoisite*.

KNEBELITE, p. 457.—A variety containing magnesia (4·7 p. c. MgO) has been called *talk-knebelite* by Igelström (Jb. Min., **1**, 248, 1890). It occurs with eisenknebelite (Min., p. 457) at the Hilläng mine, Dalecarlia, Sweden.

**Knopite.** *P. J. Holmquist*, G. För. Förh., **16**, 73, 1894; also *ibid.*, **15**, 588, 1893.

A mineral closely related to perovskite (Min., p. 722), but containing cerium without niobium or tantalum and thus intermediate between it and dysanalyte (p. 724).

Type A is in cubo-octahedrons also with (911) and (920); color lead-gray; luster metallic; these show on a polished surface lamellæ, thus on *a*, parallel to the cubic edges, also diagonal. In thin sections optically biaxial with high birefringence and a lamellar structure. H. = 5–6. G. = 4·11.

Type B is in cubes, *o* very small or absent; penetration-twins with *o* as tw. pl.; without distinct lamellæ and opaque except in fine powder. H. = 5–6. G. = 4·21–4·29.

Composition corresponds to RO.TiO₂. Analyses:

| | $TiO_2$ | $ZrO_2$ | $SiO_2$ | $Ce_2O_3$ | $Y_2O_3$? | FeO | MnO | MgO | CaO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Type A. | 58·74 | 0·91 | 1·29 | 5·80 | 0·06 | 3·23 | 0·31 | 0·19 | 26·84 | 0·75 | 0·29 | 1·00=99·41 |
| 2. " | — | — | — | 5·15 | | 2·63 | — | — | 27·29 | 1·99 | | |
| 3. Type B. | 54·12 | — | — | 6·81 | — | 4·19 | — | — | 33·32 | 0·38 | 0·79 | 0·21=99·82 |
| 4. " | 56·30 | — | — | 4·46 | — | 5·15 | — | 0·35 | 32·22 | 0·39 | | 0·30=99·17 |
| 5. " | 54·52 | — | — | 4·42 | — | 4·94 | — | 0·32 | 32·84 | 1·68 | | 0·92=99·64 |

From Alnö, Sweden, and the neighboring mainland. Type A occurs in a limestone, crystalline, as a result of contact-metamorphism, with garnet, titanomagnetite, etc. Type B is from a brecciated limestone also in a syenitic rock. Named after Prof. A. Knop of Carlsruhe, who described dysanalyte.

**Kosmochlor.** *Laspeyres*, Zs. Kr., **27**, 592, 1896.—Kosmochromit, *Groth*, Tab. Ueb., 132, 1898.—See *Cosmochlore*.

**Kosmochromite.**—See *Kosmochlor* and *Cosmochlore*.

KRENNERITE, pp. 105, 1039.—Chester quotes the results of an examination by Penfield of crystals from Cripple Creek, Colorado, which have the habit of Fig. 1. Myers obtained for them (deducting 1·21 insol.): Te 55·68, Au 43·86, Ag 0·46 = 100, or AuTe₂. The original Nagyág mineral contained silver. It is urged that calaverite is probably a sylvanite essentially free from silver. Am. J. Sc., **5**, 375, 1898. See also *Calaverite* and *Goldschmidtite*.

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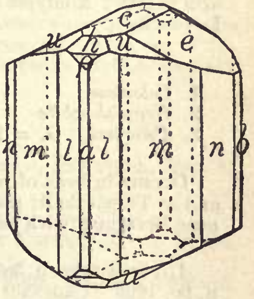


Krennerite.

**Ktypeite.** *A. Lacroix*, C. R., **126**, 602, 1898. Calcium carbonate in the form of pisolites from Carlsbad, Bohemia, and Hammam-Meskoutine in Algeria; formerly referred to aragonite. The specific gravity varies from 2·58 to 2·70, or less than that of calcite. Birefringence = 0·020. In parallel polarized light a distorted black cross is noted, while portions give a positive black cross in converging light. Heated to low redness, the pisolites decrepitate and are finally transformed into calcite; the name given refers to this fact.

**Kubeite.** *L. Darapsky*, Jb. Min., **1**, 163, 1898.—See *Cubeite*.

**Kylindrite.** *A. Frenzel*, Jb. Min., 2, 125, 1893.—See *Cylindrite.*

**Lagoriolite.** Kalk-Natron-Granat, Lagoriolith, *J. Morozewicz*, Min. petr. Mitth., **18**, **147**, 1898.—See *Garnet.*

**Lamprophyllite.** *W. Ramsay*, *V Hackman*, Fennia, **11**, No. 2, p. 119, Helsingfors, 1894. Also *W. Ramsay*, *ibid.*, 3, No. 7, p. 45, 1890.

A mineral related to astrophyllite in form and cleavage, occurring in the nephelite-syenite of Lujavor-Urt, peninsula of Kola, Russian Lapland. Occurs macroscopically in minute flattened prisms with mica-like cleavage. Color yellow-brown and luster submetallic. Obtuse negative bisectrix with large axial angle symmetrically normal to cleavage. Pleochroism distinct, $\mathfrak{c}$ brown-yellow, $\mathfrak{b}$ bright golden-yellow. Absorption $\mathfrak{c} > \mathfrak{b}$ (for astrophyllite $\mathfrak{b} > \mathfrak{c}$). In thin sections, a form (110) was noted inclined 41° to 42° with the cleavage (100), also terminations. Twins common, parallel the direction of elongation ; also polysynthetic twinning. Pleochroism distinct, $\mathfrak{a}$, $\mathfrak{b}$ straw-yellow, $\mathfrak{c}$ orange-yellow.

These observations agree with earlier ones by Ramsey (l. c.) ; he remarks on the resemblance to låvenite, noting also a form (210) inclined 27° to 100. G. = 3·45. Absorption $\mathfrak{a} \leqq \mathfrak{b} < \mathfrak{c}$. Birefringence lower than with ægirite. Contains silica, titanium, iron, manganese, and sodium.

**Lamprostibian.** *L. J. Igelström*, G. För. Förh., **15**, 471, 1893; Zs. Kr., **22**, 467, 1893. A partially described mineral from the Sjö mine, Örebro, Sweden. Occurs in foliated or scaly forms. H. = 4. Brittle. Luster brilliant. Opaque and color lead-gray, except in very thin layers, then blood-red in color. Streak red. Not magnetic. Difficultly soluble in hot concentrated hydrochloric acid without evolution of chlorine. Inferred to be an anhydrous antimonate of iron and manganese (FeO,MnO).

LANARKITE, p. 923.—Artificial production of crystals, A. de Schulten, Bull. Soc. Min., **21**, 142, 1898.

LÅNGBANITE, Longbanite, pp. 543, 1039.—Crystals from Långban examined by Hj. Sjögren (Bull. G. Inst. Upsala, **1**, 41, 1892) are shown to be rhombohedral, not hexagonal. Crystals complex; habit varied, prismatic or tabular, sometimes with prominent rhombohedral development.

Also occurs with rhodonite, manganophyllite, braunite, calcite, at the Sjö mine, *ibid.*, **2**, 96, 1894. Analyses by R. Mauzelius quoted by Sjögren :

| | G. | $Sb_2O_3$ | $Fe_2O_3$ | $SiO_2$ | $MnO_2$ | MnO | CaO | Mg | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Långban | 4·65 | 11·76 | 14·15 | 12·23 | 26·15 | 31·54 | 2·24 | 1·61 | — | = 99·68 (O 3·50) |
| 2. " | 4·73 | 11·61 | 14·31 | 11·32 | 27·13 | 32·30 | 2·04 | 0·86 | 0·32 | = 99·89 (O 3·70) |
| 3. " | 4·83 | 12·92 | 4·33 | 8·95 | 35·15 | 36·39 | 1·95 | 0·47 | — | = 100·16 (O 5·03) |
| 4. Sjö mine | 4·60 | 12·51 | 13·98 | 12·82 | 24·36 | 32·22 | 2·40 | 1·11 | 0·52 | = 99·92 (O 3·09) |

The formula calculated is $m\mathrm{Sb_2O_3}.n\mathrm{Fe_2O_3}.p\overset{\mathrm{IV}}{\mathrm{R}}\overset{\mathrm{II}}{\mathrm{R}}\mathrm{O_3}$ ; a relation to hematite is suggested.

**Langbeinite.** *S. Zuckschwerdt*, Zs. ang. Ch., 356, 1891. *O. Luedecke*, Zs. Kr., **29**, 255, 1897.

Isometric-tetartohedral. Observed forms : *a* (100), *o* (111), $o_1$ ($1\bar{1}1$), *d* (110), *y* (920), *f* (310), *e* (210), $p_1$ ($2\bar{2}1$), *n* (211). Crystals highly modified.

Fracture conchoidal. H. = 3–4. G. = 2·81–2·86. Luster greasy to vitreous. Colorless when fresh, but speedily taking up water when exposed to the air. Tasteless. Index $n_y$ = 1·5329. Shows no circular polarization.

Composition, $K_2Mg_2(SO_4)_3$ or $K_2SO_4.2MgSO_4$ = Potassium sulphate 42·1, magnesium sulphate 57·9 = 100. Analyses : 1, 2, Zuckschwerdt, Zs. ang. Ch., 356, 1891. 3, Edw. Wagner, quoted by Luedecke :

| | $K_2SO_4$ | $Mg_2SO_4$ | $CaSO_4$ | $MgCl_2$ | MgO | NaCl | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 1. *Colorless* | 41·30 | 58·20 | — | 0·22 | 0·08 | — | 0·20 = 100 |
| 2. *Grayish-white* | 38·99 | 58·55 | 0·57 | 0·55 | 0·13 | 0·43 | 0·78 = 100 |
| 3. *Colorless.* G. = 2·81 | 41·0 | 58·1 | — | — | — | — | 1·0 |

Occurs in beds of rock salt (taking the place of polyhalite) at Wilhelmshall near Anderbeck, and at Thiederhall; also at Westeregeln and Neu-Strassfurt as a secondary mineral; at Solvayhall near Bernburg with carnallite. Named after A. Langbein of Dessau.

LAUMONTITE, p. 587.—**Anal.**, from the Plauenschen Grund, Dresden, Zschau, Abh. Ges. Isis, p. 90, 1893 Caucasus (also of stilbite), Zjemjatschensky, Zs. Kr., **25**, 574. 1895. Grand Marais, Minn., Berkey, 23 Ann. Rept. Minn. G. Surv., p. 196.

**Laurionite**, p. 171.—Twin crystals with rectangular axes from Laurion, noted by Lacroix, C. R., **123**, 955, 1896. See also (new forms) G. F. Herbert Smith, Min. Mag., **12**, 102, 1899.

On the formation of artificial crystals, also of (PbBrOH), A. de Schulten, Bull. Soc. Min., **20**, 186, 194, 1897.

See also *Paralaurionite.*

**Lautarite**, p. 1040.—Crystals examined by Osann showed the forms : *b* (010), *c* (001), *m* (110), *l* (120), *r* (101), *n* ($\bar{1}01$), *q* (011); habit prismatic. Angles : $mm''' = {}^{*}62° 33'$, $qq' = {}^{*}63° 36'$, $mr = {}^{*}46° 31'$, whence $\grave{a} : \bar{b} : \acute{c} = 0·6331 : 1 : 0·6462$, $\beta = 73° 38'$. Zs. Kr., **23**, 586, 1894.

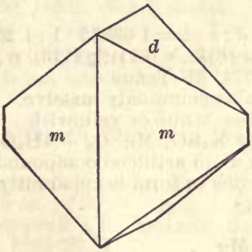
Crystals artificially produced, A. de Schulten, Bull. Soc. Min., **21**, 144, 1898.

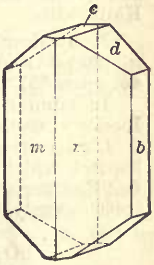
**Lautite**, p. 148.—Analysis of the pure mineral gave Frenzel : S 17·88, As 45·66, Cu 36·10 = 99·64. This leads to the formula CuAsS. Min. petr. Mitth., **14**, 125, 1894.

**Låvenite**, pp. 375, 1040.—Reported as occurring in nephelite-syenite of Paisano Pass, Davis Mts., Texas, Osann, 4th Ann. Rep. G. Surv. Texas, 128, 1892.

**Lawsonite.** *F. Leslie Ransome*, Bull. Univ. California, **1**, 301, 1895. *Ransome* and *Palache*, Zs. Kr., **25**, 531, 1895.

Orthorhombic. Axes $\breve{a} : \bar{b} : \breve{c} = 0·66524 : 1 : 0·7385$. Forms : *b* (010), *c* (001), *m* (110), *d* (011), *δ* (041). Angles : $mm''' = {}^{*}67° 36'$, $dd' = {}^{*}72° 53\tfrac{1}{2}'$. Crystals rather large, prismatic or tabular ‖ *c*, also distorted by extension of an *m*-face. Twins : tw. pl. *m*. Faces *m*, *d* striated ‖ intersections with *c*.





Cleavage : *b* very perfect ; *c* perfect ; *m* indistinct. Fracture uneven. Brittle. H. = 8·25. G. = 3·084, 3·091. Luster vitreous to greasy. Color pale blue to grayish blue. Absorption distinct; $\mathfrak{a} > \mathfrak{b} > \mathfrak{c}$. Pleochroism distinct in thick sections : $\mathfrak{a}$ blue, $\mathfrak{b}$ yellowish or colorless, $\mathfrak{c}$ colorless ; colors often in bands. Optical +. Ax. pl. ‖ *b*. $Bx_a \perp c$. Ax. angles : $2H_{a.y} = 88° 27'$, $2H_{o.y} = 103° 16'$, $\therefore 2V_{a.y} = 84° 6'$. Indices for Na : $\alpha = 1·6650$, $\beta = 1·6690$, $\gamma = 1·6840$, $\gamma - \alpha = 0·019$.

Composition, $H_4CaAl_2Si_2O_{10}$ or $Ca[Al(OH)_2]_2[SiO_3]_2$ Groth. Hence, analogous to carpholite (Min., p. 549). Analyses, 1, Ransome ; 2, Palache :

| | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $Na_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 1. | 38·10 | 28·88 | 0·85 | 18·26 | 0·23 | 0·65 | 11·42 | = 98·39 |
| 2. | 37·32 | 35·14 | | 17·83 | — | — | 11·21 | = 101·50 |

B.B. becomes clouded and fuses easily to a colorless, blebby glass. Yields water in the closed tube. Resists acids, but easily decomposed with gelatinization after ignition. The specific gravity of the ignited powder was 2·558.

Occurs in a crystalline schist (lawsonite-schist), which is associated with serpentine in the Tiburon peninsula, Marin Co., California. The schist also contains glaucophane abundantly, actinolite, margarite, epidote, garnet ; also rutile, titanite. Further in glaucophane-schist at other points near Berkeley, and probably at Sulphur Creek, Sonoma Co., Cal. Also observed in the metamorphic rocks of the Piedmontese Alps near Elva, Val Maira and at other points (Franchi, Bull. Soc. Min., **20**, 5, 1897, and Att. Accad. Torino, **32**, 260, 1896). In the massive rocks (gabbro-diabase-peridotite types) of the Southern Apennines, on the boundary between the provinces of Basilicata and Calabria (Viola, Zs. Kr., **28**, 553, 1897). In the glaucophane rocks of Corsica ; also in New Caledonia (Lacroix, Bull. Soc. Min., **20**, 309, 1897).

Named after Prof. A. C. Lawson of the University of California.

**Lazulite**, p. 798.—Occurs with quartz near Lake Mistassini, Quebec, Hoffmann, Rep. G. Canada, **5**, 66R, 1889-90.

**Lead**, p. 24.—Occurs with rœblingite, native copper, etc., at Franklin Furnace, N. J., W. M. Foote, Am. J. Sc., **6**, 187, 1898.

On artificial crystals with hexagonal pseudo-symmetry, Miers, Min. Mag., **12**, 113, 1899 ; A. Dick, *ibid.*, p. 118.

**Leadhillite**, p. 921. Occurs at Granby, Mo., in well-formed prismatic crystals (Figs. 1, 2). Pirsson and Wells, Am. J. Sc., **48**, 219, 1894. Wells obtained on pure material: $SO_3$ 7·33, $CO_2$ 8·14, PbO 82·44, $H_2O$ 1·68 = 99·59, confirming the formula given by Groth (Dana Min., p. 921), which is equivalent to $PbSO_4.2PbCO_3.Pb(OH)_2$. Pseudomorphs after calcite and galena also observed, W. M. Foote, *ibid.*, **50**, 99, 1895.

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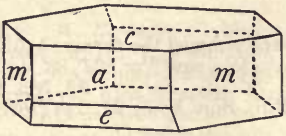

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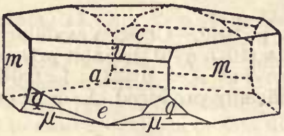


Occurs in ancient lead slags from the Mendip Hills, L. J. Spencer, Rep. Brit. Assoc., 1898.

**Lembergite.** *Lagorio* [Trav. Soc. Nat. Varsovie, **6**, xi, 7–9, 1895], Zs. Kr., **28**, 526, 1897. This is the artificial mineral, $5Na_2Al_2Si_2O_8 + 4H_2O$, called by Lemberg nephelin-hydrat (see Zs. G. Ges., **39**, 562, 1887).

**Leonite.** Kalium-Astrachanite, *J. K. van der Heide*, Ber. Ch. Ges., **26**, 414, 1893; *Naupert* and *Wense*, *ibid.*, p. 873. Leonite, *C. A. Tenne*, Zs. G. Ges., **48**, 632, 1896. Kaliastrakanite. Kaliblödite.

Monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 1·03855 : 1 : 1·23365$, $\beta = {}^*84° 50'$. Forms: *b* (010), *c* (001), *μ* (120); *d* (102), *δ* ($\bar{1}02$); *o* (013), *n* (011); *q* (113), *p* (111), *π* ($\bar{1}11$). Angles: $\mu\mu' = 51° 36'$, $nn' = 101° 43'$, $cp = {}^*57° 1'$, $pp' = {}^*74° 21'$ Tenne.

In tabular crystals, also commonly massive. Cleavage not distinct. Fracture conchoidal. Luster vitreous. Colorless, white or yellowish. Ax. pl. ⊥ *b*. $Bx_0$ nearly ⊥ *c* (001).

Composition, probably $K_2SO_4.MgSO_4 + 4H_2O$, the potash salt corresponding to blödite (astrakanite), which is known as an artificial compound (van der Heide). Groth calls attention to the fact that the correspondence in form is apparently not what would be expected, Zs. Kr., **30**, 655, 1899. Analysis, Tenne:

| $SO_3$ | Mg | K | Cl | $H_2O$ | insol. |
|---|---|---|---|---|---|
| 43·73 | 6·54 | 25·48 | 4·84 | 18·99 | 0·42 = 100 |

Occurs usually massive, also in crystals with kainite, in the salt deposits of Westeregeln, and Leopoldshall, Germany.

**Lepidolite**, p. 624.—Tanagama Yamo, Japan, analysis of grayish-white or slightly pinkish plates, Genth, Am. J. Sc., **44**, 387, 1892.

Composition of the lithia micas discussed by F. W. Clarke, J. Am. Chem. Soc., **15**, No. 5, 1893; Bull. U. S. G. Surv., **113**, 1893.

**Lepidomelane**, p. 634.—Occurs with arsenopyrite at the Bob Neil mine, Marmora, Hastings Co., Ontario (analysis by Wait), Hoffmann, Rep. G. Canada, **6**, 14R, 1892–93.

**Leucite**, pp. 341, 1041.—Discussion of optical characters, relation to analcite, etc., Klein, Jb. Min., Beil.-Bd., **11**, 475, 1898 (Ber. Ak. Berlin, 290, 1897).

Occurs (chiefly altered to analcite) in a leucite-tephrite associated with elæolite-syenite at Hamburg, Sussex Co., N. J., Kemp, Am. J. Sc., **45**, 298, 1893; **47**, 339, 1894. In bowlders in the auriferous gravels of the Horsefly river, Cariboo district, Br. Columbia, Hoffmann, Rep. G. Canada, **7**, 14R, 1894. In the Highwood and Bearpaw Mts., Montana, Weed and Pirsson, Am. J. Sc., **2**, 143, 1896. In igneous rocks, Province of Rome, Viola, Jb. Min., **1**, 121, 1899. In the lavas of the lower Celebes (Wichmann).

**Lewisite.** *E. Hussak* and *G. T. Prior*, Min. Mag., **11**, 80, 1895.

Isometric. In minute octahedrons. Cleavage octahedral, nearly perfect. H. = 5·5. G. = 4·950. Luster vitreous to resinous. Color honey-yellow to colophony-brown. Streak light yellowish brown. Translucent.

Composition, $5CaO.2TiO_2.3Sb_2O_5$; closely related to mauzeliite. Analyses, Prior:

| $Sb_2O_5$ | $TiO_2$ | CaO | FeO | MnO | $Na_2O$ |
|---|---|---|---|---|---|
| 67·52 | 11·35 | 15·93 | 4·55 | 0·38 | 0·99 = 100·72 |
| 65·52 | 11·70 | 15·47 | 6·79 | — | 1·06 = 100·54 |

Fuses rather readily on the edges in the Bunsen flame, coloring it greenish blue. In salt of phosphorus yields a bead, yellow when hot and violet when cold. Insoluble in acids.

From the cinnabar mine of Tripuhy, near Ouro Preto, Minas Geraes, Brazil; occurs in the gravel, consisting largely, after washing, of cinnabar and hematite; also xenotime, monazite, zircon, cyanite, rutile, etc. Named after Prof. W. J. Lewis of Cambridge, England.

A new titano-antimonate of iron in slender six-sided ($m$, $a$) crystals of a resinous black color, G. = 4·529, was also noted, but owing to lack of material it has not yet been fully investigated.

**Libollite.** *J. P. Gomes*, Comm. Dir. Trabalhos Geol. Portugal, **3**, 244, 290, 1896–98. A kind of asphaltum occurring near Libollo, in western Africa, has been called *libollite* by Gomes. It resembles albertite, having a pitch-black color, brilliant luster, and more or less conchoidal fracture. H. = 2·5; G. = 1·1. An analysis by A. Machado and A. Noronha gave: C 80·30, H 8·41, O 9·45, N 1·84 = 100. The ash (6·92 p. c.) has been deducted. Compare albertite and grahamite, Min., p. 1020.

**LINARITE**, p. 927.—From San Giovanni mine, Sardinia, crystals described by Brugnatelli (new form (718)), also optical characters. Optically $-$. Ax. pl. and $Bx_o \perp b$. $Bx_a \wedge \dot{c} = -24°$ (hence $Bx_a$ nearly coincident with the normal to $s$ $(\bar{1}01)$). $2H_a = 106° 21'$ red, $= 106° 42'$ Na, $= 110° 12'$ blue. $2V_a = 79° 59'$ Na. Indices $\alpha = 1·8092$, $\beta = 1·8380$, $\gamma = 1·8593$. Riv. Min. Ital., **17**, 56, 1897, and Zs. Kr., **28**, 307, 1897.

Occurs in New Caledonia, Lacroix, C. R., **118**, 553, 1894.

**Lindesite.** *L. J. Igelström*, Zs. Kr., **23**, 590, 1894.—See *Urbanite.*

**LINTONITE**, p. 607.—Shown by N. H. Winchell to differ in optical characters from thomsonite, with which it agrees chemically and to which it has been referred. Amer. Geol., **22**, 348, 1898.

**LIROCONITE**, p. 853.—Cornwall, analysis by Church, Min. Mag., **11**, 3, 1895.

**LÖLLINGITE**, p. 96.—Occurs at Drum's Farm, Alexander Co., N. C., massive, G. = 7·031, analysis, Genth: As 27·93, S 0·77, Fe 70·83, Cu *tr.* = 99·53. Am. J. Sc., **44**, 384, 1892.

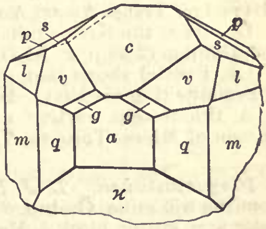
Also occurs in Galway township, Peterborough Co., Ontario, analysis (2·88 p. c. Co) by Johnston, Hoffmann, Rep. G. Canada, **6**, 19R, 1892–93.

**LONGBANITE.**—See *Långbanite.*

**Lorandite.** *J. A. Krenner* [Mat. es Értesitö, **12**, 473, 1894; **13**, 258, 1895], Zs. Kr., **27**, 98, 1897. *Goldschmidt*, Zs. Kr., **30**, 272, 1898.

Monoclinic. Axes $\dot{a} : \bar{b} : \dot{c} = 1·3291 : 1 : 1·0780$. $\beta = 52° 27'$ Goldschmidt. Forms: $a$ (100, $t$), $b$ (010), $c$ (001, $a$); $q$ (210), $\epsilon$ (320), $m$ (110, $x$), $e$ (120), $\mu$ (130), $u$ (140)?; $\beta$ $(\bar{2}05)$, $d$ $(\bar{1}01)$, $\kappa$ $(\bar{2}01, c)$; $\alpha$ (034), $h$ (045), $w$ (021); $v$ (112), $s$ $(\bar{1}12)$, $z$ $(\bar{1}11)$; $g$ (425), $f$ (212), $\gamma$ (748), $j$ (536); $i$ (324)?, $l$ (122), $\delta$ (1·13·8)?; $y$ $(\bar{3}12)$, $n$ $(\bar{5}25)$, $p$ $(\bar{2}12)$, $r$ $(\bar{2}11)$, $\zeta$ $(\bar{3}24)$, $k$ $(\bar{3}22)$, $\eta$ $(\bar{2}·5·10)$? Angles $ac = 52° 57'$, $mm''' = 93° 0'$, $qq''' = 55° 24'$, $c\kappa = 89° 29'$.

Crystals highly modified, often tabular, or prismatic ($m$); faces in prismatic zone vertically striated, especially $m$ ($x$). A similarity to miargyrite is noted (cf. Gdt.). Cleavage: $a$ perfect; $c$ and $d$ (101) good. Flexible, separating easily into cleavage lamellæ. H. = 2–2·5. G. = 5·529 Loczka. Luster metallic-adamantine. Color cochineal- to carmine-red, often dark lead-gray on the surface and frequently covered with an ocher-yellow powder. Streak dark cherry-red. Translucent to transparent. Refractive index high.



Lorandite, Gdt.

Composition, a sulpharsenide of thallium, $TlAsS_2$ or $Tl_2S.As_2S_3$ = Sulphur 18·7, arsenic 21·9, thallium 59·4 = 100. Analysis by J. Loczka:

S 19·02 As [21·47] Tl 59·51 = 100.

B.B. on charcoal fuses easily, colors the flame bright green, yields arsenical fumes and volatilizes completely. In the closed tube fuses and yields a black sublimate of thallium sulphide, also an orange one of arsenic sulphide, further some arsenic oxide. Soluble in nitric acid with separation of sulphur.

From Allchar in Macedonia, where it occurs in crystals implanted upon realgar.

The position of Goldschmidt is here provisionally accepted: 100, 001, 110, 201 of Gdt. correspond to $\bar{1}01$, 100, $\bar{1}21$, 001 of Krenner.

**Lossenite.** *L Milch*, Zs. Kr., **24**, 100, 1894.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·843 : 1 : 0·945 approx. In acute pyramids, resembling scorodite in angle, with $pp' = 79°$ and $pp''' = 64°$. Color brownish red, often altered on the surface. Optically +. Ax. pl. ∥ *a*. Bx. ⊥ *c*.

Composition probably $2PbSO_4.3(FeOH)_3As_2O_8 + 12H_2O$. Analysis:

| $As_2O_5$ | $SO_3$ | PbO | $Fe_2O_3$ | $H_2O$ | $H_2O$ |
|---|---|---|---|---|---|
| 33·44 | 3·74 | 10·63 | 34·53 | 3·74 | 11·81[a], $SiO_2$ 1·13, $CaCO_3$ 1·46 = 100·48 |

[a] Water of crystallization.

From Laurion, Greece, where it was found in a drusy ferruginous quartzose rock.

LOVENITE.—See *Låvenite.*

**Lutécine, Lutécite.** *Michel-Lévy* and *Munier-Chalmas*, Bull. Soc. Min., **15**, 159, 1892.—See *Quartzine.*

**Mackintoshite.** *W. E. Hidden*, Am. J. Sc., **46**, 98, 1893.

Tetragonal, in square prisms with pyramid; commonly massive, nodular. Fracture small subconchoidal. H. = 5·5. G. = 5·438. Luster dull. Color black. Opaque. In composition allied to thorogummite (Min., p. 893); perhaps $UO_2.3ThO_2.3SiO_2.3H_2O$. Analyses, W. H. Hillebrand:

| $SiO_2$ | $UO_2$ | $ZrO_2$? | $ThO_2,Ce_2O_3$ | $La_2O_3,Y_2O_3$ | PbO | FeO | CaO | MgO | $K_2O$ | $(Na,Li)_2O$ | $P_2O_5$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13·90 | 22·40 | 0·88 | 45·30 | 1·86 | 3·74 | 1·15 | 0·59 | 0·10 | 0·42 | 0·68 | 0·67 | 4·81[a] = 96·50 |
| 13·92 | 21·86 | *undet.* | | | 3·92 | — | 0·44 | 0·13 | 0·70 | | 0·46 | 0·35[b] |

[a] Above 100° 4·31, below 0·50. [b] Below 100°.

From the gadolinite locality of Llano Co., Texas. The alteration of mackintoshite seems to have yielded thorogummite. Named after James B. Mackintosh (died 1891), chemist of New York City.

MAGNESIOFERRITE, p. 226.—Roc de Cuzeau, Mont Dore, France, crystals (largely made up of plates of hematite) similar to those of Mte. Somma, Lacroix, Bull. Soc. Min., **15**, 11, 1892.

MAGNESITE, p. 274.—Crystals from Val Lanterna, Brugnatelli, Zs. Kr., **31**, 55, 1899.

MAGNETITE, pp. 224, 1041.—Occurs in cubic crystals, in part penetration-twins, at the Moss mine, Nordmark, Sweden. Hj. Sjögren, Bull. G. Inst. Upsala, **2**, 63, 1894.

Crystals described from Acquacetosa, near Rome, new forms (520), (331), Zambonini, Riv. Min. Ital., **21**, 21, 1898.

Magnetic properties of crystals investigated, Weiss, Bull. Soc. Min., **20**, 137, 1897.

Present in various minerals (hematite, etc.), and thus giving them magnetic properties, Liversidge, Trans. Austr. Assoc. Adv. Sci., 1892.

Occurs at the Kodúr mines, Vizagapatam, Madras, India, containing manganese (2·08 $Mn_3O_4$) and alumina (2·54 p. c $Al_2O_3$), G. = 5·045. Holland, Rec. G. Surv. India, **26**, 164, 1893.

Ch. Friedel shows that slow heating in the air at a rather high temperature changes crystals to hematite (i.e. martite). Bull. Soc. Min., **17**, 150, 1894.

A titaniferous variety containing nickel occurs in Eastern Ontario, W. G. Miller, Rep't Bureau of Mines, Toronto, **7**, Part III, p. 230, 1898.

**Magnetostibian.** *L. J. Igelström*, Zs. Kr., **23**, 212, 1894. A partially investigated mineral from the Sjö mine, Örebro, Sweden. Occurs in grains and granular aggregates. Luster metallic. Color and streak black. Magnetic. An analysis (after deducting 68·6 p. c. impurities, $CaCO_3$, $MgCO_3$ and tephroite) gave:

$Sb_2O_5$ 9·83  $As_2O_5$ 1·54  $Fe_2O_3$ 12·36  FeO 17·16  MnO 59·11 = 100

MAGNOCHROMITE, p. 228.—See *Chromite.*

MAGNOFRANKLINITE.—A local name (credited to Koenig) for a highly magnetic franklinite containing little zinc. From Sterling Hill, N. J.; see Rep. G. Surv. N. J., **2**, (1) 14, 1892; also Chester, Dict. Names Minerals, 164, 1896.

MALACHITE, p. 294.—Artificial formation by a new process, A. de Schulten, C. R., June 8, 1896.

**Maltesite.** *J. J. Sederholm*, G. För. Förh., **18**, 390, 1896.—See *Andalusite.*

**Manganandalusite.** *H. Bäckström*, G. För. Förh., **18**, 386, 1896.—See *Andalusite.*

**Manganberzeliite.** *L. J. Igelström*, Zs. Kr., **23**, 592, 1894.—See *Berzeliite.*

MANGANITE, p. 248.—Crystals from the Harz described, Luedecke, Min. d. Harzes, 237, 1896. Analyses, Ilfeld, Gorgeu, Bull. Soc. Chim., **9**, 650, 1893.

MANGANOSITE, p. 207.—Discussion of origin at Långban and Nordmark, Hj. Söjgren, G. För. Förh., **20**, 25, 1898.

MARCASITE, pp. 94, 1041.—Crystals from Capo Schino, Sicily, described, G. La Valle, Riv. Min. Ital., **13**, 3, 1893.

Occurs at Pontpéan, Ille-et-Vilaine, forming with galena pseudomorphs after pyrrhotite with regular orientation of its minute crystals, Lacroix, Bull. Soc. Min., **20**, 223, 1897, and C. R., **125**, 265, 1897.

Occurs in spear-head forms in the Raritan clay at Sayreville, near New Brunswick, N. J., Hamilton, Proc. Acad. Nat. Sc. Philad., 485, 1898.

See also *Pyrite.*

MARIPOSITE, p. 1041.—Analyses by Hillebrand of green and white varieties are quoted by Turner. The former (G. = 2·817) contains chromium, the latter has none (G. = 2·787); a similarity to pinite is noted Am. J. Sc., **49**, 377, 1895,

**Marshite.** *Liversidge, C. W. Marsh,* Proc. Roy. Soc. N. S. W., **26**, 326, 1892. *Miers*, Zs. Kr., **24**, 207, 1894.

Isometric-tetrahedral. Fracture subconchoidal. Brittle. Luster adamantine. Color oil-brown. Streak orange-yellow. Translucent. Consists essentially of cuprous iodide, $Cu_2I_2$. Occurs in cerussite or anglesite at the Broken Hill mines, New South Wales.

MARTITE, p 216.—See *Magnetite.*

**Masrite.** *H. Droop Richmond* and *Hussein Off*, J. Ch. Soc., **61**, 491, 1892. A fibrous alum from Egypt, containing a small amount of cobalt and the supposed new element *masrium* (called after the Arab name of Egypt). Composition, $RO.Al_2O_3.4SO_3.20H_2O$. Analysis:

| $SO_3$ | $Al_2O_3$ | $Fe_2O_3$ | MsO | MnO | CoO | FeO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 36·78 | 10·62 | 1·63 | 0·20 | 2·56 | 1·02 | 4·23 | [40·35] | insol. 2·61 = 100 |

MASSICOT, p. 209.—Occurs in the lead slags of Laurion, Greece.

**Mauzeliite.** *Hj. Sjögren*, G. För. Förh., **17**, 313, 1895.

Isometric. In octahedrons, *o* (111), with *a* (100) and *m* (311). **H.** = 6–6·5. **G.** = 5·11. Color dark brown, lighter in fragments, and of the powder light yellow or yellowish white. Translucent.

In composition, a titano-antimonate of lead and calcium chiefly. Assuming that the water is present as (CaOH), the ratio calculated is $\overset{\text{II}}{\text{R}}\text{O}:TiO_2:Sb_2O_5:F = 4:1:2:1$. It is related to lewisite, p. 42 Analysis, R. Mauzelius:

| $Sb_2O_5$ | $TiO_2$ | PbO | FeO | MnO | CaO | MgO | $K_2O$ | $Na_2O$ | F | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|
| $\frac{2}{2}$ 59·25 | 7·93 | 6·79 | 0·79 | 1·27 | 17·97 | 0·11 | 0·22 | 2·70 | [3·63] | 0·87=101·53 less (O=F) 1·53=100 |

Occurs with svabite and calcite at Jakobsberg, Wermland, Sweden; these minerals form narrow veins in a mixture of hausmannite, limestone, a yellow garnet, schefferite and manganophyllite.

MELANOPHLOGITE, pp. 194, 1041.—Discussion of conditions of formation, G. Friedel, Bull. Soc. Min., **15**, 49, 1892; Bombicci, *ibid.*, p. 144. Investigated by Bombicci, Accad. Sc. Ist. Bologna, March 22, 1891.—Giona, G. Spezia, Riv. Min. Ital., **11**, 37, 1892.

**Melanostibian.** *L. J. Igelström*, G För. Förh., **14**, 583, 1892; Zs. Kr., **21**, 246, 1893. Massive, foliated; also in microscopic crystals H. = 4. Luster metallic. Color black. Streak cherry-red. Composition, perhaps $6(Mn,Fe)O.\ Sb_2O_3$. Analysis (assuming the state of oxidation as given):

| $Sb_2O_3$ | FeO | MnO | CaO | MgO | $H_2O$ |
|---|---|---|---|---|---|
| 37·50 | 27·30 | 29·62 | 1·97 | 1·03 | 1·06 = 98·48 |

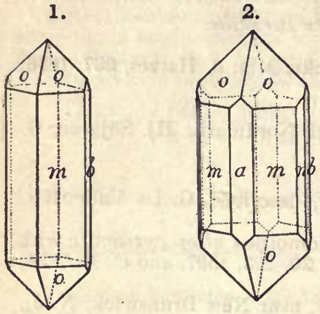
From the Sjö mine, Örebro, Sweden, where it occurs in veins in dolomite.

Melanotekite, p. 545.—Occurs in prismatic crystals with *a* (100), *m* (110), *d* (110), *o* (111), *s* (221) at Pajsberg, Sweden, G. Nordenskiöld, G. För. Förh., **16**, 158, 1894 ; in habit and angles resembling kentrolite.

Also found at Hillsboro, New Mexico, associated with cerussite and a brown jasper-like material, C. H. Warren. Crystals (Figs. 1, 2) with forms *a* (100), *b* (010), *m* (110), *n* (130), *k* (150), *o* (111). Habit like kentrolite, angles $oo'' =$ *119° 13′, $oo''' =$ *55° 0′, $mm''' =$ 64° 44′ (calc.). Axes $\breve{a} : \bar{b} : \dot{c} =$ 0·6338 : 1 : 0·9127 (Nordenskiöld obtained 0·6216 : 1 : 0·9041). Analysis gave :

| G | $SiO_2$ | PbO | $Fe_2O_3$ | X | $H_2O$ |
|---|---|---|---|---|---|
| $\frac{2}{2}$ 5·854 | 15·49 | 55·56 | 27·51 | 0·82 | 0·68 = 100·06 |

whence the formula $Fe_4Pb_3Si_3O_{18}$ or $(Fe_4O_3)Pb_3(SiO_4)_3$. It is shown that the analogous formula $(Mn_4O_3)Pb_3(SiO_4)_3$ probably belongs to kentrolite (p. 39, Min. p. 544). Am. J. Sc., **6**, 116, 1898.



Melanotekite, New Mexico.

Melanterite, p. 941.—Laurion, Greece, analysis of zinc-bearing variety, L. Michel : $SO_3$ 28·85, FeO 17·74, ZnO 8·92, $H_2O$ 44·21 = 99·72. Bull. Soc. Min., **17**, 204, 1894.

Discussion of the chemical constitution and genesis of various iron sulphates, Scharizer, Zs. Kr., **30**, 209, 1898.

Melilite, p. 474.—Crystals from Vesuvius described with new form (201), Kaiser, Zs. Kr., **31**, 24, 1899. Discussion of microscopic structure, Gentil, Bull. Soc. Min., **17**, 108, 1894.

Composition discussed, Bodländer, Jb. Min., **1**, 15, 1893 ; cf. Vogt, *ibid.*, **2**, 73, 1892.

Occurs at Ste. Anne de Belleville, near Montreal, Canada, in alnoite, F. D. Adams, Am. J. Sc., **43**, 269, 1892 ; also (optically *positiv* ) in alnoite of Manheim, N. Y., C. H. Smith, *ibid.*, **46**, 104, 1893. Cf. Berwerth, Ann. Mus. Wien, **10**, 75, 1895.

Formed by the burning of Portland cement, Bodländer, Jb. Min., **1**, 53, 1892.

A soda-alumina silicate, tetragonal, and resembling melilite in habit, which occurs in the new rock-type farrisite, from Norway, has been called *natronmelilith* by Brögger (Die Eruptivgesteine d. Kristianiagebietes, 3, 69, 1898). It is largely altered to natrolite. A later examination (*ibid.*, p. 366) has led to the conclusion that it should perhaps be referred to the Scapolite Group.

A new type of rock containing melilite, a chrysolite-melilite-leucite rock, occurs as a volcanic cone at San Venanzo, Umbria, Italy, and is called *venanzite*, by Sabatini Boll. Com. Geol., Sept., 1898. The same rock was later described by Rosenbusch and by him named *euctolite* (Ber. Ak. Berlin, 110, 1899).

**Mesabite.**—See *Göthite.*

Metabrushite, p. 828.—Brushite, or metabrushite, occurs with minervite (wh. see) in the limestone caves of the Nummulite limestone of Southern France ; thus in the Grotto of Minerva on the Cessc, Valley of the Aude, Gautier, C. R., **116**, 1171, 1893.—See also *Brushite.*

Metacinnabarite, pp. 62, 1041.—Idria, discussion of occurrence, paragenesis, etc. ; crystals are dodecahedral in habit with also *a* (100) and *o* (111), Schrauf, Jahrb. G. Reichs., **41**, 349, 1891.

Occurs at San Joaquin, Orange Co., California, in iron-black particles in barite ; G. = 7·706 ; analysis: S 13·69, Hg 85·89, Cl 0·32 = 99·90, Genth, Am. J. Sc., **44**, 383, 1892.

Also occurs amorphous filling cavities in quartz on the west side of Read Is., near Vancouver Is., Br. Columbia, Hoffmann, Rep. G. Canada, 5, 66R, 1889–90.

**Metadesmine.** *F. Rinne*, Jb. Min., **1**, 57, 1897.—See *Stilbite.*

**Metanocerine.** *Sandberger*, Jb. Min., **1**, 221, 1892. A partially investigated mineral occurring with the babingtonite of Arendal in white crystals resembling bromlite ; H. = 4·5. From the qualitative analysis a possible relation to nocerite (Min., p. 174) is inferred, and the name provisionally given refers to this.

**Metascolecite.** *F. Rinne*, Jb. Min., **2**, 51, 60, 1894.—See *Scolecite.*

Mica Group, p. 611.—Discussion of the crystalline form based upon the percussion-figure, the etching-figures, etc. It is concluded that probably phlogopite, biotite and perhaps the lithia micas should be regarded as triclinic ; muscovite appears to be monoclinic. T. L. Walker, Am. J. Sc., **7**, 199, 1899.—See also G. Friedel, Bull. Soc. Min., **19**, 18, 1896.

General discussion of chemical composition, F. W. Clarke, Bull. U. S. G. Surv., **113** and **125**, 1893; Clarke and Schneider, Am. J. Sc., **43**, 378, 1892.

Analyses are quoted by Stelzner, Zs. prakt. Geol., **4**, 377, 1896.

MICROLINE, pp. 322, 1042.—From the Spessart, analysis, E. Philippi, Ber. Senck. Nat. Ges., 1896, p. 125. Analyses, Jones Falls, Maryland, Hillebrand, Bull. U. S. G. Surv., **113**, 110, 1893.—See also *Anorthoclase*.

MICROLITE, pp. 728, 1042.—Igaliko, Greenland, approximate analysis of impure material, G. Nordenskiöld, G. För. Förh., **16**, 336, 1894.

Occurs at Rumford, Me., in honey-yellow crystals, G. = 5·17 (Penfield), Foote, Am. J. Sc., **1**, 461, 1896.

**Miersite.** *L. J. Spencer*, Nature, **57**, 574, 1898.

Isometric-tetrahedral. In small cubes, with *o* (111) and $o_1$ (1$\bar{1}$1), the latter differing in size but not in luster. Twins: tw. pl. *o*. Cleavage: dodecahedral. Brittle. Luster adamantine. Color pale to bright yellow. Streak the same or deeper. Optically isotropic.

Composition essentially silver iodide, probably $Ag_2I_2$, analogous to marshite, $Cu_2I_2$ (this Appendix, p. 45), and nantokite, $Cu_2Cl_2$ (Min., p. 154).

From the Broken Hill mines, New South Wales, associated with chalcocite, garnet, quartz; also with malachite, anglesite. Named after Prof. H. A. Miers of Oxford, England.

MILARITE, p. 312.—Analysis, Treadwell, $SiO_2$ 72·79, $Al_2O_3$ 10·12, CaO 11·32; MgO *tr.*, $K_2O$ 4·32, $Na_2O$ 0·21, $H_2O$ 1·19 = 100. Jb. Min., **1**, 167, 1892.

MILLERITE, p. 70.—Occurrence (also of other nickel minerals) in the Rhine region, Laspeyres, Vh. Nat. Ver. Bonn, pp. 143, 375, 1893.

MILOSIN.—See *Avalite*.

**Minervite.** A. Gautier, Ann. Mines, **5**, 23, 1894; C. R., **116**, 928, 1022, 1171, 1271, 1893. An aluminium phosphate, $Al_2O_3.P_2O_5.7H_2O$, occurring with phosphate of lime as a white plastic mass mixed with clay, etc., in the "Grotte de Minerve" on the shores of the Cesse, Valley of the Aude, France. Analyses of impure material are given. The above formula applies to air-dried material.

**Mitchellite.** *J. H. Pratt*, Am. J. Sc., **7**, 286, 1899.—See *Chron*

MIZZONITE, p. 471.—Franco obtained *ar* = 67° 56′ and 67° 58′; also $\omega_y$ = 1·563, $\epsilon_y$ = 1·545, Giorn. Min., **5**, 193, 1894.—See also *Wernerite*.

MOLYBDENITE, pp. 41, 1042.—Crystals from Frankford, Penn., examined by A. P. Brown, are hexagonal in habit, prismatic or barrel-shaped, resembling some mica. Forms as interpreted: *c* (0001), *m* (10$\bar{1}$0) *o* (10$\bar{1}$1), *p* (20$\bar{2}$1), *q* (30$\bar{3}$1). Angles: *co* = *65° 35′, *cp* = 77° 13′, *cq* = 81° 24′; axis $\dot{c}$ = 1·9077. Proc. Acad. Nat. Sc. Philad., 210, 1896

Occurs in large crystals (3·5 × 5·5 in. and 2 or 3 in. thick) with native bismuth, etc., at Kingsgate, Glen Innes, N. S. W., Liversidge, Rec. Austr. Mus., **2**, 1892.

MONAZITE, p. 749.—Cryst.—Nil-Saint-Vincent, Belgium, Franck, Bull. Acad. Belg., **21**, 40, 1891. Brazil, Hussak, Min. petr. Mitth., **12**, 470, 1892. South Lyme, Conn., occurs in distinct crystals, Matthew, School Mines Q., **16**, 232, 1895.

Occurrence on New York island, Niven, Am J. Sc., **50**, 75, 1895. Distribution in European rocks, Derby, Min. Mag., **11**, 304, 1897. Distribution in U. S., and elsewhere, U. S. G. Surv., 16 Ann. Rept., Pt. IV, p. 667. Occurs rather abundantly in the gold sands of southern Idaho, Lindgren, Am. J. Sc., **4**. 63, 1897.

Yields helium and other gases, Ramsay, Collie and Travers, J. Ch. Soc., **65**, 684, 1895; also Ramsay and Travers, Proc. Roy. Soc., **60**, 442, 1897. Also Erdmann, Ber. Ch. Ges., **29**, 1710, 1896.

MORDENITE, p. 573.—Relation in composition to ptilolite, Clarke, Am. J. Sc., **44**, 101, 1892.

MORENOSITE, p. 940.—Zermatt, analysis of magnesium variety, Pisani: $SO_3$ 28·7, NiO 18·5, MgO 6·5, $H_2O$ 46·5 = 100·2. Bull. Soc. Min., **15**, 48, 1892.

MORONITE.—A mixture of calcium carbonate with the remains of foraminifera, cf. S. Calderon [Anal. Soc. Espagñ. Hist. Nat., **23**, 21, 1894], Zs. Kr., **26**, 331, 1896.

**Mossite.** *W. C. Brögger*, Vidensk. Skrift. I. Math.-nat. Klasse, No. 7, Christiania, 1897.

Tetragonal. Axis $\dot{c} = 0{\cdot}6438$; $001 \wedge 101 = 32° 46\frac{1}{3}'$. Forms: *a* (100), *c* (001), *m* (110), *φ* (6·9 10), *y* (305) *e* (101), *v* (301), *s* (111). $cp = 42° 19'$, $mp = {}^*47° 41'$. Crystals small; commonly twins with tw. pl. *e*, these often prismatic, elongated parallel a pyramidal edge analogous to twins of rutile (cf. Fig., Min., p. 1047, and Fig. 1 of tapiolite, this Append.), hence simulating orthorhombic forms; also drillings, fourlings. Cleavage none. G. = 6·45. Luster metallic, brilliant. Color black.

Composition, $Fe(Nb,Ta)_2O_6$, like tapiolite, with probably Nb : Ta = 1 : 1. Analysis, G. Theseu:

| $Nb_2O_5,Ta_2O_5$ | $SnO_2$ | FeO |
|---|---|---|
| 82·92 | 0·18 | 16·62 = 99·72 |

Occurs very sparingly, with yttrotantalite and columbite on feldspar, in a pegmatite vein at Berg near Moss, Norway.

**Munkforssite.** *L. J. Igelström*, Zs. Kr., **27**, 601, 1896.

Massive, foliated or small granular; the grains apparently monoclinic in crystallization. Cleavage in one direction. H. = 5. Color white or pale reddish.

Near svanbergite in composition. Analysis after deducting 10·74 p. c. insol.:

| $SO_3$ | $P_2O_5$ | $Al_2O_3$ | CaO | ign.($SO_3$ ?) |
|---|---|---|---|---|
| 15·12 | 16·01 | 29·23 | 36·64 | 3·00 = 100 |

B. B. infusible and does not yield a blue color with cobalt solution; only partially decomposed by acids.

Occurs in the cyanite of a damouritic quartzite at Horrsjöberg, Westanå, and Dicksberg in the Ransät parish, Wermland, Sweden. Named from the Munkforss iron-works.

**Munkrudite.** *L. J. Igelström*, Zs. Kr., **28**, 311, 1897. Near svanbergite in composition, containing $P_2O_5,SO_3,FeO,CaO$, but not analyzed. Occurs foliated and crystalline; colorless to yellow. From Munkerud, near Dicksberg, Wermland, Sweden.

MUSCOVITE, p. 614.—Percussion-figure shown to deviate from the assumed normal position; thus the angle between the rays opening opposite *b* (010) was found to be 53° to 56° instead of 60°; similarly in other micas, e.g. in phlogopite (Ceylon) this angle was 63½°. T. L. Walker, Am. J. Sc. **2**, 5, 1896.

From Matawatchan, Renfrew Co., Ontario, analysis by Wait (1·26 $Cr_2O_3$), quoted by Hoffmann, Rep. G. Canada, **5**, 21R, 1889–90.

*Fuchsite* (2·73 p. c. $Cr_2O_3$) occurs in Habersham Co., Ga., in emerald-green scales, analysis, Genth, Am. J. Sc., **44**, 388, 1892. On the occurrence of fuchsite in the Swiss Alps, see J. Erb, Nat. Ges. Zürich, **43**, 276, 1898.

Analysis of compact variety, G. Friedel, Bull. Soc. Min., **21**, 135, 1898.

On certain new silicates yielded in synthetic experiments, C. and G. Friedel, Bull. Soc. Min., **22**, 17, 20, 1899.

See *Baddeckite*.

NAGYAGITE, p. 105.—Occurs at the Sylvia mine, Tararu creek, New Zealand, J. Park, Austr. Assoc. Adv. Sci., **3**, 150, 1891.

NANTOKITE, p. 154.—From the Broken Hill mines, New South Wales, Liversidge. Occurs in indistinct crystals in a matrix of cuprite with native copper and cerussite. G. = 4·7. Analysis by Carmichael: Cl 35·92, Cu 64·28 = 100·20. Also Min. Mag., **10**, 326, 1894 (but here Cl = 35·82). [Proc. R. Soc. N. S. W., **28**, 96, June 6, 1894.]

See also *Marshite* and *Miersite*.

**Nasonite.** *S. L. Penfield* and *C. H. Warren*, priv. contr.

Massive, granular, cleavable and probably monoclinic. Luster greasy. Color white.

Composition, $(Ca,Pb)_{10}Cl_2Si_6O_{21}$. Analysis:

| $SiO_2$ | PbO | CaO | MnO | ZnO | FeO | Cl | (OH) |
|---|---|---|---|---|---|---|---|
| 18·47 | 65·84 | 11·20 | 0·90 | 0·84 | 0·10 | 2·80 | 0·26 = 100·41 |

B.B. on charcoal, decrepitates, but fuses easily when powdered, giving a lead flame and coating of PbO. In closed tube decrepitates, giving off a little $H_2O$ and an abundant sublimate of lead chloride.

Occurs at Franklin Furnace, N. J., associated with brown garnet, yellow axinite, glaucochroite (wh. see) and a little franklinite. Named after Mr. F. L. Nason, formerly of the Geological Survey of the State of New Jersey.

**Natrolite**, pp. 600, 1042.—Crystals described, from Puy-de-Dôme, Gonnard, Bull. Soc. Min., **15**, 221, 1892. Also, with analysis, Magnet Cove, Arkansas, W. H. Melville, Bull. U. S. G. Surv., **90**, 38, 1892.

Analysis, from the Plauenschen Grund. Dresden, Zschau, Abh. Ges. Isis, p. 100, 1893.

Weed and Pirsson conclude from the analysis of a portion (G. = about 2·30) of the leucite rock called by them *missourite*, from the Highwood Mts., Montana, that it probably consists of analcite and a new potash zeolite, $(K_2,Ca)Al_2Si_3O_{10}.2H_2O$. This would correspond to a natrolite containing potassium and calcium in place of sodium. Am. J. Sc., **2**, 319, 1896.

**Natronberzeliite.**—See *Berzeliite.*

**Natrongranat.**—See *Garnet.*

**Natronmelilith.**—See *Melilite.*

**Natronmikroklin.**—See *Anorthoclase.*

**Natronrichterite.**—See *Astochite* and *Richterite.*

**Neochrysolite**, p. 455.—Identical with fayalite according to Wichmann, Zs. Kr., **28**, 538, 1897.

**Nephelite**, pp. 423, 1042.—Crystals from Vesuvius, with new form (51$\bar{6}$0), Kaiser, Zs. Kr., **31**, 24, 1899. Relation to davyne also discussed.

Discussion of symmetry of crystallization and twinning, etc., as revealed by etching, etc., Traube, Jb. Min., Beil.-Bd., **9**, 466, 1895.

Occurrence in New Zealand, Ulrich, Trans. Austr. Assoc. Sc., **3**, 127, 1891.

From the nephelite-syenite of Dungannon, Ontario, analysis by Harrington, Am. J. Sc., **48**, 16, 1894.

Artificial formation of a purely potash compound, Duboin, C. R , **115**, 56, 1892.

**Neptunite.** *G. Flink*, G. För. Förh., **15**, 196, 467, 1893; Zs. Kr., **23**, 346, 1894. *G. Nordenskiöld*, G. För. Förh., **16**, 346, 1894.

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c}$ = 1·3164 : 1 : 0·8076; $\beta$ = *64° 22′ = 001 ∧ 100. 100 ∧ 110 = 49° 53′, 001 ∧ 101 = 23° 36½′, 001 ∧ 011 = 36° 3½′. Forms: *a* (100), *b* (010), *c* (001); *m* (110); *e* ($\bar{2}$01), *d* ($\bar{3}$01): *s* (111), *v* (221); *o* ($\bar{1}$11); *u* ($\bar{5}$12). Angles: *mm‴* = *99° 46′, *cs* = *35° 51′, *cm* = 73° 49′, *ss′* = 55° 36′. In prismatic crystals, with *c* (001) and *u* ($\bar{5}$12) prominent. Twins: tw. pl. *c*.

Cleavage: *m* distinct. Fracture conchoidal. Brittle. H. = 5–6. G. = 3·234. Luster vitreous. Color black; in very thin splinters deep blood-red. Streak cinnamon-brown. Nearly opaque. Optically +. Ax. pl. ⊥ *b*. $Bx_a \wedge \acute{c} = +18°$. Pleochroic; absorption $\mathfrak{c} > \mathfrak{b} > \mathfrak{a}$.

In composition, a titano-silicate of iron (manganese) and the alkali metals; formula $\overset{I}{R}_2\overset{II}{R}TiSi_4O_{12}$, with $\overset{I}{R}$ = Na : K = 3 : 1 and $\overset{II}{R}$ = Fe : Mn = 2 : 1. Neptunite is therefore related in composition to titanite, and as Flink shows there is also a rather close correspondence in angle.

Analyses, 1, Flink. 2, O. A. Sjöström, G. För. Förh., **15**, 393, 1893.

| | | $SiO_2$ | $TiO_2$ | FeO | MnO | CaO | MgO | $K_2O$ | $Na_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| 1. | | 51·53 | 18·13 | 10·91 | 4·97 | — | 0·49 | 4·88 | 9·26 = 100·17 |
| 2. | $\frac{2}{2}$ | 51·93 | 17·45 | 10·23 | 5·32 | 0·71 | — | 5·71 | 9·63 = 100·98 |

Obtained from Greenland, the locality probably not the well-known Kangerdluarsuk, but rather Narsasik, near Igaliko. It occurs closely associated with ægirite (whence the name), also eudialyte, arfvedsonite, etc.

**Nickel-skutterudite.**—See *Skutterudite.*

**Niter**, p. 871.—Occurs in cavities of the leucite rocks of North Table Butte, Leucite Hills, Wyoming. In the rock of the Boar's Tusk of the same region, soda niter also occurs. Cross, Am. J. Sc., **4**, 118, 1897.

**Northupite.** *Warren M. Foote*, Am. J. Sc., **50**, 480, 1895. *J. H. Pratt, ibid.*, **2**, 123, 1896.

Isometric, in octahedrons. Cleavage none. Fracture conchoidal. H. = 3·5–4. G. = 2·380. Colorless when perfectly pure; also pale yellow to gray and brown. Index $n_y$ = 1·5144 Na.

Composition, $MgCO_3.Na_2CO_3.NaCl$. Analysis, Pratt.

$CO_2$ 35·43, MgO 16·22, $Na_2O$ 24·90, Cl 14·23, Na 9·22 = 100.

B.B. fuses at 1 with frothing to a white alkaline mass; colors the flame intense yellow. Easily soluble in acids.

Occurs in a clay at a depth of 450 feet at Borax lake, San Bernardino Co., California. Named after Mr. Northup, who first obtained the mineral.

This compound has been formed synthetically by A. de Schulten, Bull. Soc. Min , **19**, 164, 1896.

**Octahedrite**, pp. 240, 1043.—Cryst.—Bourg d'Oisans, new form σ (11·3·44)?, K. Busz, Zs. Kr., **20**, 557, 1892. Jämtland, Hamberg, G. För. Förh., **16**, 307, 1894. Glacier de la Meije, Hautes Alpes, Lacroix, C. R., **122**, 1429, 1896.

Investigation of crystalline structure, Baumhauer, Zs. Kr., **24**, 555, 1895.

Occurs with brookite at Placerville, Eldorado Co., Cal., Kunz, Am. J. Sc., **43**, 329, 1892. Also at Magnet Cove, Ark., Penfield, Am. J. Sc., **48**, 114, 1894.

See *Halite.*

**Oligoclase**, p. 322.—Cleavage and parting planes, Penfield, Am. J. Sc., **48**, 115, 1894.

See also *Feldspar.*

**Onofrite**, p. 64.—Occurs with cinnabar at Ouen-Shan-Tchiang, Central China, Termier (anal. by Pisani), Bull. Soc. Min., **20**, 204, 1897.

**Opal**, pp. 194, 1038.—Occurrence in New South Wales, Anderson [Rec. G. Surv. N. S. Wales, **3**, 29, 1892], Jb. Min., **2**, 221 ref., 1894.

**Orpiment**, pp. 35, 1043.—Obtained in fine crystals in cavities in clay at Mercur, Utah; these are monoclinic (Penfield, priv. contr.) as earlier (1866) deduced for Hungarian crystals by Breithaupt; Groth has also reached this conclusion (Tab. Ueb. Min., 17, 1898; cf. also notes by Hintze, Zs. Kr., **24**, 204, 1894). Miers found nothing in the optical characters at variance with orthorhombic crystallization, Min. Mag., **10**, 204, 1894.

**Orthoclase**, p. 315.—Vesuvius, measurement of crystals, Franco, Giorn. Min., **5**, 184, 1894.

Crystals from Lapland with (370) as tw. plane, Jeremejev, Vh. Min. Ges., **30**, 463, 1893. Also twin with tw. pl. ⊥ plane *cm*, Goldschmidt and Wright, Zs. Kr., **30**, 300, 1898 (earlier noted by Tschermak, Min. petr. Mitth., **8**, 414, 1887). Sanidine from Monte Cimino, near Viterbo, Italy, Zambonini, Riv. Min. Ital., **20**, 20, 1898.

Noted as a gangue mineral in a fissure vein in the Silver City district, Idaho, Lindgren, Am. J. Sc., **5**, 418, 1898.

See also *Feldspar.*

**Ottrelite**, pp. 642, 1043.—Analysis, Liberty, Maryland, Eakins, Bull. U. S. G. Surv., **113**, 111, 1893.

In metamorphic conglomerate in the Green Mts., Vermont, Whittle, Am. J. Sc., **44**, 270, 1892.

See *Chloritoid, Bliabergsite.*

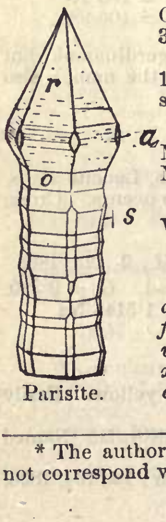
**Paralaurionite.** G. F. Herbert Smith, Min. Mag., **12**, 108, 1899.

Monoclinic. Forms: *a* (100), *c* (001), *m* (110), *d* (101), *h* ($\bar{2}01$), *k* ($\bar{4}01$), *l* ($\bar{6}01$); *p* (111). Angles* *ac* = *62° 47′, *am* = *67° 25′, *ap* = *58° 28′, *cm* = 79° 53′, *cp* = 52° 37½′.

In prismatic (∥ $\bar{b}$) or tabular (∥ *a*) crystals; twins with *a* as tw. pl. and thus pseudo-orthorhombic. Cleavage, basal. G. = 6·05. Sections ∥ *a* show in monochromatic light a double interference-figure. Refractive index $\beta = 2·1463$.

Composition as for laurionite, PbClOH. Analysis, Cl 14·9, O [3·6], Pb 78·1, $H_2O$ 3·4 = 100. The water is given off at 180°; laurionite loses its water at 142°.

Occurs in lead slags from Laurion, Greece.



Parisite.

**Parisite**, p. 290.—Crystals (rhombohedral, with new forms) from Igaliko, Greenland, described, also analysis, G. Nordenskiöld, G. För. Förh., **16**, 338, 1894.

Obtained from Ravalli County, Montana, in striated hexagonal crystals (Fig. 1), with pyramidal terminations, embedded in a white siliceous matrix. Analyses, 1, by C. H. Warren; also 2, from Muso, *id.*:

| | G. | $CO_2$ | $Ce_2O_3$ | $(La,Di)_2O_3$ | CaO | F | gangue = | | O = F |
|---|---|---|---|---|---|---|---|---|---|
| Montana, | 4·128 | 22·93 | 26·14 | 28·46 | 10·98 | 5·90 | [8·07] | =102·48 | 2·48 |
| Muso Valley, | 4·302 | 24·22 | 30·67 | 29·74 | 10·70 | 6·82 | 0·50 | =102·65 | 2·87 |

These analyses lead to the formula $[(Ce,La,Di)F]_2Ca(CO_3)_2$. Penfield and Warren, priv. contr.

**Pearceite.** *S. L. Penfield*, Am. J. Sc., **2**, 17, 1896.

Monoclinic. Axes $\grave{a} : \bar{b} : \acute{c} = 1·7309 : 1 : 1·6199$, $\beta$ = *89° 51′. Observed forms: *a* (100), *b* (010), *c* (001); *l* (310), *m* (110), *h* (130); *d* (102), *n* (101), *t* (201), *e* (401), *f* (601), *Δ* ($\bar{2}03$), $n_0$ ($\bar{1}01$), $t_0$ ($\bar{2}01$), $e_0$ ($\bar{4}01$), $f_0$ ($\bar{6}01$); *k* (021); *o* (114), *r* (112), *p* (111), *v* (332), *s* (221), *u* (331), $o_0$ ($\bar{1}14$), $q_0$ ($\bar{1}13$), $r_0$ ($\bar{1}12$), $p_0$ ($\bar{1}11$), $v_0$ ($\bar{3}32$), $s_0$ (221), $u_0$ ($\bar{3}31$), *x* (311), *y* (313), *z* (3·1·12). Angles: *mm′* (110 ∧ $\bar{1}10$) = *60° 2′, *cd* = *25° 3′, *cn* = 43° 2′, *cr* = 43° 3′, *cp* = 61° 49′.

In pseudo-rhombohedral crystals, tabular ∥ *c*; basal faces with triangular

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* The author gives the axes, $a : \bar{b} : \acute{c} = 0·8811 : 1 : 0·6752$ ($\beta$ = 62° 47′), which, however, do not correspond with the angles quoted.

markings (Fig. 1). Twinning probable as with the micas and chlorites, but not definitely determined; this would explain the occurrence of some of the forms in the list above. Also massive.

Figs. 1, 2, Marysvale, Montana.

Cleavage none. Fracture conchoidal. Brittle. H. = 3. G. = 6·125–6·166. Luster metallic. Color and streak black. Opaque.

Composition, $Ag_9AsS_6$ or $9Ag_2S.As_2S_3$, hence an arsenical polybasite. Analyses: 1, F. C. Knight, quoted by Penfield, l. c. 2, S. H. Pearce, Am. J. Sc., **44**, 16, 1892, after deducting 28·18 p. c. impurities (siderite, galena). 3, Penfield, l. c., deducting 12·81 p. c. (chiefly galena). Here belongs also an analysis by H. Rose of a Schemnitz mineral (No. 2, Dana Min., p. 146).

| | S | As | Sb | Ag | Cu | Zn | |
|---|---|---|---|---|---|---|---|
| 1. Marysvale, Mont. | 17·71 | 7·39 | — | 55.17 | 18·11 | — | Fe 1·05, insol. 0·42 = 99·85 |
| 2. Aspen, Colo. *mass.* | 17·73 | 6·29 | 0·18 | 59·73 | 12·91 | 3·16 = 100 | |
| 3. " " *cryst.* | 18·13 | 7·01 | 0·30 | 56·90 | 14·85 | 2·81 = 100 | |

B.B. decrepitates slightly and fuses readily. On charcoal in O.F. a slight arsenical coating; with soda a silver globule. In the open tube fumes of sulphur dioxide and sublimate of arsenic trioxide. In the closed tube fuses, gives a yellow sublimate of arsenic trisulphide and above a faint deposit of sulphur. Readily oxidized and dissolved in powder by nitric acid.

Occurs with quartz and calcite, also chalcopyrite, in a cavity at the Drumlummon mine, Marysvale, Montana. Also at the Mollie Gibson mine, Aspen, Colorado, both massive in large quantity disseminated through a pink barite; also in tabular crystals embedded in siderite, in both cases associated with galena. Also in good crystals from the Tintic district, Utah.

Named after Dr. Richard Pearce of Denver.

**PECTOLITE**, p. 373.—Torosay in Mull, Scotland, analyses, Heddle, Trans. G. Soc. Glasgow, 241, 1892.

**Pelionite.** A name suggested by W. F. Petterd for a bituminous coal (Pelion Coal) resembling the English cannel coal, from near Monte Pelion, Tasmania. Catalogue of Minerals of Tasmania, 1893.

**PENCATITE**, p. 271.—Investigated (also predazzite), Leneček, Min. petr. Mitth., **12**, 429, 447, 1892.

**Penfieldite.** *F. A. Genth*, Am. J. Sc., **44**, 260, 1892. *S. L. Penfield, ibid.*, **48**, 114, 1894.

Hexagonal. Axis $\dot{c} = 0·8967$ ; $0001 \wedge 01\bar{1}1 = 39° \ 26\frac{1}{4}'$. In hexagonal prisms (Fig. 1) with *c* (0001), *m* (10$\bar{1}$0) and *p* (1122) ; also undetermined acute pyramids of the unit series forming tapering crystals. Angle *cp* = *41° 53′.

Cleavage: basal, distinct. Luster vitreous, inclining to greasy. Color white. Transparent to translucent. Double refraction, strong, positive.

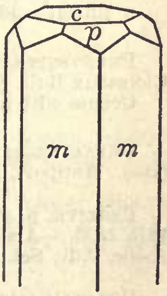
Composition, a lead oxychloride, $PbO.2PbCl_2$ = Chlorine 18·2, lead 79·7, oxygen 2·1 = 100. Analysis, Genth :

| | Cl | Pb |
|---|---|---|
| 1. *Tapering cryst.* | 18·55 | 78·25 |
| 2. *Opaque cryst.* | 17·94 | *undet.* |

B.B. in the closed tube decrepitates and yields a sublimate of lead chloride but no water. Easily soluble in nitric acid.

Found in the ancient lead slags from Laurion, Greece, in which it has resulted from the action of sea-water. Other lead oxychlorides occuring at Laurion are : laurionite, fiedlerite and paralaurionite (this Append., p. 50).

1.



Penfieldite.

**PENNINITE**, p. 650.—Analysis of kämmererite, from Tampadel, Zobtengebirge, Lower Silesia, Traube, Zs. G. Ges., **48**, 53, 1894.

See *Clinochlore.*

**Pentlandite.** p. 65.—Shown by Penfield (Am. J. Sc., **45**, 493, 1893) to occur intimately mixed with pyrrhotite at Sudbury, Ontario. It is non-magnetic, has a lighter color and is isometric as shown by the octahedral parting. G. = 4·946–5·006. Analysis gave S: 33·42, Fe 30·25, Ni 34·23, Co 0 85, gangue 0·67 = 99 42. It is also shown that the *folgerite* of Emmens (ref., p. 26) from the Worthington mine, 30 miles southwest of Sudbury, is only pentlandite.

Occurs at Beiern, Norway, (analysis), J. H. L. Vogt, G. För. Förh., **14**, 325, 1892.

See also *Heazlewoodite.*

**Percylite**, pp. 172, 1028.—Synthetic experiments by C. Friedel lead to the composition before suggested for the species, viz. $PbCuCl_2(OH)_2$ or $Pb(OH)Cl.Cu(OH)Cl$. This is the composition of boléite (Min., p. 1028) except that it contains a small amount of silver chloride ($\frac{1}{3}AgCl$). Bull. Soc. Min., **15**, 96, 1892. Friedel has also obtained crystals with the latter composition (boléite), *ibid.*, **17**, 6, 1894.

The locality at Boléo, Lower California has yielded not only the cubes of boléite to which belong the formula $PbCuCl_2(OH)_2 + \frac{1}{3}AgCl$ (see Min., p. 1028, and Mallard and Cumenge, Bull. Soc. Min., **14**, 283, 1891), but also octahedral or pyramidal crystals, sometimes in pseudo-isometric groupings of six crystals. They are referred to the tetragonal system by Cumenge, C, R., **116**, 898. 1893. Analyses, 1, Fourment, quoted by Cumenge; 2, Friedel, Bull. Soc. Min., **16**, 187, 1893.

| | G. | Cl | Pb | Cu | Ag | $H_2O$ | O | |
|---|---|---|---|---|---|---|---|---|
| 1. | 4·675 | 18·53 | 52·99 | 15·20 | 0·15 | 9·00 | 4·13 | = 100 |
| 2. | 4·71 | 19·04 | 52·85 | 17·95 | — | 5·44* | 4·55 | $SiO_2$ 0·39 = 100·26 |

* Ignition.

Analysis 2 (1 being incorrect in the $H_2O$) corresponds to $PbCuCl_2(OH)_2$, the composition above given for percylite. These crystals are called *cumengéite* by Mallard, Bull. Soc. Min., **16**, 184, 1893. He obtained $001 \wedge 101 = 58° 44'$; $\dot{c} = 1·6469$; optically negative, uniaxial; indices $\omega = 2·026$, $\epsilon = 1·965$, $\omega - \epsilon = 0·061$.

The relation of percylite to boléite and cumengite has also been discussed by Lacroix (Bull. Mus. d'Hist, Nat., Paris, p. 39, 1895), but his conclusions rest on insufficient data. He would recognize a series passing from cumengite containing no silver ($PbCuCl_2(OH)_2$, through *pseudoboléite* with less than $\frac{1}{3}AgCl$ and boléite with $\frac{1}{3}AgCl$, to percylite in which still more AgCl is present (but see Friedel above). He would also find a progressive increase in specific gravity, viz. for the four substances named: 4·71, $\nless$ 5 08, 5·08, 5·254; also a decreasing birefringence, viz. 0·061 (cumengite), 0·03, (pseudoboléite), 0·01 (boléite), to 0 or nearly 0 in percylite. The substance called *pseudoboléite* forms part at least of the cubic crystals with re-entrant angles ($001 \wedge 102 = 63° 44'$) referred to cumengite and percylite by Mallard.

A mineral from the Broken Hill mines, New South Wales, is referred to boléite by Liversidge, Proc. R. Soc. N. S. W., **28**, 94, 1894. In cubic crystals with *o* and *d*. H. = 3·5. G. = 5·02, Analysis by Carmichael and Armstrong: Cl 13·50, Pb 47·20, Cu 19·20, Ag 8·25, O calc. [6·10]. $H_2O$ calc. [5·44] = 99·69. $H_2O$ determined by Liversidge 6·39 p. c.

Obviously these supposed distinct minerals need further examination, especially on the chemical side.

**Periclase**, p. 207.—Occurs in small grains at Långban, Hj. Sjögren, G. För. Förh, 17, 288, 1895.

Discussion of method of origin at Långban and Nordmark, Hj. Sjögren, G. För. Förh., **20**, 25, 1898.

Artificial production, A. de Schulten, Bull. Soc. Min., **21**, 87, 1898.

**Perovskite**, p. 722.—Further investigation of crystallographic and optical characters, Des Cloizeaux Bull. Soc. Min., **16**, 218, 1893.

Occurs with magnetite as a rock at Catalão, Goyaz, Brazil, Hussak, Jb. Min., **2**, 297, 1894.

**Petalite**, p. 311.—Occurs near the source of the Amanaur river, Caucasus, C. Jeremejev (anal., Antipov), Bull. Ac. St. Pet., **5**, 1896, Proc. Verb., p. viii.

**Petzite**, p. 48.—Occurs in the Yale district, Br. Columbia, Hoffmann, Rep. G. Canada, 8, 12R, 1895. Also at the Nordenfeldt mine, Thames gold-field, New Zealand, J. Park, Austr. Assoc. Adv. Sci., **3**, 152, 1891.

**Pharmacolite**, p. 827.—Analysis by Church gives 12·37 p. c. as loss of water *in vacuo* ($3 = H_2O$), and 3·11 between 100° and 200° ($H_2O$). Min. Mag., **11**, 7, 1895.

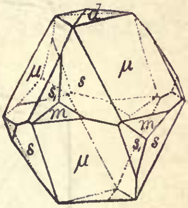
**Phenacite**, p. 462.—Crystals described (anal. by Preis) from Ober-Neusattel, Vrba, Zs. Kr., **24**, 119, 1894.

Crystals occur at Kragerö of prismatic habit, the usually tri-rhombohedral symmetry not distinctly shown, twins of both contact and penetration types, with *m* (10$\bar{1}$0) as tw. plane, Bäckström, G. För. Förh., **20**, 295, 1898, and Zs. Kr., **30**, 352, 1898

Pseudomorphous crystals (Fig. 1) of very large size (one weighed 28 lbs.) occur at Greenwood, Me., C. H. Warren, Am. J. Sc., **6**, 119, 1898.

Occurrence at St. Christophe-en-Oisans, Dauphiné, Des Cloizeaux and Lacroix, C. R., **116**, 1231, 1892. Also at Striegau, Silesia, Hintze, Zs. Kr., **28**, 174, 1897.

1.



Phenacite.

**Philipstadite.** *R. A. Daly,* Proc. Amer. Acad. Sc., **34**, 433, 1899.—See *Amphibole.*

PHILLIPSITE, p. 579.—Analysis by G. H. Edwards of crystals from Bass Strait, Australia, gave:

| G. | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | (Ba,Sr)O | CaO | $Na_2O$ | $K_2O$ |
|---|---|---|---|---|---|---|---|
| 2·20 | 47·94 | 21·72 | 4·44 | 0·77 | 2·25 | 2·73 | 9·87 = 100·65 |

This leads to the formula $RAl_2Si_4O_{12}.4H_2O$, where R = $K_2$, $Na_2$ and Ca. That phillipsite should contain $4H_2O$, instead of $4\frac{1}{2}H_2O$ as generally accepted (Min., p. 580), was indicated by Pratt and Foote in their discussion (Am. J. Sc., 3, 448, 1897) of the wellsite-phillipsite-harmotome-stilbite series. S. L. Penfield, priv. contr.—See *Wellsite.*

PHLOGOPITE.—See *Mica.*

PHŒNICOCHROITE, p. 914.—Synthesis, Ludeking, Am. J. Sc., **44**, 57, 1892. Also Lachaud and Lepierre, Bull. Soc. Chim., **6**, 232, 1891.

PHOSGENITE, p. 292.—Crystals from Monteponi, Sardinia, studied by Goldschmidt, are referred to the trapezohedral group of the tetragonal system, Zs. Kr., **21**, 321, 1893; **23**, 139, 1894; **26**, 9, 1896. Traube concludes, however, that etching-figures are not at variance with crystallization in the normal (holohedral) group, Jb. Min., Beil.-Bd., **10**, 456, 1896. On crystals from Laurion, Greece, G. F. Herbert Smith, Min. Mag., **12**, 107, 1899.

Formation of artificial crystals also of $PbCO_3.PbBr_2$, A. de Schulten, Bull. Soc. Min., **20**, 191, 194, 1897.

PICROMERITE, p. 948.—(Schoenite.) Relation to other sulphates, etc., J. K. van der Heide, Zs. phys. Ch., **12**, 416, 1893.

PIEDMONTITE, p. 521.—Shown by G. H. Williams to occur at South Mountain, Pa., in an ancient rhyolite with scheelite, etc.; analysis by W. F. Hillebrand, after deducting quartz assumed to be present to the amount of 10 p. c.: $SiO_2$ 37·37, $Al_2O_3$ 22·07, $Ce_2O_3$ 0·89, $R_2O_3{}^a$ 1·52, $Fe_2O_3$ 4·78, $Mn_2O_3$ 8·15, MnO 2·285, CaO 18·825, MgO 0·30, $K_2O$ 0·81, $Na_2O$ 0·27, $H_2O$ 2·48, CuO 0·13, PbO 0·17 = 100·05. (ᵃ Other rare earths.) Am. J. Sc., **46**, 50, 1893.

Occurs in rhyolite in Province of Shinano, Japan, Yamasaki, J. Coll. Sc. Japan, **9**, 117, 1897.

PINAKIOLITE, p. 877.—A related mineral from Långban has been analyzed by Bäckström, G. För. Förh, **17**, 257, 1895.

PINITE, p. 621.—Breage, Cornwall, analysis, Collins, Min. Mag., **10**, 8, 1892.

**Pirssonite.** *J. H. Pratt,* Am. J. Sc., **2**, 126, 1896.

Orthorhombic-hemimorphic. Axes $\breve{a} : \bar{b} : \dot{c}$ = 0·5662 : 1 : 0·3019. Forms: *b* (010), *m* (110), *p* (111), $p_1$ (11$\bar{1}$), *e* (131), *x* (311). Angles: *mm'''* = *59° 2', *pp''* = *63° 0', *pp'* = 54° 6', *pp'''* = 29° 50'. Habit prismatic (Figs. 1 to 4).

Cleavage none. Fracture conchoidal Brittle. H. = 3–3·5. G. = 2·352. Luster vitreous. Colorless to white, sometimes dark from impurities. Pyroelectric. Optically +. Ax. pl. ∥ *c*. $Bx_a \perp b$. $2E_y = 48° 14'$. Indices (Na): $\alpha = 1·5043$, $\beta = 1·5095$, $\gamma = 1·5751$ (∴ 2V = 32° 48').

Composition, $CaCO_3.Na_2CO_3.2H_2O$. Analysis:

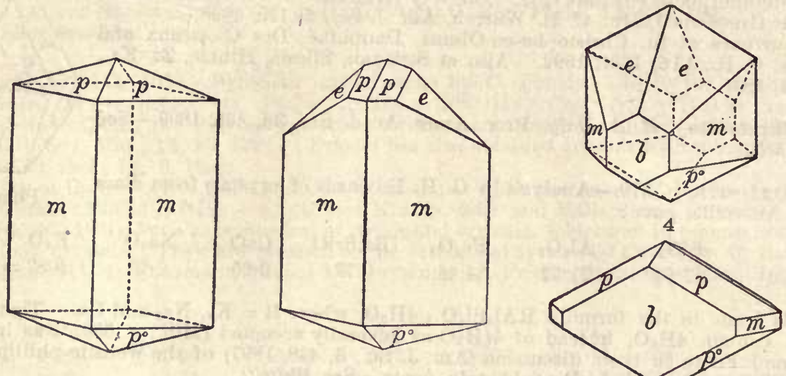
| | $CO_2$ | CaO | $Na_2O$ | $K_2O$ | $H_2O$ | |
|---|---|---|---|---|---|---|
| ½ | 36·07 | 23·38 | 25·70 | 0·15 | 14·73 | $Al_2O_3,SiO_2$ 0·32 = 100·45 |

B.B. decrepitates, fuses at 2–2·5, coloring the flame deep yellow; alkaline reaction after heating. Soluble in cold acids with effervescence.

Occurs sparingly with gay-lussite and northupite at a boring near Borax lake, San Bernardino Co., California. Named after Prof. L. V. Pirsson of New Haven.

This mineral has been obtained artificially by A. de Schulten, C. R., **123**, 1023, 1896.

1. 2. 3. 4



Figs. 1–4, Pirssonite.

PLAGIOCLASE.—See *Feldpar.*

PLAGIONITE, p. 118.—Description of crystals from Wolfsberg, Luedecke, Min. d. Harzes, 125, 1896; also with new forms, L. J. Spencer, Min. Mag., **11**, 192, 1897, and **12**, 56, 1899 (see further *Semseyite*).

**Planoferrite.** *L. Darapsky*, Zs. Kr., **29**, 213, 1897.

In rhombic or hexagonal tabular crystals (probably orthorhombic) with basal cleavage and faces on the edges. Brittle. H. = 3. Color yellowish green to brown (Grünling) streak chrome-yellow. Composition $Fe_2O_3.SO_3.15H_2O$. Analysis:

$SO_3$ 15·57, $Fe_2O_3$ 31·20, $H_2O$ 51·82, insol. 1·41 = 100.

Occurs in druses in copiapite at the Lautaro mine near Morro Moreno, Antofagasta, Atacama.

PLATINUM, pp. 25, 1044.—Venable concludes that the reported occurrence of platinum in North Carolina is very doubtful, Am. J. Sc., **43**, 540, 1882; J. Elisha Mitchell Sc. Soc., 8, 1892.

Occurs with gold in the sand of the N. Saskatchewan river, near Edmonton, Alberta, Hoffmann, Rep. G. Canada, **5**, 65R, 1889–90. Also on Rock creek, Kettle river, Yale district, Br. Columbia, *ib.*, **6**, 14R.

PLATTNERITE, p. 239.—Mullan, Idaho, analysis (Yeates) and cryst. description (Ayres) as given in Syst. Min., p. 240. Am. J. Sc., **43**, 407, 1892.

PLUMBOCUPRITE.—See *Cuproplumbite.*

PLUMBOFERRITE, p. 228.—Sjö mine, Örebro, Sweden, analysis of impure material, Igelström, G. För. Förh., **16**, 594, 1894, and Zs. Kr., **24**, 129, 1894.

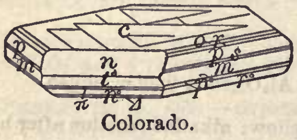
POLIANITE, p. 236.—Analyses, Gorgeu, Bull. Soc. Min., **16**, 96, 1893.

POLLUCITE, pp. 343, 1044.—Rumford, Me., analysis by H. W. Foote confirming formula of Wells, Am. J. Sc., **1**, 457, 1896.

| | $SiO_2$ | $Al_2O_3$ | $Cs_2O$ | $K_2O$ | $Na_2O$ | $Li_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| G. = 2·984 $\frac{2}{3}$ | 43·64 | 16·84 | 36·14 | 0·37 | 2·09 | 0·08 | 1·58 = 100·74. |

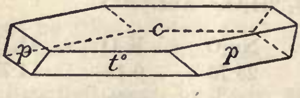
POLYBASITE, pp. 146, 1045.—Crystals from the Yankee Boy mine, Ouray, Colorado, are shown by Penfield to be monoclinic and pseudo-rhombohedral (Fig. 1). Axes: $\grave{a} : \bar{b} : \acute{c} = 1·7309 : 1 : 1·5796$, $\beta = 90° 0'$. Forms: *c* ($\underline{0}01$), *l* (310), *m* ($1\underline{1}0$), *n* (101), *Δ* ($\bar{2}03$), $n_0$ ($\bar{1}01$), *π* ($\bar{4}03$), $t_0$ (201); *o* (114), *r* (112), *p* (111), *s* ($2\underline{2}1$), *u* (331)?, $o_0$ ($\bar{1}14$), $r_0$ ($\bar{1}12$), $p_0$ ($\bar{1}12$).

1.



Colorado.

2.



Freiberg.

Angles *cm* = *90° 0′, *mm′* = *60° 2′, *cn* = *42° 23′, *cr* = 42° 22′, *co* = 24° 31′. Crystals tabular

‖ *c*, Figs. 1, 2. The form is very near that of *pearceite*, p. 50, Fig. 2 shows a crystal from the Himmelfahrt mine, Freiberg, perhaps a twin. Am. J. Sc., **2**, 23, 1896. See also *Pearceite*. Also occurs in fine crystals at the Big Seven Mine, Neihart, Montana (Pfd.).

Analysis from Quespisiza, Chili, by Bodländer: S 16·37, Sb 5·15, As 3·88, Ag 67·95, Cu 6·07, Pb 0·76 = 100·18. This gives the ratio of $Ag_2(Cu_2)S : Sb_2(As_2)S_3 = 7·74 : 1$ instead of **9 : 1** as commonly accepted, Jb. Min., **1**, 98, 1895.

POLYCRASE, p. 744.—Occurs in the township of Calvin, Nipissing, Ontario, Canada, Hoffmann, Am. J. Sc., **7**, 243, 1899.

POLYLITE, p. 1045.—Thomson's supposed mineral is shown to be a mixture containing fayalite derived from an iron furnace, Lacroix, Bull. Soc. Min., **20**, 308, 1897.

POWELLITE, p. 989.—Occurs at the South Hecla copper mine, Houghton Co., Michigan, ($WO_3$ 1·65 and 4·50 p. c.,) Koenig and Hubbard, Am. J. Sc., **46**, 356, 1893. The same locality has afforded some fine crystals described by C. Palache, *ibid.*, **7**, 367, 1899. G. = 4·356, color bluish green. Habit as in Fig. 1. Observed forms: *e* (101), *p* (111), *h* (133), *j* (3·11·11); also narrow and doubtful, *k* (155), *l* (1·11·11). Angles near those of scheelite. Cleavage *e* interrupted. One specimen showed a dark, nearly black exterior and bluish-green interior presumably due to variation in composition.

Crystals, with *c* (001), *e* (101), *p* (111), have been obtained artificially by L. Michel; analysis gave $MoO_3$ 62·37, $WO_3$ 10·23, CaO 26·41 = 99·01. Bull. Soc. Min., **17**, 612, 1894.

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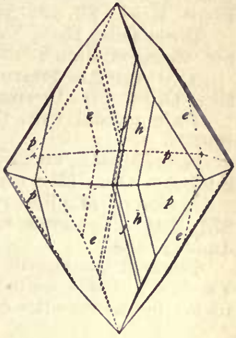

Powellite.

PREHNITE, p. 530.—Occurs in crystals at Friedensdorf near Marburg, Brauns (anal. by A. Nau), Jb. Min., **2**, 6, 1892.

Crystals described and investigated pyroelectrically; new forms (301), (601), (10·0·1); crystals hemimorphic and twinned (tw. pl. *a* (100)). Traube, Jb. Min., Beil.-Bd., **9**, 134, 1894.

Crystals described from Tulferthal, Tyrol, Habert, Zs. Kr., **28**, 258, 1897. Anal., Fassa, Tyrol, Schneider, Bull. U. S. G. Surv., **113**, 112, 1893.

Identification in rocks, Lacroix, Bull. Soc. Min., **21**, 277, 1893.

**Prolectite.** *Hj. Sjögren*, Bull. G. Inst. Upsala, **1**, 40, 1892; **2**, 99, 1894.

A new member of the HUMITE GROUP, thus far only known from two fragments of crystals obtained with humite, chondrodite, and clinohumite at the Ko mine at Nordmark, Sweden. In appearance and physical characters like other members of the group. Crystallization, monoclinic. Axes $\grave{a} : \bar{b} : \grave{c} = 1·0803 : 1 : 1·8862$, $\beta = 90°$. Forms: (001), (010); (110); (103), (503), ($\bar{4}$09); (012), (011); (121), (367), (362); ($\bar{2}$27), ($\bar{2}$23), ($\bar{1}$11); ($\bar{1}$21), ($\bar{2}$49). Ax. plane ($\mathfrak{a} = Bx_o$) inclined 44° to 47° 15′ to (001), that is, 46° to 42° 45′ to $\grave{c}$. $2K_{a.y} = 79° 45′$ ($n^y = 1·6703$).

Not yet analyzed, but the composition is probably $Mg[Mg(F,OH)]SiO_4$, the member of the group predicted by Penfield and Howe as noted under the *Humite Group*, p. 35. Hence named from *προλέγειν*, to foretell.

PROSOPITE, p. 178.—Analysis of a pale green variety from Utah, Hillebrand, Am. J. Sc., **7**, 53, 1899.

**Pseudoboléite.** *A. Lacroix*, Bull. Mus. d'Hist. Nat. Paris, p. 39, 1895.—See *Percylite*.

PSEUDOBROOKITE, p. 232.—Crystals from Aranyer Berg have been examined by Traube, Zs. Kr., **20** 327, 1892. Doss has described crystals obtained as a furnace product, *ibid.*, p. 566. He deduced the composition $Fe_2O_3.TiO_2$ and urges isomorphism with andalusite; Frenzel, however, has confirmed the accepted formula, $2Fe_2O_3.3TiO_2$, Min. petr. Mitth., **14**, 126, 1894.

PSEUDOGAYLUSSITE.—Discussion as to the origin of the barley-corn pseudomorphs of calcium carbonate (see Min., pp. 907, 271) with description of forms occurring in Holland, F. J. P. van Calker, Zs. Kr., **28**, 556, 1897.—See also *Jarrowite*.

PSEUDOMALACHITE, p. 794.—Analysis of *ehlite*, from Semipalatinsk, Antipov, Vh. Min. Ges., **28**, 527, 1891.

**Pseudopyrophyllite.** *F. Loewinson-Lessing*, Vh. Min. Ges., **33**, 283, 1895. Zs. Kr., **28**, 516. —See *Pyrophyllite*.

PTILOLITE, p. 572.—A new locality near Silver Cliff, Custer Co., Colorado, is described by Cross and Eakins, Am. J. Sc., **44**, 96, 1892. Occurrence similar to that of Green Mountain. Analysis, Eakins: $SiO_2$ 67·83, $Al_2O_3$ 11·44, CaO 3·30, $K_2O$ 0·64, $Na_2O$ 2·63, $H_2O$ 13·44 = 99·28. The relation in composition between ptilolite and mordenite is discussed by Clarke, *ibid.*, p. 101.

**Pyrargyrite**, p. 131.—Crystals from Mexico with new form (11$\bar{2}$6), Busz, Zs. Kr., **20**, 557, 1892. From the Harz described by Luedecke, Min. d. Harzes, 134, 1896.

Occurs in galena near Bear Lake, West Kootanie, Br. Columbia, Hoffmann, Rep. G. Canada, **6**, 27R, 1892–93.

**Pyrite**, pp. 84, 1045.—Crystals described from Bélabánya, Hungary; new forms (11·5·0), (13·8·0), (13·9·0), (10·7·0), (15·11·0), (8·13·0), (7·11·0), (11·15·0), (16·9·1). A. Franzenau, Ber. aus Ungarn, **15**, 198, 1898. Also from Kotterbach, with new forms (21·1·0), (17·1·0), etc., Zimanyi, Földt. Közl., **28**, 192, 1898.

Monte della Riva, Valle del Dardagna, description of peculiar crystals, Bombicci, Mem. Accad. Sci. Bologna, Jan. 8, 1893.

A twinning of tetartohedral crystals (similar to ullmannite) is suggested by Miers for a specimen from Gilpin Co., Colorado, Min. Mag., **12**, 112, 1899.

Twin crystal with (320) as tw. plane, G. D'Achiardi, Att. Soc. Tosc., Proc. verb., March 14, 1897.

From Müsen, containing 4·13 Ni and 1·97 Co, Laspeyres, Zs. Kr., **20**, 553, 1892. Also from Sudbury, Ont., (Murray mine,) containing 4·34 p. c. Ni, Walker, Am. J. Sc., **47**, 312, 1894.

Action of alkaline reagents on pyrite compared with that on marcasite, Doelter, Jb. Min., **2**, 273, 1894. The same subject has been fully studied by A. P. Brown, Proc. Am. Phil. Soc., **33**, June 19, 1894.

Penfield has shown that the uncertain *blueite* and *whartonite* of Emmens (J. Am. Ch. Soc., **14**, No. 7, 1892), both from the Sudbury region, are (even if the analyses are trustworthy) only nickeliferous varieties of pyrite. Am. J. Sc., **45**, 496, 1893.

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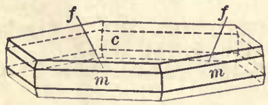

**Pyroaurite**, p. 256.—Described by Hj. Sjögren from the Moss mine, Norway. Occurs in hexagonal or rounded tabular crystals (Fig. 1). Forms: *c* (0001), *m* (10$\bar{1}$0), *h* (21$\bar{3}$0), *f* (10$\bar{1}$1); *cf** = 76° 30′, hence $\dot{c}$ = 3·6073. Crystals apparently show pyramidal hemihedrism in the development of *h*. H. = 2–3. G. = 2·07. Luster pearly to greasy. Color yellow to yellowish brown. Translucent. Optically – ; birefringence low. Analysis (on 0·02 gr.) by R. Mauzelius: $Fe_2O_3$ 22·0, MnO 4·5, MgO 34·8, $H_2O$ 36·1, insol. 0·5 = 97·9. Associated with pyrochroite (often altered to manganite) in manganiferous dolomite. Bull. G. Inst. Upsala, **2**, 59, 1895.

**Pyrochlore**, p. 726.—From Alnö, analyses and discussion of composition (also of related minerals), Holmquist, G. För. Förh., **15**, 588, 1893. From the Ural, analysis, Khrushchov, Vh. Min. Ges., **31**, 415, 1894.

**Pyrolusite**, pp. 243, 1045.—Analyses, Gorgeu, Bull. Soc. Min., **16**, 96, 1893.

**Pyromorphite**, p. 770.—Crystals from New Caledonia with new forms (15·0·$\bar{15}$·4), (90$\bar{9}$1). Lacroix, C. R., **118**, 553, 1894, and Bull. Soc. Min., **17**, 120, 1894.

Crystals described from Nil-Saint-Vincent, Belgium, G. Cesàro, Mem. Acad. Belg., **53**, 1897.

**Pyrophyllite**, p. 691.—F. Loewinson-Lessing concludes from his investigations of the mineral of Pyshminsk that it represents a mixture of pyrophyllite, $3H_2O.3Al_2O_3.11SiO_2$, and *pseudo-pyrophyllite*, $3MgO.4Al_2O_3.9SiO_2.8H_2O$. These were separated by the Thoulet solution. Both are assumed to be orthorhombic with $Bx_a \perp$ base (cleavage); the former is optically negative, the latter positive. Vh. Min. Ges., **33**, 283, 1895, and Zs. Kr., **28**, 516, 1897.

**Pyrostilpnite**, p. 135.—Discussion of crystalline form, Luedecke, Min. d. Harzes, 133, 1896.

**Pyroxene**, pp. 352, 1045.—Crystals from New York State described, with optical investigation and analyses, H. Ries, Ann. N. Y. Acad. Sc., **9**, 124, 1896.

*Diopside*, Achmatovsk, new form *H* (551), Busz, Zs. Kr., **20**, 558, 1892. Crystals from several localities described, also *augite*, new forms 𝕱 (10·1·0), 𝕲 (710), 𝕳 (750), 𝕶 (140), 𝕸 (160), 𝕹 (0·11·5), 𝕾 ($\bar{4}$14), 𝖁 ($\bar{4}$21), 𝖂 ($\bar{5}$31), A. Schmidt, Zs. Kr. **21**, 1, 1892. From Graubünden, Baumhauer, *ibid.*, p. 200. From Zöptau, optical and chemical description, Graber, Min. petr. Mitth., **14**, 265, 1894.

Forms a saccharoidal rock of an azure-blue color, on the Gila river, 40 miles from Silver City, New Mexico. Analysis by Merrill and Packard gave: $SiO_2$ 54·30, MgO 18·33, CaO 25·00, FeO 1·11 = 98·74. Am. J. Sc., **43**, 279, 1892.

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* The author gives $10\bar{1}0 \wedge 10\bar{1}1 = 76° 30$.

*Violan*, p. 357.—Analysis of original material by Penfield shows it to be essentially a diopside, Am. J. Sc., **46**, 293, 1893. Color light blue. G. = 3·237–3·272.

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | ign. |
|---|---|---|---|---|---|---|---|---|---|
| 53·94 | 1·00 | 0·86 | 0·88 | 0·36 | 16·63 | 23·80 | 1·22 | 0·05 | 0 66 = 99·40 |

*Salite*, from Sala, optical exam. and analysis, Hovey, Min. petr. Mitth., **13**, 218, 1892.

*Hedenbergite*, Su Poru, Sardinia, analysis by Fasolc, quoted by Lovisato (10·92 p. c. MnO and no $Al_2O_3$); also epidote, etc., Rend. Accad. Linc., **4** (1), 111, 1895. From Renfrew Co., Ontario, optical characters, analysis, etc., Wülfing, Min. petr. Mitth., **15**, 29, 1895.

*Iron-schefferite*, Långban, analysis by Mauzelius, Hj. Sjögren, G. För. Förh., **14**, 251, 1892. See *Urbanite*.

*Jeffersonite*, from Franklin Furnace, N. J., analyzed by Hillebrand, Am. J. Sc., **7**, 55, 1899.

*Augite*, on crystals, see diopside above.

Analysis, Italian Peak, Gunnison Co., Colo., Eakins, Bull. U. S. G. Surv., **113**, 112, 1893. From Highwood Mts., Montana, L. V. Pirsson, Bull. G. Soc. Am., **6**, 410, 1895. In analcite-basalt, Colorado, Hillebrand, quoted by Cross, J. Geol., **5**, 687, 1897.

On the pyroxene (ægirite-augite, augite) from the volcanic rocks (leucitite, etc.) of the Ernici, Province of Rome, Italy, see Viola, Jb. Min., **1**, 101 *et seq.*, 1899. Crystals often show zonal structure with varying extinction; twins noted with *m* (110) as tw. plane. The name *federovite* is suggested by Viola for a pyroxene from this region, which falls between ægirite-augite and ægirite, containing 9 to 13 p. c. alkalies and about 24 p. c. FeO; pleochroism strong, $\mathfrak{c}$ yellow, $\mathfrak{b} = \mathfrak{a}$ olive-green; $\mathfrak{c} \wedge \dot{c} = 65°$ to 75°, $2V < 50°$.

On the extinction-angles in the vertical zone, see R. A. Daly, Proc. Amer. Acad., **34**, 311, 1899; also the same on etching-figures, *ibid.*, p. 374.

Many petrographical papers (in Jb. Min. *et al.*) contain analyses, optical determinations, etc.; a summary of some of these is given by Viola, Jb. Min., **1**, 115–120, 1899.

Conditions of formation in a magma, Morozewicz, Min. petr. Mitth., **18**, 113, 1898.

The meteorite of Vaca Muerta, Sierra de Chico, contains an unidentified silicate, in some respects resembling augite. Weinschenk, Min. petr. Mitth., **17**, 567, 1897.

PYRRHARSENITE, p. 753.—See *Berzeliite*.

PYRRHOTITE, p. 73.—Crystals from Andreasberg, described with *t* $(10\bar{1}2)$, *r* $(70\bar{7}1)$, Busz, Jb. Min., **1**, 124, 1895. From Frontenac Co., Canada, with $(20\bar{2}1)$, $(40\bar{4}1)$, etc., W. Nicol, Zs. Kr., **31**, 53, 1899.

Investigation of magnetic properties, Abt, Wied. Ann., **57**, 135, 1896.

From Sudbury, Ont., containing nickel, Vogt, G. För. Förh., **14**, 315, 1892.

Linck shows reason for not regarding pyrrhotite and troilite as heteromorphic modifications of the same compound (FeS), Ber. Ch. Ges., **32**, 895, 1899.

QUARTZ, pp. 183, 1046.—**Cryst.**—Monograph for crystals from Val Malenco, Rossignoli, Riv. Min. Ital., **10**, 3, 1892. No. Carolina, A. Capen Gill, Inaug. Diss., Leipzig, 1893, reproduced in Zs. Kr., **22**, 97, 1893; also H. A. Miers, Am. J. Sc., **46**, 420, 1893. Jämtland, Hamberg, G. För. Förh., **16**, 307, 1894. Wurmthal, Harz, cryst. described, Luedecke, Abh. Nat. Ges. Halle, **20**, 1894; Min. d. Harzes, 196, 1896. Devil's Lake, Wisconsin, Hobbs, Bull. Univ. Wisconsin, **1**, 109, 1895. Switzerland, Termier, Bull. Soc. Min., **18**, 443, 1895, and C. R., **121**, 842, 1895. Nil-St.-Vincent, Butgenbach, Ann. Soc. G. Belg., **24**, 11, 1897. Pisek, Bohemia, Heberdey, Zs. Kr., **26**, 267, 1896. Tuscany, G. D'Achiardi, Att. Soc. Tosc., Mem., **17**, 1898.

Crystalline structure of pyrogene quartz, Rinne, Jb. Min. **1**, 1, 1892. Lamellar structure shown to be of secondary origin, also effect on optical character, Judd, Min. Mag., **10**, 123, 1893.

Mechanical deformation of crystals from Pitourles-en-Lordat, Ariège, Lacroix, Bull. Soc. Min., **14**, 306, 1891. Discussion of curved and twisted complex crystals and groups from Switzerland. G. Tschermak, Ber. Ak. Wien, Denkschr., July 12, 1894. Also from Cararra, Bombicci, Mem. Accad. Bologna, **2**, 1892.

Inclusions in quartz of Stromboli lava, H. Johnston-Lavis, Soc. G. Ital., April 1, 1894.

Dichroism for infra-red waves, E. Merritt, Wied. Ann., **55**, 49, 1895.

Rotatory power at low temperatures (to − 71·5°), Soret and Guye, Bibl. Univ., **29**, 242, 1892. Rotatory polarization for infra-red waves, Carvallo, Ann. Ch. Phys., **26**, 113, 1892, and C. R., **114**, 288, 1892. Rotatory power and double refraction, Beaulard, J. Phys., **2**, 393, 1893; effect of pressure on optical phenomena, *id.*, *ibid.*, pp. 459, 472; see also Wiechmann, Sch. Mines Q., **20**, 267, 1899. Measurement of rotatory power, Gumlich, Zs. Instrumentenkunde, **16**, 97, 1896. Tenacity investigated, Sella and Voigt, Wied. Ann., **48**, 663, 1893.

Piezo-electric property discussed, Lord Kelvin, Phil. Mag., **36**, 331, 1894.

Refractive indices measured, Wülfing, Min. petr. Mitth., **15**, 59, 1895.

Investigation of coloring matter of smoky quartz (titanium), Weinschenk, Zs. G. Ges., **48**, 704, 1896; Zs. anorg. Ch., **12**, 375, 1896.

Observations on the solvent power of water at elevated temperatures (153° to 323°) and after long duration, G. Spezia, Att. Accad. Sc. Torino, **33**, June 16, 1898; also *ibid.*, **31**, Dec. 29, 1895.
Stated to occur in the Toluca meteoric iron, Laspeyres, Zs. Kr., **24**, 485, 1895.

A supposed cubic form of silica from Guanabacoa, Cuba, has been called *cubaite* by F. Vidal y Careta [Cron. Cient. Barcelona, **13**, 497, 1890]; shown by L. F. Navarro to be rhombohedrons of ordinary quartz, Anal. Soc Españ. Hist. Nat., **21**, Actas p. 120, 1893. Later (*ibid.*, **14**, 268, 1891) the first author proposed to substitute the name *guanabaquite* (*guanabacoite*); this includes also pseudomorphous chalcedony (analogous to that from Hungary) as further shown by Navarro, l. c.

**Quartzine. Lutécine, Lutecite.** *Michel-Lévy* and *Munier-Chalmas*, C. R., **110**, 649, 1892, and Bull. Soc. Min., **15**, 159, 1892. *Wallerant*, Bull. Soc. Min., **20**, 52, 1897.

The forms of anhydrous silica having a fibrous structure differ from quartz in slightly lower density (G. = 2·5–2 6) and more distinctly in optical characters. They are optically +, but *biaxial* with a small axial angle, 20° to 35°; birefringence 0·009 to 0·010. Three varieties have been distinguished, according to the direction of elongation of the fibers. (1) In *chalcedony* the elongation coincides with the axis $\mathfrak{a}$ (= $Bx_o$), in other words the direction of the fibers is sometimes said to be negative. (2) In *quartzine* it coincides with $\mathfrak{c}$, and in *lutécine* with a plane of symmetry (= $Bx_a$) to the axes $\mathfrak{c}$ and $\mathfrak{b}$, the fibers making an angle of 29° with $\mathfrak{c}$ and of 61° with $\mathfrak{b}$.

As interpreted by Michel-Lévy and Munier-Chalmas the regular arrangement of the fibers of chalcedony give rise to spherulites with concentric zones of like extinction; regular ternary (120°) aggregates of quartzine are regarded as producing ordinary quartz; the regular hexagonal (60°) arrangement of the elementary *lutécine* gives the double hexagonal pyramids of *lutécite*, aggregates about an axis inclined 45° to $\mathfrak{c}$ and 74° to the elongation of the fibers in the plane $\mathfrak{b}$ and $\mathfrak{c}$. According to Wallerant (l. c.) all quartz is to be regarded as formed by regular intergrowths of minute elements of quartzine.

It is obvious that these three forms of fibrous silica are essentially identical, and all their various aggregates seem to have been derived from original colloidal concretions. Groth (Tab. Ueb., 42, 1898) uses *quartzine* as a general term to embrace them all.

On quartzine from Heřman Mestec, Barvíř, Ber. Ak. Böhm., March 10, 1893.

*Christobalite* (p. 193) has been shown to result from the action of water and hydrofluoric acid (at 200° and 26 atmospheres) upon amorphous silica, Khrushchov, Bull. Acad. St. Pet., **2**, 27, 1895.

On the peculiar form of silica obtained from heulandite, with G. = 2·14 and optically negative, see Rinne, Jb. Min., 147, 1896.

QUENSTEDTITE, p. 957.—A ferric sulphate having the composition of quenstedite has been observed by O. Kuntze as a yellow incrustation in sandstone near Montpelier, Muscatine county, Iowa. H. = 2·5. G. = 2·212. Analysis gave: $SO_3$ 39·01, $Fe_2O_3$ 26·86, $Al_2O_3$ 0·27, $H_2O$ 32·32, insol. ($SiO_2$) 1·79 = 100·25. Amer. Geol., **23**, 119, 1899.

**Quirogite.** L. F. Navarro [Anal. Soc. Españ. Hist. Nat., **24**, Actas p. 96, 1895] Zs. Kr., **28**, 202, 1897. A supposed tetragonal mineral of metallic luster and lead-gray color, often tarnished dull. H. = 3. G. = 7·22. Analysis on material containing pyrite gave: S 17·51, Pb 63·89, Sb 9·69, Fe 6·30, Ag *tr.* = 97·39. From the mines San Andrés, Georgina, etc., Sierra Almagrera, Spain. Named after the Spanish mineralogist, F. Quiroga. Probably only an impure galena (cf. remarks credited to Schrauf, Zs. Kr., l. c.).

**Ransätite.** *L. J. Iglesträm*, G. För. Förh., **18**, 41, 1896.—See *Garnet.*

**Raspite.** *C. Hlawatsch*, Ann. Mus. Wien, **12**, 38, 1897; Zs. Kr., **29**, 137, 1897; **31**, 8, 1899.

Monoclinic. Axes $\grave{a} : \overset{+}{b} : \grave{c}$ = (1·3358 : 1 : 1·1112; $\beta$ = 72° 19′ = 1$\underline{0}$0 ∧ 001 = *ac*. Angles *ce* = 46° 41′, *cd* = 46° 38′. Observed forms: *a* (100), *b* (010), *c* (001), *e* ($\bar{1}01$), *d* (011). Crystals small, elongated ∥ $\overset{+}{b}$ and tabular ∥ *a* with this face as twinning plane; *a* striated horizontally.

Cleavage: *a* perfect. H. = 2·5. G. undetermined. Luster adamantine, brilliant. Color brownish yellow. Transparent. Ax. pl. ∥ *b*. An axis and negative bisectrix oblique to *a*. Index = 2·6 approx.

Composition, lead tungstate, $PbWO_4$, like stolzite. Analysis, Treadwell:

$WO_3$ 49·06 PbO 48·32 $Fe_2O_3$,MnO 1·43 = 98·81

Occurs with reddish stolzite on limonite at the Broken Hill mines, New South Wales. Named after Mr. Rasp, the discoverer of the Broken Hill mines.

**Rathite.** *Baumhauer*, Zs. Kryst., **26**, 593, 1896.

Orthorhombic. Axes $\breve{a} : \bar{b} : \grave{c}$ : = 0·6681 : 0 : 1·0579. 100 ∧ 110 = 33° $44\frac{4}{5}'$, 001 ∧ 101 = 57° $43\frac{1}{2}'$, 001 ∧ 011 = 46° $36\frac{2}{3}'$. Also 001 ∧ 203 = *46° 33′, 001 ∧ 045 = *40° $14\frac{1}{2}'$, 001 ∧ 021 = 64° 42′. Observed forms: (001), (107), (106), (209), (207), (103), (205), (102), (203), (405), (101), (403), (302), (201), (401), (601); (045), (0·11·10), (021), (0·16·3); also other forms in part vicinal.

In crystals, prismatic $\parallel \bar{b}$, with numerous macrodomes finely striated $\parallel$ an undetermined brachydome. Twins: tw.-plane an obtuse brachydome. In luster and color not to be distinguished from dufrenoysite.

In composition allied to dufrenoysite and jamesonite, but formula uncertain. Analysis, Bömer:

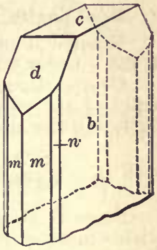
S 23·72 As 17·24 Sb 4·53 Pb 52·98 Fe 0·56 = 99·03

From the dolomite of the Binnenthal, Switzerland, with other related species. Named after Prof. G. vom Rath (1830–1888).

**Realgar**, pp. 33, 1046.—Crystals from Allchar, Macedonia, described (new form ζ (450)), Hackman, Zs. Kr., **27**, 608, 1896; also Vrba, Ber. Ak. Böhm., Dec. 7, 1894.

**Retzian.** *Hj. Sjögren*, Bull. G. Inst. Upsala, **2**, 54, 1894; G. För. Förh., **19**, 106, 1897.

Orthorhombic. Axes $\breve{a} : \bar{b} : \acute{c} = 0·4414 : 1 : 0·7269$. Forms: *b* (010), *m* (110), *n* (130), *d* (101), *k* (071). Angles: *mm‴* = 47° 38′, *bm* = *66° 11′, *cd* = *58° 44′. Crystals prismatic, sometimes tabular $\parallel b$. The axial ratio is near that of flinkite (Min., p. 802).



Cleavage none. Fracture conchoidal to uneven. H. = 4. G. = 4·15. Luster vitreous to greasy. Color dark chocolate-brown to chestnut-brown. Streak light brown. Subtranslucent. Strongly pleochroic. Ax. pl. $\parallel b$. Ax. angle large. $\mathfrak{a}, \mathfrak{b}, \mathfrak{c} = \acute{c}, \bar{b}, \grave{a}$.

In composition, a basic arsenate of manganese, calcium and undetermined rare metals; formula uncertain. Analysis, on 0·08 gr., R. Mauzelius:

| $As_2O_5$ | X[a] | MnO | FeO | PbO | CaO | MgO | $H_2O$ | |
|---|---|---|---|---|---|---|---|---|
| 24·4 | 10·3 | 30·2 | 1·7 | 0·2 | 19·2 | 2·7 | 8·4 | $SiO_2$ 0·5, insol. 4·3 = 101·9 |

[a] X = rare earths.

B.B. almost infusible; yields water. With soda on charcoal gives arsenical fumes; reacts for manganese and iron. Soluble in acids.

Found sparingly in small drusy cavities in the manganiferous limestone of the Moss mine, Nordmark, Sweden; it is associated with jacobsite. Named after the Swedish naturalist, Anders Jahan Retzian (1742–1821).

**Rhabdite**, p. 31.—See *Schreibersite.*

**Rhodoarsenian.** *L. J. Igelström*, Zs. Kr., **22**, 469, 1893. A partially described mineral from the Sjö mine, Örebro, Sweden. Occurs in small rose-red spherules embedded in arseniopleite. H. = 4. Luster vitreous. An analysis (after deducting $CaCO_3$) yielded: $As_2O_5$ 12·17, MnO 49·28, CaO 21·53, MgO 5·37, $H_2O$ 11·65, Pb,Cl *tr.* = 100. Regarded as the arsenic compound corresponding to ferrostibian (Min., p. 804).

**Rhodochrosite**, p. 278.—Artificial formation, A. de Schulten, Bull. Soc. Min., **20**, 195, 1897.

**Rhodolite.** *Hidden* and *Pratt*, Am. J. Sc., **5**, 294; **6**, 463, 1898.—See *Garnet.*

**Rhodonite**, pp. 378, 1046.—Etching-figures investigated, T. L. Walker, Am. J. Sc., **5**, 182, 1898.

**Rhodophosphite.** *L. J. Igelström*, Zs. Kryst., **25**, 433, 1895. A mineral occurring in a quartzite carrying cyanite with svanbergite, lazulite, etc., at the Hörrsjöberg Mts., Wermland, Sweden. Occurs crystalline (hexagonal), cleavable; color white or pale red; translucent. Analysis: $P_2O_5$ 36·42, CaO 45·17, MnO,FeO 8·80, Cl 2·92, $SO_3$ 1·34, F *undet.* = 94·65 (author gives 97·93). It is probably simply apatite.

**Rhodusite.** H. B. Foullon, Ber. Ak. Wien, **100** (1), 176, 1891.—See *Glaucophane.*

**Richterite**, pp. 386, 391.—Hj. Sjögren has shown that the original mineral of Breithaupt is identical with that examined by Michaelson, Igelström and Flink. His astochite (Min., p. 1027) is simply a *soda-richterite*, see astochite, this Append., p. 6). Sjögren also refers here the marmairolite of Hulst, Min., p. 391. G. För. Förh., **13**, 604, 1891; *ib.*, **14**, 253, 1892; Bull. G. Inst. Upsala, **2**, 71, 1894; also Hamberg, G. För. Förh., **13**, 801, 1891.

**Riebeckite**, pp. 400, 1047.—Occurs in pebbles in the glacial drift of the east coast of Ireland; crystals found at Portrane have been measured by Sollas. Observed forms: *b* (010), *m* (110), *x* (150), *t* (101), *p* ($\bar{1}$01), *r* (011), *z* ($\bar{1}$21). Angles: *mm‴* = 56°, *pm′* = 77° 50′, *pt* = 54° 20′, hence $\grave{a} : \bar{b} : \acute{c} = 0·5558 : 1 : 0·2927$, $\beta = 73° 4′$. A partial analysis gave: $SiO_2$ 42·69, $Al_2O_3$,$Fe_2O_3$ 41·71, $Na_2O$ 10·00, $K_2O$ 0·87. Proc. R. Irish Acad., **3**, 516, 1895.

Heddle has noted on crystals from the micro-granite of Ailsa Craig, Scotland, the additional forms: *a* (100), *c* (001), *e* (130), *i* (031), *o* (021). Trans. Edinb. G. Soc., **7**, 265, 1897.

Occurs in an intrusive rock in slates between Song and Tikobu, Southern Sikkim, India, Holland, Rec. G. Surv. India, **25**, 159, 1892. Extinction-angle 7° 30′ to 10° with $\dot{c}$. Also reported by A. Osann as occurring in the nephelite-syenite of Paisano Pass, Davis Mountains, Texas, Geol. Surv. Texas, 4th Ann. Report, 1892, p. 28. Occurs in trachytic rocks from Abyssinia, Prior, Min. Mag., **12**, 92, 1899.

See *Crossite.*

RITTINGERITE, p. 136.—Shown by Miers to be identical with xanthoconite, wh. see. Min. Mag., **10**, 185, 1893.

**Roeblingite.** *S. L. Penfield* and *H. W. Foote,* Am. J. Sc., **3**, 413, 1897.

Massive; closely compact; consisting of aggregates of prismatic crystals. H. = 3·25. G. = 3·433. Color white. Extinction parallel; birefringence low.

Composition, probably $H_{10}Ca_7Pb_2Si_6S_2O_{28}$, which is regarded as a combination of five molecules of the silicate, $H_2CaSiO_4$, and two of the basic sulphite, $CaPbSO_4$. This requires: Silica 22·1, sulphur trioxide 9·4, lead protoxide 32·9, lime 29·0, water 6·6 = 100. Analysis:

| | SiO | $SO_3$ | PbO | MnO | CaO | SrO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| ⅔ | 23·58 | 9·00 | 31·03 | 2·48 | 25·95 | 1·40 | 0·13 | 0·40 | 6·35 = 100·32 |

Fuses B. B. at 3 to a gray globule giving the pale blue flame of lead. With soda on charcoal yields metallic lead and a lead coating. In the closed tube yields water. Dissolves readily even in dilute acid, yielding gelatinous silica on evaporation.

Found at a depth of 1000 feet in the Parker shaft at Franklin Furnace, N. J.; occurs at or near the contact of the granite and limestone with garnet rock; associated with titanite, axinite, zircon, willemite, rhodonite, etc. Named after W. A. Roebling of Trenton, N. J.

ROUMÄNITE.—See *Rumänite,* Min., p. 1005.

ROWLANDITE, p. 1047.—Further described by Hidden with analysis by Hillebrand, Am. J. Sc., **46**, 208, 1893.

RUTILE, pp. 237, 1047.—Crystals from the Valais, twins, etc., described, Baumhauer, Cong. Sc. Catholiques, Fribourg, 1897.

Parting ‖ (902) (cf. Min., p. 238) observed on crystals from Prägratten and Georgia, Mügge, Jb. Min., **2**, 82, 1897.

Occurs at West Cheyenne Cañon, El Paso Co., Colorado, in iron-black distorted crystals containing 6·68 p. c. $Fe_2O_3$; G. = 4·249, Genth and Penfield, Am. J. Sc., **44**, 384, 1892.

Shown by spectroscopic examination to often contain vanadium in small amount, Hasselberg, Astrophysical Journal, **6**, 22, 1897; **9**, 143, 1899. Ak. H. Stockh., Bih., **23**, (1), No. 3, 1898. Cf. also Hillebrand, Am. J. Sc., **6**, 209, 1898.

Artificial formation, Michel, Bull. Soc. Min., **15**, 37, 1892.

See *Dicksbergite.*

SAFFLORITE, p. 100.—A related mineral occurs at the Ko mine, Nordmark, Sweden, with chondrodite, tremolite, etc. Usually massive, rarely in prismatic crystals elongated, ‖ $\bar{b}$; *e* (101) prominent. Forms: *a* (100), *m* (110), *e* (001), *d* (011), *o* (111). Angles $ee''' = 59° 14'$, $oo' = 105° 20'$. Axial ratio $\breve{a} : \bar{b} : \dot{c} = 0{\cdot}5086 : 1 : 0{\cdot}8945$ or $0{\cdot}6782 : \frac{4}{3}\, 1{\cdot}1927$, the latter showing the relation to arsenopyrite, etc. G. = 7·41. Analysis by R. Mauzelius: As 71·13, S 0·68, Fe 15·28, Co 12·99, Ni 0·20, Pb(Cu) 0·33 = 100·61. This gives the formula (nearly) $FeAs_2.CoAs_2$. Hj. Sjögren, Bull. G. Inst. Upsala, **2**, 68, 1894.

SAL-AMMONIAC, p. 157.—Observations on crystals, Wolff, Ber. Ak. Berlin, 1085, 1895.

SALITE, p. 356.—See *Pyroxene.*

**Salvadorite.** *W. Herz,* Zs. Kryst., **26**, 16, 1896.

Monoclinic. In aggregates of rough prismatic crystals, with *m* (110), also *b* (010); $mm''' = 48° 16'$. Crystals often twins united by a plane inclined 30° to $\dot{c}$.

Cleavage: *b* perfect. Luster vitreous. Color green to blue, bluish green. Ax. pl. ‖ *b*. $Bx_a$ inclined 52° to $\dot{c}$ for Na (on same side as tw. plane), 46½° for Tl; ax. angle 76° for Na.

Composition like pisanite (Min., p. 943), $(Cu,Fe)SO_4 + 7H_2O$ with Cu : Fe = 2 : 1. Analyses:

| | $SO_3$ | CuO | FeO | $H_2O$ |
|---|---|---|---|---|
| 1. *Green* | 27·87 | 18·77 | 8·49 | 44·65 = 99·78 |
| 2. *Blue* | 28·16 | 17·57 | 9·59 | 44·31 = 99·63 |

From the Salvador mine, Quetena near Calama, Chili. Differs from pisanite in optical orientation and apparently in form.

Samarskite, pp. 739, 1037.—Contains germanium in small amount (1·5 p. c ); this is also true of tantalite, fergusonite, gadolinite, columbite, etc., Khrushchov, Zs. Kr., **24**, 516, 1895. Analysis from the Ural by the same, Vh. Min. Ges., **31**, 415, 1894.

Examination of gases (helium, etc.), Ramsay, Proc. Roy. Soc., **59**, 325, 1896. Ramsay and Travers, *ib.*, **60**, 443, 1897.

Sartorite, p. 113.—Description of complex crystals (new forms) from the Binnenthal with analysis, Baumhauer, Ber. Ak. Berlin, 243, 1895.

Scapolite, p. 466.—Crystals from Eel lake, Frontenac Co., Ontario, described, G. O. Smith, Johns Hopkins Circ., No. 112, May, 1894. Analysis of a "paranthite" from Clay Co., N. C., Berkley, Am Ch. J., **14**, 628, 1892.

See also *Wernerite.*

Scheelite, p. 985.—From Marlow township, Beauce Co., Quebec, analysis by Johnston quoted by Hoffmann, Rep. G. Canada, **5**, 21R, 1889-90; also from the Ballou mine, Queens Co., Nova Scotia, *ibid.*, **7**, 14R.

Occurs at South Mountain, Pa., with piedmontite in an ancient rhyolite, Williams, Am. J. Sc., **44**, 50, 1893.

Schefferite, p. 357.—See *Pyroxene.*

Schneebergite, p. 862.—See *Garnet.*

Schoenite, p. 948.—See *Picromerite.*

Schreibersite, p. 31.—Cohen, as the result of an investigation of many meteoric irons, has shown that the tetragonal iron-nickel phosphide, called *rhabdite* (Min., p. 31), is identical with schreibersite; the relative amounts of the metals vary widely. Ann. Mus. Wien, **9**, 97, 1894.

"Rhabdite" occurs in tetragonal crystalline forms (with (001), (110), (111)) in the meteoric iron of Bendegó, Brazil; 110 ∧ 111 = 39°-40° Hussak. Cf. Derby, Arch. Mus. Nac., Rio de Janeiro, **9**, 171, 1896.

**Schulzenite.** *P. Martens* [Act. Soc. Sci. Chili, **5**, 87, 1895], Bull. Soc. Min., **19**, 211, 1896. A doubtful substance of uncertain origin, related to asbolite. Found in the collection of J. Schulze and supposed to have come from northern Chili. Amorphous with conchoidal fracture. H. = 3·5. G. = 3·39. Color and streak black. Gives off chlorine when treated with hydrochloric acid. Analysis gave: Co 46·76, Cu 12·65, $SiO_2$ 1·76, $Fe_2O_3$ 0·29, $H_2O$ (comb.) 14·08, $H_2O$ (hygr.) 4·92, O [19·54] = 100. From this the formula is deduced: $CuO.2CoO.Co_2O_3 + 4H_2O$.

Scolecite, p. 604.—Referred to the clinohedral group of the monoclinic system by Rinne, who gives the results of investigation by etching, pyroelectricity, etc. Jb. Min., **2**, 51, 1894. Moderate heating causes a partial loss of water, and this is accompanied by molecular changes, the new form being called *metascolecite*, *ibid.*, p. 60; also Ber. Ak. Berlin, **46**, 1163, 1890.

Crystals from the Tulferthal, Tyrol, described by Habert, Zs. Kr., **28**, 252, 1897.

Analysis, from granite on the Struth, Thuringia, Fomme [Ber. phys.-med. Soc. Erlangen, **25**, 1893]. Zs. Kr., **25**, 616. Also from Italian Peak, Gunnison Co., Colo., Eakins, Bull. U. S. G. Surv., **113**, 112, 1898.

Scorodite, p. 821.—Crystals from the Lölling show the forms *h* (101), *f* (011), Busz, Zs. Kr., **20**, 555, 1892.

**Seelandite.** *Brunlechner* [Jb. Nat. Land.-Mus. Klagenfurt. **22**, 192, 1893], Bull. Soc. Min., **19**, 121, 1896. A variety of pickeringite forming an efflorescence on the siderite of Lölling, Carinthia. Composition, $MgAl_2(SO_4)_4 + 27H_2O$, deduced from the analysis: $SO_3$ 34·03, $Al_2O_3$ 10·54, MgO 4·07, $H_2O$ 51·22 = 99·86.

Semseyite, p. 123.—L. J. Spencer has described (Min. Mag., **12**, 60, 1899) crystals from Wolfsberg similar to Krenner's mineral and yielding: S 19·42, Sb 28·62, Pb 51·84 = 99·88, G = 5·92; calculated formula $21PbS.10Sb_2S_3$. The form is near that of plagionite. The author also discusses the relations of plagionite, heteromorphite and semseyite, and the suggestion is made that they may form a morphotropic series from $5PbS.4Sb_2S_3$ (through $7PbS.4Sb_2S_3$, etc., heteromorphite) to $9PbS.4Sb_2S_3$. The complex formulas often obtained (cf. plagionite) may be explained by assuming that the crystals analyzed in a given case are compounded of smaller crystals in nearly parallel position but differing among themselves slightly in angle and composition.

**Senaite.** *E. Hussak* and *G. T. Prior*, Min. Mag., **12**, 30, 1898.

Tri-rhombohedral like ilmenite (phenacite type). Axis 0·997. *cr* = 49° 4′. In crystals with the forms *c* (0001); *r* $(10\bar{1}1)$, *S* $(20\bar{2}1)$, *z* $(40\bar{4}1)$. Twins common, tw. pl. *a* $(11\bar{2}0)$.

Cleavage none. Fracture conchoidal. H. = 6 or slightly above. G. = 5·301 unchanged cryst.; 4·78 fresh grains; 4·22 altered cryst. Luster submetallic. Color black. Streak brownish black. In very thin splinters oil-green to greenish brown. Optically uniaxial; birefringence low Not magnetic.

Composition uncertain; if the iron is all FeO and the manganese $MnO_2$, the approximate formula is $(Fe,Pb)O.2(Ti,Mn)O_2$. Analysis, Prior:

| $TiO_2$ | $Fe_2O_3$ | PbO | FeO | MnO | MgO | $SnO_2$ |
|---|---|---|---|---|---|---|
| 57·21 | 20·22 | 10·51 | 4·14 | 7·00 | 0·49 | 0·11 = 99·68 |

Occurs in rounded fragments and rough crystals in the diamond-bearing sands of Diamantina, Minas Geraes, Brazil. Named after Prof. Joachim da Costa Sena of Ouro Preto, Brazil.

Senarmontite, p. 198.—Occurs at Nieddoris, Sardinia, Brugnatelli, Rend. Accad. Linc., **3** (1), 78, 1894.

Sepiolite, p. 680.—Optical structure investigated, also of other compact "amorphous" minerals (glauconite, celadonite, halloysite, nontronite), which are shown to be crystalline with minute mica-like scales, Lacroix, C. R., **121**, 737, 1895; Bull. Soc. Min., **18**, 426, and Min. France, Vol. 1.

Analysis from Eskishehir, Asia Minor, Weinschenk, Zs. Kr., **27**, 574, 1896.

Serpentine, pp. 669, 1047.—**Anal.**—Kynance Cove, Lizard, England, aluminous var. (pseudophyte), Fox, Min. Mag., **9**, 275, 1891. Binnenthal, Duparc and Mrazec, Bull Soc. Min., **17**, 210, 1894. Elzivir, Ontario, antholite, Coleman, Am. J. Sc., **48**, 281, 1894. Serpentine and serpentine rocks of northern Syria, formation from gabbros and associated peridotites, Finckh, Zs. G. Ges., **50**, 113 *et seq.*, 1898.

**Comp.**—Discussion of composition with experiments and analyses, R. Brauns, Jb. Min., **1**, 205, 1894; Zs. anorg. Ch., **8**, 348, 1895, Schneider, *ibid.*, **8**, 98, 1895; A. Lindner [Inaug. Diss., Breslau, 1893], Zs. Kr., **25**, 589, 1896.

Occurrence and associated minerals in the Austrian Alps, Weinschenk, Zs. Kr., **26**, 337, **27**, 559, 1896.

Serpierite, p. 963.—Laurion, Greece, analysis by Frenzel: (G. = 2·52), $SO_3$ 24·29, CuO 36·12, ZnO 13·95, CaO 8·00, $H_2O$ 16·75 = 99·11. The formula deduced is $3(Cu,Zn,Ca)SO_4 + 3H_2O$. Min. petr. Mitth., **14**, 121, 1894.

Siderite, pp. 276, 1047.—Description of crystals from France with the new forms $(03\bar{3}2)$, $(10\bar{1}2)$, $(30\bar{3}4)$, Gonnard, Bull. Soc. Min., **18**, 382, 1895.

From Neunkirchen, Siegen, containing 3·85 p. c. CoO, Bodländer, Jb. Min., **2**, 236, 1892. Occurrence and origin in the Province of Drenthe, Holland, G. M. van Bemmelen, Arch. Néerland., **30**, 25, 1897. Occurrence in the Mecklenburg Moors, A. Gärtner, Arch. Ver. Meckl., **51**, 1897.

The "clay-ironstone" of Yorkshire, England, contains gallium, Hartley and Ramage, Proc. Roy. Soc., **60**, 35, 393, 1896.

**Siderotil.** *A. Schrauf*, Jb. G. Reichs., **41**, 380, 1892. A rare iron sulphate occurring in groups of divergent needles with melanterite at Idria, Carniola. Composition, $FeSO_4.5H_2O$, deduced from the approximate analysis: $SO_3$ 34·3, $Fe_2O_3$ 31·7, FeO 30·0, $H_2O$ [34·0], MgO *tr.* = 100.

Silicates.—Discussion of constitution, F. W. Clarke, Bull. U. S. G. Surv., **125**, also **113**.

Sillimanite, p. 498.—Experimental investigation of conditions of formation in a magma, Morozewicz, Min. petr. Mitth., **18**, 22, 1898.

Silver, p. 19.—Occurs at Silver Hill, near Livingston, Davidson Co., N. C., Kunz, Am. J. Sc., **7**, 242, 1899. Also in groups of minute crystals at the Elkhorn mine, Jefferson Co., Montana (Pfd.).

**Sjögrufvite** *Igelström*, G. För. Förh., **14**, 309, 1892. A partially investigated mineral from the Sjö mine, Örebro, Sweden. Occurs in cavities and minute veins with jacobsite. Crystalline. Color yellow; blood-red in thin layers. Streak yellow. Dissolves completely in cold hydrochloric acid without evolution of gas. Analysis gave: $As_2O_5$ 49·46, $Fe_2O_3$ 11·29, MnO 27·26, CaO 3·61, PbO 1·74, $H_2O$ 6·81 = 100·17. It is related to arseniopleite (Min., p. 803).

**Skutterudite**, p. 93.—Crystals from the Turtmannthal, Switzerland, show the forms: *a* (100), *o* (111), *d* (110), *e* (210), *n* (211). Analysis: As 74·45, S 0·72, Bi 4·40, Co,Ni 10·47, Fe 3·90, gangue 0·28 = 100·22. Staudenmaier, Zs. Kr., **20**, 468, 1892.

*Bismutosmaltite* is a skutterudite containing bismuth. Occurs in small crystals, *a* and *o* or *a* and *d*. Brittle. H. = 6. G. = 6·92. Luster metallic. Color tin-white. Streak black. Composition, $Co(As,Bi)_3$. Analysis: As 61·59, Bi 20·17, Sb 0·16, Co 13·70, Cu 0·69, Fe 3·71, S 0·05 = 100·07. Occurs with other bismuth minerals at Zschorlau, near Schneeberg, Saxony. Frenzel, Min. petr. Mitth., **16**, 524, 1896.

*Nickel-skutterudite* is a variety occurring in granular form in the Bullard's Peak distr., Grant Co., New Mexico. H. = 5; color gray; streak black. Analysis, after deducting 4·56 $SiO_2$ and 8·38 Ag (native silver), yielded: As 78·10, Ni 12·80, Co 5·95, Fe 3·15 = 100. This corresponds to $RAs_3$ with R = Ni : Co : Fe = 4 : 2 : 1. Waller and Moses, Sch. Mines Q., **14**, 49, 1892.

**Smithsonite**, p. 279.—A variety from Bolco, Lower California, has a delicate pink color, G. = 3·874, and contains 39·02 p. c. ZnO, 10·25 CoO, 3·36 MnO, 7·22 MgO. C. H. Warren, Am. J. Sc., **6**, 123, 1898.

Analysis of the "turkey-fat ore" of Marion Co., Arkansas, gave H. N. Stokes, CdS 0·25, CdO 0·63, etc., Bull. U. S. G. Surv., **90**, 62, 1892.

On the occurrence of lead and zinc ores in Iowa, A. G. Leonard, Iowa Geol. Surv., **6**, 1896.

**Soda-berzeliite.**—See *Berzeliite.*

**Soda-niter**, p. 870.—On the morphology, see Wolff, Ber. Ak. Berlin, 715, 1895; 135, 1896.

**Soda-richterite.**—See *Astochite* and *Richterite.*

**Sodalite**, p. 428.—**Anal.**—Hastings Co., Ontario, etc., Luquer and Volckening, Am. J. Sc., **49**, 465, 1895. Dungannon, Hastings Co., Ontario, Harrington, *ibid.*, **48**, 17, 1894. From the trachyte of Montesanto, Italy, Franco, Zs. Kr., **25**, 332, 1895.

Reported by Osann as occurring in the nephelite-syenite of Paisano Pass, Davis Mts., Texas, Geol. Surv. Texas, 4th Ann. Rep., 128, 1892.

On the formation of some twenty-five analogous compounds, Thugutt [Inaug. Diss., Dorpat, 1891], Zs. anorg. Ch., **2**, 65, 113, 1892, also Jb. Min., **2**, 10 ref., 1893.

Experimental investigation of conditions of formation in a magma (also for related species), Morozewicz, Min. petr. Mitth., **18**, 128, 1898.

**Spangolite**, p. 919.—Associated with connellite, clinoclasite, liroconite from Cornwall (probably the St. Day distr., Redruth?); in *hemimorphic*, hexagonal crystals, pyroelectric. Miers Nature, **48**, 426, 1893, and Min. Mag., **10**. 273, 1894.

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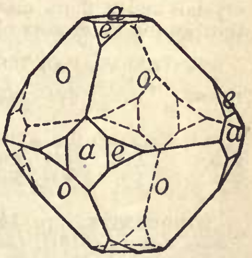


Sperrylite

**Sperrylite**, p. 92.—Crystals from the Vermillion mine show the diploid (10·5·2), T. L. Walker, Am. J. Sc., **1**, 110, 1896.

Occurrence and crystals (Fig. 1 by G. H. Edwards) described, from Macon Co., N. Carolina, Hidden, Am. J. Sc., **6**, 381, 467, 1898.

**Sphærostilbite**, p. 583.—Prior shows that the supposed mineral of Beudant probably has no existence. Specimens from various localities called by this name proved to be thomsonite, not stilbite. Min. Mag., **12**, 26, 1898.

**Sphalerite**, pp. 59, 1048.—**Cryst.**—Binnenthal, new form $3\bar{1}6$, Cesàro. Bull. Acad. Belg., **25**, 88, 1893; also earlier 618 (or $6\bar{1}8$), *idem*, Ann. Soc. G. Belg., **17**, 237, 1890. Kis-Almás, Hungary, new form (10·10·1), Franzenau, Zs. Kr., **27**, 95, 1896 Galena, Ill., new form (775), Hobbs, Bull. Univ. Wisconsin, **1**, 134, 1895, and Zs. Kr., **25**, 268 Harz Mts., Luedecke, Min d. Harzes, 53 1896. Val Trompia. Bóvegno, Artini, Rend. Ist. Lombardo, **30**, 1526, 1897.

Analysis of "schalenblende" from Mies, Bohemia, with 1 02 p. c. cadmium. Becke, Min. petr. Mitth., **14**, 278, 1894.

Peelwood, N. S. W., contains gallium and indium, Kirkland, Austr. Assoc. Adv. Sci., **4**, 266, 1892.

A variety (Cornwall?) containing 9·29 p. c. Fe has perfect metallic luster, Miers, Min. Mag., **12**, 111, 1899.

**Spinel**, pp. 220, 1048.—Experimental investigation of the conditions of formation in a magma, Morozewicz, Min. petr. Mitth., **18**, 22, 1898

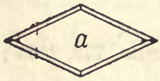
SPODIOSITE, p. 777.—Crystals from Nordmark, Sweden, examined by G. Nordenskiöld were orthorhombic with the forms: *a* (100), *b* (010), *c* (001), *m* (110), *d* (102), *e* (021), *p* (111), *q* (254)?, *r* (854)?. Axes deduced $\breve{a} : \bar{b} : \dot{c}$ = 0·8944 : 1 : 1·5836; *bm* = *48° 11′·4, *cp* = *67° 10′·2. Analysis on material much decomposed gave (cf. anal., p. 777): $P_2O_5$ 29·62, CaO 45·84, MgO 8·56, $Al_2O_3 + Fe_2O_3$ 2·38, $SiO_2$ 8·74, $H_2O$ 3·76, F 2·94 = 101·84. The formula deduced is $mCa_3P_2O_8 + nCaF_2$. G. För. Förh., **15**, 460, 1893.

STANNITE, p. 83.—Tetrahedral crystals are mentioned by vom Rath, Vh. Ver. Rheinl., **41**, 296, 1884; also Stelzner (from Bolivia), Zs. G. Ges., **49**, 97, 1897.

Shown by Headden to occur at the Peerless and Etta mines, Black Hills, S. Dakota, Am. J. Sc., **45**, 105, 1893. Analysis (Peerless mine) gave: S 28·26, Sn 24·08, Cu 29·81, Fe 7·45, Zn 8·71, Cd 0·33, Sb *tr.*, insol. 1·51 = 100·15. G. = 4·534; color grayish black. Largely altered by oxidation to a greenish earthy mass; this substance has been made by Ulke (Trans. Am. Inst. Mng. Eng., **21**, 240, Feb., 1892) the basis of a new species, *cuprocassiterite*, supposed (as the result of a partial analysis) to have the formula, $4SnO_2 + Cu_2Sn(OH)_2$. Headden shows, however, that the composition varies widely.

STAUROLITE, p. 558.—Penfield and Pratt, on the basis of new analyses (below) on pure material, have established the formula $HAl_5FeSi_2O_{13}$, or $(AlO)_4(AlOH)Fe(SiO_4)_2$. Sections of crystals from Lisbon, N. H., show a regular arrangement of carbonaceous inclusions, thus Figs. 1 to 4, cut from the same crystal.

1.



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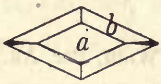

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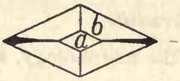

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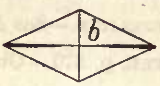


| | G. | | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | MgO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| 1. St. Gothard | 3·748 | $\frac{2}{2}$ | 27·73 | 53·29 | 2·83 | 11·21 | 0·53 | 1·81 | 2·19 = 99·59 |
| 2. Windham, Me. | 3·728 | $\frac{3}{3}$ | 27·84 | 54·46 | 2·83 | 10·60 | 0·59 | 1·85 | 2·24 = 100·41 |
| 3. Lisbon, N. H. | 3·775 | | 27·81 | 54·09 | 2·76 | 12·48 | — | 1.92 | 1·70 = 100·76 |
| 4. Burnsville, N. C. | 3·773 | $\frac{5}{5}$ | 27·70 | 53·22 | 4·82 | 9·72 | 0·34 | 2·66 | 1·97 = 100·43 |

The composition has also been discussed by Rammelsberg, Jb. Min., Beil.-Bd., **9**, 480, and Ber. Ak. Berlin, 435, 1893.

STEENSTRUPINE, p. 415.—Further examined by Moberg (Zs. Kr., **29**, 386, 1898) with the following results: Crystallization rhombohedral, axis $\dot{c}$ = 1·0842, *cr* = *51° 23′, *rr′* = 85° 10′. Forms: *c* (0001), *a* $(11\bar{2}0)$, *ρ* $(50\bar{5}9)$, *r* $(10\bar{1}1)$, *z* $(40\bar{4}1)$, *ε* $(01\bar{1}3)$, *e* $(01\bar{1}2)$, *f* $(04\bar{4}5)$, *d* $(02\bar{2}1)$, *ξ* $(08\bar{8}1)$. Habit rhombohedral, *r* predominating. Cleavage none. Fracture conchoidal. H. = 4. G. = 3·40–3·47 cryst.; 3·19 massive. Luster resinous. Color dark brown to nearly black. Streak brown. Optically –. Birefringence low. By alteration isotropic. Analyses by Blomstrand, 1 on crystals and 2, 3 on massive material; all somewhat altered, the crystals least so. About one-third of the water goes off at 100° to 110°.

| | $SiO_2$ | $(Ta,Nb)_2O_5$ | $P_2O_5$ | $ThO_2$ | $Ce_2O_3$ | $(La,Di)_2O_3$ | $Y_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ | MnO | $Al_2O_3$ | BeO | CaO | PbO | $Na_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 26·57 | 1·21 | 5·81 | 3·03 | 14·40 | 15·90 | | 4·55 | 1·82 | 2·32 | 2·55 | | 4·03 | 0·46 | 8·34 |

$K_2O$ 0·50, $H_2O$ 7·58 = 99·07

| | $SiO_2$ | $(Ta,Nb)_2O_5$ | $P_2O_5$ | $ThO_2$ | $CeO_2$ | $(La,Di)_2O_3$ | $Y_2O_3$ | $Fe_2O_3$ | $Mn_2O_3$ | $Al_2O_3$ | BeO | CaO | PbO | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2. | 20·61 | 1·58 | 4·53 | 8·84 | 17·85 | 15·52 | 2·19 | 5·18 | 5·79 | 0·40 | 1·22 | 4·22 | 1·02 | 2·53 | 12·73 = 99·21 |
| 3. | 21·30 | 1·02 | 4·39 | 4·13 | 19·40 | 16·68 | 1·68 | 4·91 | 6·80 | 0·60 | 1·93 | 4·55 | 0·78 | 2·54 | 10·30 = 101·01 |

STEPHANITE, pp. 143, 1025, 1048.—**Cryst.**—Sarrabus, Sardinia, crystal monograph, new forms noted: (510)?, (230), (0·5·11)?, (818), (18·5·5), (13·4·4), (7·11·9), (372), (141), (2·10·1), (161). Artini, Giorn. Min., **2**, 241, 1891. Přibram, cryst. memoir, new forms: *N* (522), $r_3$ (441), $h_3$ (9·13·18)?, $t_3$ (8·33·16)?, Nejdl, Ber. Böhm. Ges., Feb. 8, 1895. Harz Mts., Luedecke, Min. d. Harzes, 168, 1896. Chili, new forms (551), (10·10·3), L. J. Spencer, Min. Mag., **11**, 196, 1897.

**Stevensite.**—See *Talc.*

**Stibiotantalite.** *G. A. Goyder*, J. Ch. Soc., **63**, 1076, 1893. A mineral substance, occurring in water-worn fragments in the tin-bearing sands of Greenbushes, West Australia. Analysis on nearly pure material gave: $Ta_2O_5$ 51·13, $Nb_2O_5$ 7·56, $Sb_2O_3$ 40·23, $Bi_2O_3$ 0·82, NiO 0·08, $H_2O$ 0·08 = 99·90. G. = 7·37. H. = 5–5·5. Luster adamantine to resinous. Color pale reddish yellow to greenish yellow and yellow. Fracture subconchoidal to granular. Structure crystalline.

STIBNITE, pp. 36, 1048.—**Cryst.**—Cetine, Italy, Artini, Rend. Accad. Linc., 3 (2), 416, 1894. **Allchar, Macedonia,** Vrba, Ber. Ak. Böhm. Dec. 7, 1894. Schlaining, Hungary, new forms

$\mathfrak{b}$ (034), $\mathfrak{A}$ (10·9·15), $\mathfrak{w}$ (12·19·3), $\mathfrak{s}$ (40·19·10), $\mathfrak{r}$ (563), A. Schmidt, Zs. Kr., **29**, 196, 1897. Brixlegg, Tyrol, Worobieff, Zs. Kr., **31**, 52, 1899.

Heat conductivity measured, F. B. Peck, Zs. Kr., **27**, 316, 1896.

STILBITE, p. 583.—Crystals from the Tulferthal, Tyrol, described, Habert, Zs. Kr., **28**, 243, 1897.

Change in physical and chemical characters brought about by the action of sulphuric acid, Rinne, Jb. Min., **1**, 41, 1897. The name *metadesmine* (p. 58) is given to the forms resulting from more or less complete dehydration; the chemical and physical changes are found to go on together.

See *Sphærostilbite*.

STILPNOMELANE, p. 658.—Occurs at the Wallbridge mine, Madoc, Hastings Co., Ontario; Also on Partridge Is., Nova Scotia. Hoffmann, Rep. G. Canada, **7**, 15R.

STOLZITE, p. 989.—Crystals from Loudville, Mass., described by Emerson are hemihedral with the forms: (120), (130), (101), (111), (131), (342). Bull. U. S. G. Surv., **126**, 163, 1895.

Crystals from the Broken Hill mines, New South Wales, described by C. Hlawatsch, show the new forms; *a* (100), $\Omega$ (1·0·10) ?, $\varpi$ (109), $\tau$ (103), *o* (102), $\eta$ (203), *h* (304), $\epsilon$ (201), $\pi$ (133), *A* (155). Axis $\dot{c} = 1·5606$. Optically −. Indices $\omega_y = 2·2685$, $\epsilon_y = 2·182$. Analysis by Treadwell. Zs. Kr., **29**, 180, 1897.

On rounded faces, etching-figures, etc., Hlawatsch, Zs. Kr., **31**, 1, 1899.

STRIGOVITE, p. 659.—Analysis, Grand Marais, Minn., Berkey 23d Ann. Rep't Minn. G. Surv., p. 197.

STROMEYERITE, pp. 56, 1048.—Occurs at the Silver King mine, Toad Mt., Yale district, Br. Columbia (anal. by Johnston), Hoffmann, Rep. G. Canada, **8**, 13R, 1895.

STRONTIANITE, pp. 285, 1048.—Occurs in Nepean township, Carleton Co., Ontario, Hoffmann, Rep. G. Canada, **6**, 22R, 30R, 1892–93 At Lubna, near Rakonitz, Bohemia, Eichleiter, Vh. G. Reichs., 297, 1898.

SUCCINITE, p. 1004.—See investigations on succinite and related resins by Dahms, Schrift. Ges. Danzig, **8**, Nos. 3–4, p. 97, 1892; **9**, No. 2, 1, 1895. Also Aweng [Arch. f. Pharm., **232**, 660, 1894], Jb. Min., **2**, 254 ref., 1896; Helm [*ibid.*, **233**, 191, 1895], Jb. Min., **2**, 255, 1896. Also Monograph. d. baltisch. Bernsteinbäume, H. Conwentz, Danzig, 1890.

See also *allingite*, *burmite*, *cedarite*, etc.

**Sulfoborite.** See *Sulphoborite*.

**Sulphoborite.** Sulfoborit, *H. Naupert* and *W. Wense*, Ber. Ch. Ges. **26**, 874, 1893. *H. Bücking*, Ber. Ak. Berlin, 967, 1893.

Orthorhombic. Axes $\breve{a} : \bar{b} : \dot{c} = 0·6196 : 1 : 0·8100$. Observed forms: *b* (010), *c* (001), *m* (110), *r* (101), *o* (111). Angles: $mm''' = 63° 34'$, $oo' = {*}90° 53'$, $oo^{iv} = {*}66° 4'$, $oo'' = 113° 56'$, $oo''' = 52° 24'$. In small prismatic crystals of varying habit.

Cleavage: *m* rather perfect; *c* less so. Brittle. H. = 4. G. = 2·38–2·45 Naupert and Wense; 2·416 Thaddéeff, also clear cryst. 2·440. Luster dull on *c*. Colorless or reddish on the exterior ($Fe_2O_3$). Transparent. Optically − . Ax. pl. ∥ *b*. $Bx_a \perp c$. $2H_{a.y} = 79° 36'$, $2H_{o.y} = 85° 4'$ Na. $\therefore \beta_y = 1·5396$, also $\alpha_y = 1·5272$, $\gamma_y = 1·5443$.

Composition, $2MgSO_4.4MgHBO_3.7H_2O$ Thaddéeff; Naupert and Wense obtained $3MgSO_4.2Mg_3B_4O_9 + 12H_2O$. Analyses, 1, Naupert and Wense; 2 Thaddéeff, Zs. Kr., 28, 264, 1897.

| | $SO_3$ | $B_2O_3$ | MgO | $H_2O$ |
|---|---|---|---|---|
| 1. | 21·95 ($\frac{2}{2}$) | [23·64] | 32·91 | 21·50 = 100 |
| 2. | 22·46 | 19·79 | 33·48 | 23·43 (ign.), $H_2O$ 0·10 (110°–170°), $Fe_2O_3$ 0·11, insol. 0·32 = 99·69 |

B.B. fuses with intumescence, coloring the flame green; reacts for sulphur with soda on charcoal. Dissolves rather readily in mineral acids.

From the salt mines of Westeregeln, where it occurs with anhydrite, carnallite, kieserite, celestite, eisenboracite, etc.

SULPHOHALITE, p. 917.—Van't Hoff and Saunders suggest doubts as to the existence of this species on the insufficient grounds: (1) since they failed to obtain it synthetically; and (2) since specimens furnished as sulphohalite by a dealer proved to be simply halite. Ber. Ak. Berlin, p.

392, 1898. Penfield, however, has examined (priv. contr.) the original specimen and finds it to be homogeneous and to contain both sulphate and chloride of sodium. A new analysis will be made.

SULPHUR, pp. 8, 1048.—**Cryst.**—Milo: Roisdorf, new form *f* (151); Bassick, *η* (553); Comil, near Cadiz, twins, tw. pl. (101), Busz, Zs. Kr., **20**, 558 *et seq.*, 1892. Allchar, Macedonia, new form *k* (122), Pelikan, Min. petr. Mitth., **12**, 344, 1892; also Vrba, Ber Ak. Böhm., Dec. 7, 1894. Schlaining, Hungary, occurring with stibnite, Schmidt, Zs. Kr., **29**, 207, 1897. Buggeru, Sardinia, new forms, *φ* (305), *μ* (319), *λ* (155), Millosevich, Riv. Min. Ital., **21**, 43, 1898.

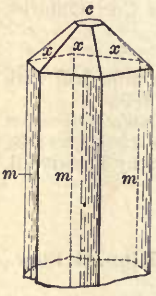
Occurs in the Upper Helderberg limestone of Monroe Co., Mich., Sherzer, Am. J. Sc., **50**, 246, 1895. Occurrence in Texas, E. A. Smith, Science, **3**, May 1, 1896.

Method of formation of the third allotropic form (monoclinic), Salomon, Zs. Kr., **30**, 605, 1899.

**Sundtite.** *W. C. Brögger*, Zs. Kr., **21**, 193, 1893.—See *Andorite.*

SVABITE, p. 1052.—Further described by Hj. Sjögren, G. För. Förh., **13**, 789, 1891; **17**, 313, 1895; Bull. G. Inst. Upsala, **1**, 50, 1892. Occurs well crystallized at the Harstig mine, Pajsberg; also in minute crystals, but usually massive, at the Jakobsberg mine, near Nordmark, Sweden. Composition essentially $Ca_4(CaF)As_3O_{12}$, or analogous to that of apatite, with which it agrees in form; F partly replaced by Cl and (OH), Ca partly by Pb, Mg and alkalies. Analyses, R. Mauzelius, quoted by Sjögren, Bull. G. Inst. Upsala, **1**, 54: 1, G. = 3·77; 2, G. = 3·82.

| | $As_2O_5$ | $P_2O_5$ | CaO | PbO | FeO | MnO | MgO | $Na_2O$ | $K_2O$ | $SO_3$ | Cl | F | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Jakobsberg | 51·05 | 0·38 | 42·07 | 3·02 | 0·08 | 0·26 | 0·52 | 0·56 | 0·30 | 0·69 | 0·12 | 1·99 | 0·25 = 101·29 |
| 2. " | 50·92 | *tr.* | 37·22 | 4·52 | 0·14 | 0·19 | 3·90 | 0·39 | 0·28 | 0·57 | 0·08 | 2·80 | 0·33 = 101·34 |



Svabite.

Svabite appears to belong distinctly to the Apatite Group; its relationship is shown not only in the similarity of angle, but also in the symmetry of the form as indicated by traces of a hexagonal prism of the third order (cf. Fig.).

SYLVANITE, p. 103.—From Nagyág, Vrba, Ber. Ak. Böhm., Dec. 7, 1894.

Occurs at Kalgoorlie, West Australia. G. = 8·14, Ag = 3·82 p. c. Frenzel, Min. petr. Mitth., **17**, 288, 1897.

Occurs at Cripple Creek, Colorado. See *Calaverite*, *Krennerite*, and *Goldschmidtite.*

SYLVITE, pp. 156, 1036, 1049.—Refractive indices for long waves, Rubens and Snow, Wied. Ann., **46**, 529, 1892.

Dispersion and absorption in infra-red, Rubens and Trowbridge, Wied. Ann., **60**, 724, 1897, and Am. J. Sc., **5**, 33, 1898.

Stassfurt, analysis by W. Schimpff, Zs. Kr., **25**, 92, 1895.

SYNGENITE, p. 945.—Optical constants determined, Mügge, Jb. Min., **1**, 266, 1895.

TACHHYDRITE, p. 178.—Discussion of conditions of formation and of alteration, van't Hoff and Meyerhoffer, Ber. Ak. Berlin, 508, 1897.

On the synthesis of isomorphous compounds, A. de Schulten, Bull. Soc. Ch., **17**, 165, 1897.

TALC, p. 678.—From the dolomite of Canaan, Conn., rose-colored, analysis by L. Kahlenberg: $SiO_2$ 61·48, $Al_2O_3$ 3·04, MgO 25·54, CaO 4·19, FeO 0·77, MnO *tr.*, $H_2O$ 5·54 = 100·56. See Hobbs, Am. J. Sc., **45**, 404, 1893.

On the origin (from enstatite and tremolite) of the fibrous talc of northern New York, C. H. Smyth, Sch. Mines Q., **17**, 333, 1896; see Am. Geol., **10**, 44, 1892.

Talc, pseudomorphous after pectolite, has been called *stevensite* by Leeds, cf. Chester, Dictionary Names Minerals, 257, 1896.

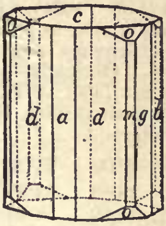
A fibrous variety perhaps pseudomorphous has been called *beaconite* by L. W. Hubbard, Rep't State Bd. Geol. Surv. Michigan, 1891–92, p. 171 (Lansing, 1893). Resembles asbestus; $\beta$ = 1·5–1·6; 2V = 60° (Lane). G. = 2·74–2·88. Analysis gave Packard: $SiO_2$ 59·72, $Fe_2O_3$,FeO 8·67, MnO 0·64, MgO 26·42, ign. 4·13 = 99·58; formula deduced $H_2(Mg,Fe)_3(SiO_4)_3$. From the Champion mine, Beacon P. O., Michigan.

A magnesium silicate near talc in composition occurs in irregular veins and streaks of a bright blue color in silver-bearing limestone near Silver City, New Mexico. As separated it is dull, earthy, resembling vivianite. An analysis gave: $SiO_2$ 62·43, MgO 28·53, ign. 6·47, $Al_2O_3$ 0·25, FeO 0·99, $Na_2O$ 0·14, $K_2O$ 0·16 = 98·97. R. L. Packard, Proc. Nat. Mus., **17**, 19, 1894. This mineral has been called *native ultramarine.*

**Talkknebelite**, **Talc-knebelite.** *L. J. Igelström*, Jb. Min., **1**, 248, 1890.—See *Knebelite.*

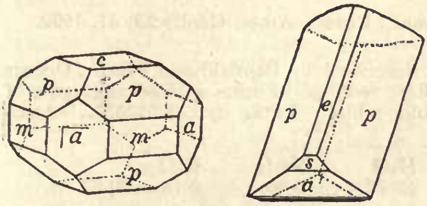
**TANTALITE**, pp. 731 *et seq.*—Crystals from Paris, Me., with G. = 7·26, agree closely with columbite in angles (Fig. 1); forms *a, b, c, m, d* (730), *g* (130), *o* (111), *n* (163), C. H. Warren, Am. J. Sc., 6, 123, 1898. These results show the correctness of the position taken in Dana's Min. (l. c.) in regard to the relation of true tantalite and columbite, as also of the former to "skogbölite" and "ixiolite." Brögger has now proved, further, that the supposed orthorhombic iron tantalite (skogbölite of Nordenskiöld), which most authors have vainly tried to bring into correspondence in form with columbite, is in fact tetragonal and identical with *tapiolite*. The crystals (Figs. 1, 2, Min., p. 736) are twins elongated parallel to *e* (101) as tw. plane (*r* = 111, etc.). In axial ratio and habit they correspond to mossite (this Append., p. 48). Vid. Skrift. I, Math.-nat. Klasse, No. 7, 1897, Christiania. See also *Tapiolite*.

1.



Analysis from Finland, Khrushchov, Vh. Min. Ges., 31, 415, 1894.
See also *Mossite*.

**TAPIOLITE**, p. 738.—Crystals, in part twins (Figs. 1, 2), with G. = 7·67–7·68, occur at Topsham, Me., C. H. Warren, Am. J. Sc., 6, 121, 1898. The twins are elongated ‖ *e* (tw. pl.), similarly to some rutile, cf. Min., p. 1047. Similar twins exist with the tapiolite of Norway formerly called tantalite (skogbölite), see *Tantalite*.



1. 2.

Tapiolite, Topsham, Me.

**Taraspite.**—A variety of dolomite from Tarasp, Switzerland, apparently the same as miemite (Min., p. 271), cf. C. v. John, Vh. G. Reichs., 67, 1891.

**Taylorite.**—This name (already in use, Min., p. 895) has been given by W. C. Knight (Eng. Mng. J., 63, 600, 1897) to an unctuous, greenish-yellow to cream-colored clay with G. = 2·132; composition variable. Forms beds in the Cretaceous shales of Rock Creek, Albany Co., Wyoming.

**TENNANTITE**, pp. 137, 1049.—A massive variety occurs at the Mollie Gibson mine, Aspen, Colorado associated with polybasite (see p. 54, this Appendix). Analysis. Penfield: (G. = 4·56), S 25·04, As 17·18, Sb 0·13, Cu 35·72, Ag 13·65, Zn 6·90, Fe 0·42, Pb 0·86 = 99·90. Also stated to occur near Central City and at the Freeland lode and Crocett mine, Idaho Springs, Colorado. Penfield and Pearce, Am. J. Sc., 44, 18, 1892.

Occurs in Barrie township, Frontenac Co., Quebec, Hoffmann, Rep. G. Canada, 6, 28R, 1892–3. Also at the Avoca claim, Bonaparte river, Lillooet distr., Br. Columbia, *ibid.*, 9, 13R, 1896.

See also *Binnite;* which is stated to be identical with tennantite.

**TETRADYMITE**, p. 39.—Analyses by W. Muthmann and E. Schröder, of specimens from Orawitza and Schubkau give the same composition, $Bi_2(Te,S)_3$ or $2Bi_2Te_3.Bi_2S_3$. Zs. Kr., 29, 140, 1897. Analyses below after deducting gangue, in 1, 11 p. c.; in 2, 0·5 p. c.

Occurs with altaite and hessite near Liddell creek, Kaslo river, West Kootanie, Br. Columbia, Hoffmann, Rep. G. Canada, 8, 10R, 1895. Analysis by Johnston (3 below after deducting 3·5 p. c. quartz).

| | G | | Te | Se | S | Bi |
|---|---|---|---|---|---|---|
| 1. Orawitza | | $\frac{2}{3}$ | 35·43 | — | 4·49 | 59·14 = 99·06 |
| 2. Schubkau | 7·095 | $\frac{3}{3}$ | 35·43 | *tr.* | 4·31 | 60·23 = 99·97 |
| 3. Br. Columbia | | | 37·29 | *tr.* | 4·45 | 53·69 Pb 3·63, Ag 0·94, Tl *tr.* = 100. |

**Tetragophosphite.** *L. J. Igelström*, Zs. Kryst., 25, 433, 1895. A supposed new phosphate resembling lazulite, occurring at Horrsjöberg in a quartzose rock carrying cyanite. In four-sided tabular crystals; color bright blue; transparent. Two analyses gave somewhat discordant results:

| $P_2O_5$ | $Al_2O_3$ | FeO,MnO | Mg,CaO | $H_2O$ |
|---|---|---|---|---|
| 36·92 | 40·00 | 9·51 | 7·50 | 5·96 = 99·89 |
| 33·64 | 41·81 | 9·51 | 6·54 | 8·30 = 100 |

**TETRAHEDRITE**, p. 137.—Crystals from Framont described with new forms, $(7\bar{7}1)$, $(11\cdot\bar{1}1\cdot2)$, $(21\cdot20\cdot20)$, Brunlechner [Inaug. Diss., Strassburg, 1892], Zs. Kr., 24, 628, 1895.

A variety containing lead (9·38 p. c. Pb) occurs at the Antelope claim, West Kootanie, Br. Columbia (anal. by Johnston), Hoffmann, Rep. G. Canada, 7, 12R, 1894. Occurs also (3·09 p. c. Ag) near Sicamons, Shuswap Lake, Br. Columbia, Hoffmann, Rep. G. Canada, 5, 65R, 1889–90. With gold ores of California, Turner and Lindgren, Am. J. Sc., 49, 379, 1895.

Specific heat determined, also of other sulphur compounds, A. Sella. Nachr. Ges. Göttingen, 311, 1891.

**Thalénite.** *Benedicks*, G. För. Förh., **20**, 308, 1898.

Monoclinic. Axes $\grave{a} : \bar{b} : \dot{c} = 1\cdot154 : 1 : 0\cdot602$ ; $\beta = 80\cdot2°$. Forms: *a* (100), *b* (010), *c* (001), *m* (110), *f* (021), *e* (111), *d* ($\bar{1}\bar{1}1$), *k* (311). Angles: $am = 48\cdot7°$, $a'd = 73° 0'$, $bd = 55\cdot7°$. Crystals tabular ‖ *a*, in part prismatic ‖ $\dot{c}$.

Cleavage none. Fracture uneven to splintery. Brittle. H. = 6·5. G. = 4·227. Color flesh-red. Optically—. Ax. pl. nearly ⊥ $\dot{c}$. $Bx_a$ ⊥ *a* (100). Indices for Na, $\alpha = 1\cdot7312$, $\beta = 1\cdot7375$, $\gamma = 1\cdot7436$. $2H_{a.y} = 81° 36'$, ∴ $2V_{a.y} = 67° 35'$.

Composition, $H_2Y_4Si_4O_{15}$ or $H_2O.2Y_2O_3.4SiO_2$. Analyses: 1, of fresh material; 2, of weathered material.

| | $SiO_2$ | $Y_2O_3$[a] | $Fe_2O_3$ | $Al_2O_3(BeO)$ | $CaO$ | $MgO$ | $Na_2O$ | $SnO$ | $H_2O$ | $CO_2$ | X[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 29·88 | 63·35 | 0·30 | 0·45 | 0·49 | 0·21 | 0·26 | 0·23 | 2·08 | 1·04 | 1·40 = 99·69 |
| 2. | 27·69 | 58·58 | 1·51 | 0·35 | 2·19 | 0·40 | 1·07 | 0·22 | 2·70 | 3·32 | 2·50 = 100·53 |

[a] $R_2O_3 = 245\cdot3$ [b] Helium, etc.

The numbers given are the mean of two to five determinations.

Occurs with fluocerite at Österby in Dalecarlia, Sweden. Named after Prof. R. Thalén. Related to yttrialite (Min., p. 512), rowlandite (p. 1047), etc.

THALITE, p. 682.—Examined by N. H. Winchell (anal., Pease), Amer. Geol., **23**, 41, 1899.

THAUMASITE, p. 698.—From West Paterson, N. J., described by Penfield and Pratt. Occurs in trap associated with pectolite, apophyllite, and various zeolites. Forms a loose aggregate of prismatic crystals (hexagonal). G. = 1·875–1·887. Color white. Index $n_y = 1\cdot5125$Na. Analysis:

| | $SiO_2$ | $CO_2$ | $SO_3$ | $CaO$ | $H_2O$ | $Na_2O$ | $K_2O$ |
|---|---|---|---|---|---|---|---|
| ($\frac{2}{3}$) | 9·26 | 6·82 | 13·44 | 27·13 | 42·77 | 0·39 | 0·18 = 99·99 |

This agrees closely with earlier results. As regards the water, 13 molecules go off at 150° and are regarded as being water of crystallization, hence the formula $[(CaOH)CO_2].[(CaOH)SO_3].[(CaOH)HSiO_4] + 13H_2O$. Am. J. Sc., **1**, 229, 1896.

Also described by Bäckström from Skottvång, Nyköping, Sweden; associated with apophyllite, G. För. Förh., **19**, 307, 1897.

See also note by Pisani, Bull. Soc. Min., **19**, 85, 1896.

THENARDITE, p. 895.—Pseudomorphs after mirabilite from Aussee in the Salzkammergut are described by Pelikan; also pyramidal crystals *r* (111) with the new forms *v* (113) and *u* (130); these yield the mean axial ratio, $\breve{a} : \bar{b} : \dot{c} = 0\cdot5970 : 1 : 1\cdot2541$. Min. petr. Mitth., **12**, 476, 1891.

THOMSONITE, pp. 607, 1050.—Crystals from the Tulferthal, Tyrol, described, Habert, Zs. Kr., **28**, 254, 1897.

See also *Bagotite* and *Lintonite*.

THORITE, pp. 488, 1050.—Crystals from Arendal, described with *c* (001), Hamberg, G. För. Förh., **16**, 327, 1894.

Occurs in granite of the Trotter mine, Franklin Furnace, N. J., Kemp, Trans. N. Y. Acad. Sc., **13**, 76, 1893.

**Tiffanyite.** *G. F. Kunz*, Trans. N. Y. Acad. Sci., **14**, 260, 1895. A name proposed for a hydrocarbon assumed to be present in certain diamonds, namely, those which, on this account, exhibit fluorescence and phosphorescence. The substance apparently has a bluish-white color.

**Tilasite, Fluor-Adelite.** *H. Sjögren*, G. För. Förh., **17**, 291, 1895. Massive, granular. Cleavage in one direction (*A*) distinct, in three others (*B*, *C*, *D*) less so. G. = 3·28. Luster resinous, on cleavage-surfaces vitreous. Color gray with a tinge of violet. A section ‖ *A* and $Bx_o$ shows the ax. plane inclined 19° to *B* and 28° to *C*.

Composition $(MgF)CaAsO_4$, or analogous to adelite (p. 1) with fluorine instead of hydroxyl. Analysis, Maúzelius:

| $As_2O_5$ | $P_2O_5$ | $FeO$ | $MnO$ | $CaO$ | $MgO$ | $Na_2O$ | $H_2O$ | F | Cl |
|---|---|---|---|---|---|---|---|---|---|
| 50·91 | *tr.* | 0·14 | 0·16 | 25·32 | 18·22 | 0·29 | 0·28 | 8·24 | 0·02 = 103·58 less (O = F) 3·47 = 100·11 |

Occurs at Långban, Sweden, with berzeliite and calcite in veins in the manganiferous (hausmannite) dolomitic limestone. Named after the Swedish mining engineer, Daniel Tilas.

TITANITE, p. 712.—Crystals from Lauvitel, Isère, France, show the new forms ($\bar{3}\cdot3\cdot20$) and (883), Termier, Bull. Soc. Min., **19**, 81, 1896. Crystals from Tyrol, Weinschenk, Zs. Kr., **26**, 502, 1896.

Pyroelectricity investigated, Traube, Jb. Min., Beil.-Bd., **11**, 209, 1897.

Occurs as a prominent constituent of the "titanite-gneiss" from near the Brenner Pass in Tyrol, Rodewyk, Min. petr. Mitth., **17**, 544, 1897.

Artificial formation, Michel, C. R., **115**, 830, 1892.

See also *Neptunite.*

**Topaz**, p. 492.—**Cryst.**—Alabashka, new form (338), Jeremejev, Vh. Min. Ges. St. Pet., **27**, 439, 1891, and Zs. Kr., **22**, 74, 1893. Ilmen Mts., new forms (290), (580), (415), (10·3·13), (8·7·15), (116)?, and others doubtful, Souheur, Zs. Kr., **20**, 232, 1892. Japan, Matthew, Sch. Mines Q., **14**, 53, 1892. Japan and New South Wales, Hahn, Zs. Kr., **21**, 334, 1893. Mino, Japan, T. Hiki, J. Coll. Sc. Japan, **9**, 69, 1895. Köhlerloh quarry near Reenersreuth, Fichtelgebirge, forms (9·9·20), (1·11·12)?, Bücking, Ber. Senckenberg. Ges., 147, 1896. Crystals in collection of U. S. National Museum, Eakle, Proc. U. S. Nat. Museum, **21**, 361, 1898.

Investigation of inclusions. Tolstopiatov, Vh. Min. Ges., **33**, 289, 1895.

Ilmen Mts. and Adun Chalon, optical characters determined, Thaddéeff, Zs. Kr., **23**, 536, 1894.

Occurs abundantly in colorless crystals in alluvial sands of district of Batang Padang, Perak, Lacroix and Sol, C. R., **123**, 135, 1896. Occurs near Palestine, Texas, in rolled crystals, Kunz, Trans. N. Y. Acad. Sc., **13**, 144, 1894, and Am. J. Sc., **47**, 403, 1894.

Synthetic experiments, A. Reich, Ber. Ak. Wien, **105** (2), 105, 1896; Monatsh. f. Chemie, **17**, 149, 1896.

By a series of accurate analyses, Penfield and Minor (Am. J. Sc., **47**, 387, 1894) have shown that the ratio for $SiO_2 : Al_2O_3 : F + OH$ is constant, viz. $= 1 : 1 : 2$, but the amounts of fluorine and hydroxyl vary widely. This ratio gives the formula $[Al(F,OH)]_2SiO_4$ or $Al(F,OH)_2AlSiO_4$. With the change in the relative amounts of fluorine and water vary also the specific gravity, crystallographic axes, and optical characters. Crystals from the Thomas Range, Utah, contained almost no water (0·19 p. c. with 20·37 F); they have G. = 3·565, $2E_y = 125° 53'$ and $\gamma - \alpha = 0·0104$. Crystals from Minas Geraes, Brazil, gave 2·45 $H_2O$ and 15·48 F; for them G. = 3·532, 2E = 84° 28' and $\gamma - \alpha = 0·0081$. Between these extremes fall crystals from Colorado, Japan, Siberia, Saxony, Maine. The presence of water has also been determined by Jannasch and Locke, Zs. anorg. Ch., **6**, 168, 321, 1894, and Am. J. Sc., **47**, 386, 1894.

**Torbernite**, p. 856.—Etching-figures indicate monoclinic symmetry T. L. Walker, Am. J. Sc., **6**, 41, 1898.

**Tourmaline**, pp. 551, 1050.—From Elba, monographs on the crystallization (new forms (2·0·$\bar{2}$·11) and (5·1·$\bar{6}$·1)) and physical characters, especially the refractive indices, also pleochroism, specific gravity, hardness, etc. G. D'Achiardi, Att. Soc. Tosc., Mem., Pisa, **13**, 229, 1894, also Proc. Verb., March 4, 1894, and **15**, 1896. Isola del Giglio, investigation of sections ∥ $\dot{c}$, showing zonal structure, *idem*, Annal. Univ. Tosc., **22**, 1897.

Etching-figures investigated, Traube, Jb. Min., Beil.-Bd., **10**, 460, 1896; also Walker, Am. J. Sc., **5**, 178, 1898. Secondary enlargement in itacolumite, Derby, Am. J. Sc., **5**, 190, 1898.

Dichroism for infra-red waves, E. Merritt, Wied. Ann., **55**, 49, 1895.

**Anal.**—Urulgá, Siberia, Prendel, Zs. Kr., **20**, 93, 1892. Kuhrau, Bohemia, Katzer; also from Benitz, Formánek, Min. petr. Mitth., **12**, 420, 1892. Nevada Co., California, W. H. Melville, Bull. U. S. G. Surv., **90**, 39, 1892. Caprera, Fasolo quoted by Lovisato, Rend. Accad. Linc., **4** (1), 84, 1895.

Occurrence of tourmaline schists, Belcher Hill, Colorado, H. B. Patton, Bull. G. Soc. Amer., **10**, 21, 1899.

**Comp.**—Penfield and Foote (Am. J. Sc., **7**, 97, 1899), on the basis of two new analyses of widely different varieties (quoted below) which were carried through with great care on material of absolute purity, and also after a discussion of many other trustworthy analyses, arrive at the conclusion that all varieties of tourmaline can be referred to the aluminium-borosilicic acid $H_9Al_3(B.OH)_2Si_4O_{19}$. More simply put, the acid derived is $H_{20}B_2Si_4O_{21}$, the ratio of $H : B_2O_3 : SiO_2$ being 20 : 1 : 4. The constant relation between the boron and silicon deduced by other analysts is fully confirmed. Of the analyses of others (for the most part quoted in Min., pp. 554, 555) the series by Riggs agree closely with the above ratio; this is also true of those by Jannasch and Kalb; the analyses by Rammelsberg are (as stated by him) low in water and require correction for the oxidation of the iron. Corrected in these points they also conform to the above ratio. The new analyses by Penfield and Foote are:

| | G | $SiO_2$ | $TiO_2$ | $B_2O_3$ | $Al_2O_3$ | FeO | MnO | MgO | CaO | $Na_2O$ | $K_2O$ | $Li_2O$ | $H_2O$ | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. DeKalb, *colorless* | 3·049 | 36·72 | 0·05 | 10·81 | 29·68 | 0·22 | — | 14·92 | 3·49 | 1·26 | 0·05 | — | 2·98 | 0·93=101·11 |
| | | | | | | | | | | | | | deduct (F= O) | 0·39=100·72 |
| 2. Haddam Neck, *green* | 3·089 | 36·96 | 0·03 | 11·00 | 39·56 | 2·14 | 2·00 | 0·15 | 1·28 | 2·10 | — | 1·64 | 3·10 | 1·13=101·09 |
| | | | | | | | | | | | | | deduct (F= O) | 0·48=100·61 |

The composition has been also discussed by Kenngott, Jb. Min., **2**, 44, 1892, and by Rheineck, Zs. Kr., **22**, 52, 1893.

**Triphylite**, p. 756.—The influence of varying amounts of iron and manganese in triphylite and lithiophilite has been minutely investigated by Penfield and Pratt, Am. J. Sc., **50**, 387, 1895.

**Tripuhyite.** *E. Hussak* and *G. T. Prior*, Min. Mag., **11**, 302, 1897

In fragments in gravel, these are micro-crystalline aggregates. G.=5·82. Color dull greenish yellow. Streak canary-yellow. Translucent. Refringence and birefringence high. Biaxial. Composition, probably $2FeO.Sb_2O_5$. Analysis, Prior

| $Sb_2O_5$ | FeO | CaO | $SiO_2$ | $Al_2O_3$ | $TiO_2$ | |
|---|---|---|---|---|---|---|
| 66·68 | 27·70 | 0·82 | 1·35 | 1·40 | 0·86 | undet. 1·19 = 100 |

From the cinnabar-bearing gravels of Tripuhy near Ouro Preto, Minas Geraes, Brazil. Associated with the new species lewisite and derbylite; also xenotime, monazite cyanite, rutile, hematite, magnetite, etc.

TROILITE, pp. 72, 1051.—See *Pyrrhotite.*

TSCHEFFKINITE, p. 718.—On the occurrence in India, see Mallet, Rec. G. Surv. India, **25**, 123, 1892. The original locality is shown to be Kanjamalai Hill in the Salem district, Southern India.

TURQUOIS, p. 844.—Analyses from New Mexico and Persia, Carnot, Bull. Soc. Min., **18**, 119, 1895.

Occurs in the Jarilla Mts., Doña Ana Co., N. M., Hidden, Am. J. Sc., **44**, 400, 1893.

TYROLITE, p. 839.—Church, working again upon material examined in 1873 (J. Ch. Soc., **27**, 108) seems to prove that the mineral (from Falkenstein or Libethen?) in fact contains $CaCO_3$ (11 p. c.) as an essential ingredient; of the total water (15·68 p. c.) 5·23 p. c. was lost in vacuo and 2·40 at 100° C. Min. Mag., **11**, 5, 1895.

TYSONITE, p. 166.—Analysis, Colorado, Hillebrand, Am. J. Sc., **7**, 51, 1899.

A partially described yttrium-calcium fluoride occurs with the astrophyllite of W. Cheyenne Cañon, El Paso, Colorado, Genth and Penfield, Am. J. Sc., **44**, 386, 1892. Granular, crystalline, cleavable. H. = 4. G. = 4·316. Color white, grayish or reddish white. Analysis (Genth) gave; $(Y,Er)_2O_3$ 47·58 (at. wght. 126), $CeO_2$ 0·83, $(La,Di)_2O_3$ 1·55, CaO 19 41, ign. 1·57, $Fe_2O_3$, F, etc., *undet.* The formula suggested is $CaF_2.(Y,Er,Ce,La,Di)F_3$.

UINTAITE, p. 1020.—For description of the occurrence and properties of this hydrocarbon (also called *gilsonite*), see Locke, Trans. Am. Mng. Eng., **17**, 162, 1888, and Eldridge, U. S. G. Surv., 17th Ann. Rep., Part. I, pp. 915–945, 1896.

URANINITE, p. 889. — The varieties ***cleveite*** and ***bröggerite*** yield helium (and other gases), Ramsay, Proc. Roy. Soc., **58**, 65, 81, 1895; **59**, 325, 1896. Also Ramsay and Travers, *ibid.*, **60**, 443, 1897. Lockyer, *ibid.*, **58**, 67, 113, 116, 192, 193; **59**, 4, 1895; **59**, 342, 1896; (and other minerals) **60**, 133, 1896. Tilden, *ibid.*, **59**, 218, 1896 Langlet, Oefv. Ak. Stockh., **52**, 211, 1895.

Regarded as containing the new substances polonium and radium, M. and Mde. P. Curie and G. Belmont, C. R., **127**, 175, 1215, 1898.

Analyses, Llano Co., Texas; Marietta, S. C., Villeneuve, Quebec, Johanngeorgenstadt, W. H. Hillebrand, Bull. U. S. G. Surv., **90**, 22, 1892.

URANOTIL, p. 699.—On the crystalline form (triclinic), Pjanitzky, Zs. Kr., **21**. 74, 1892; also Jb. Min., **2**, 249 ref., 1896.

**Urbanite.** *Hj. Sjögren*, G. För. Förh., **14**, 251, 1892; Bull. G. Inst. Upsala, **2**, 77, 106, 1894. Lindesite, *L. J Iglesträm*, Zs. Kr., **23**, 590, 1894.

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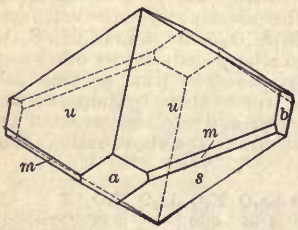

Monoclinic, belonging to the Pyroxene Group. Axes (Sjögren), $\grave{a} : \bar{b} : \acute{c} = 1·1009 : 1 . 0·6058$, $\beta = 72° 7'$. Forms: *a* (100), *b* (010), *m* (110), *p* ($\bar{1}01$), *r* (053), *u* (111), *n* (221), *s* (111), *o* ($\bar{2}21$); also doubtful, *x* ($\bar{3}22$ or 433), *y* ($\bar{6}14$). Angles: $mm''' = 92° 40'$, $uu' = 48° 28'$, $mu = 44° 5'$, $m's = 59° 6'$ (calc., Sj.).

Habit pyramidal, *u*, *s* prominent (Fig. 1). Cleavage, prismatic (*m*) distinct; *c* less so. H=. 5–6. G.= 3·52 (L.), 3·53 (G.). Luster vitreous. Color brownish black (L.), chestnut-brown (G.). Streak light brown. Faintly translucent. Strongly pleochroic. $\mathfrak{a}$ brown, $\mathfrak{b}$ yellow-brown, $\mathfrak{c}$ yellow. Ax. pl. ‖ *b* (010). $\mathfrak{a} \wedge \acute{c} = +16°$ (L.) to 22° (G.).

In composition a metasilicate corresponding to $(Ca,Mg)SiO_3$ (diopside) + 2 $Na\overset{III}{Fe}(SiO_3)_2$ (acmite). Analyses, R. Mauzelius, quoted by Sjögren (Bull. G. Inst. Upsala, l. c.):

| | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | MnO | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Långban | 51·61 | — | 0·74 | 27·24 | 0 54 | 1·73 | 4·90 | 2·75 | 0·36 | 10·59 | 0·90=101·36 |
| 2. Glakärn | 49·21 | 0·06 | 1·27 | 25·35 | 0·50 | 6·71 | 5·68 | 1·39 | 0·40 | 8·95 | 1·05 F 0·20=100·77 |

B.B. fuses with difficulty to a magnetic slag. Only slightly attacked by acids.

Occurs at Långban, Sweden, in cavities in granular hematite. This mineral was apparently earlier (1865) mentioned by Breithaupt and analyzed by Winkler (cf. Sjögren). It had been confounded with schefferite (iron-schefferite). Also found at Glakärn, province of Örebro, as idiomorphic grains in a mixture of yellowish-white feldspar and rhodonite. This mineral was partly investigated by Igelström (l. c.) and called *lindesite.* Named after the Swedish investigator Urban Hjärne.

**Utahlite.**—See *Variscite.*

VALERIITE, p. 108.—Shown by Petrén to be a mixture of covellite, pyrrhotite, hydrotalcite, siderite, spinel and probably limonite, G. För. Förh., **20**, 183, 1898.

**Valléite.** *G. Cesàro,* Bull. Acad. Belg., **29**, 508, 1895; **32**, 536, 1896. A colorless or pale-red orthorhombic amphibole accompanying the violet tremolite of Edwards, N. Y. In prismatic crystals with *a* (100), *m* (110), *x* (920)?, (021)?; $mm''' = 54° 30'$. Cleavage *m*, also (according to the author) parallel to the pinacoids, and several brachydomes. H. = 4·5. G. = 2·88. Optically negative. Ax. pl. ‖ *b* (010). $Bx_a \perp a$ (100). 2E = 90° 28′, 2V = 51° approx. $\gamma - \beta = 0{\cdot}0036$. Composition $RSiO_3$ or that of anthophyllite, deduced from the analysis by Renard: $SiO_2$ 58·02, MgO 27·99, CaO 5·04, $Fe_2O_3$ 1·28, MnO 2·88, $K_2O$ 0·89, $H_2O$ 3·13 = 99·23. Easily fusible to a white opaque bead. Named after De la Vallée-Poussin.

VARISCITE, p. 824.—From near Lewiston, Cedar Valley, Tooele Co., Utah, compact, nodular or crypto-crystalline, color bright green; analysis, R. L. Packard G. 2·62: $P_2O_5$ 44·40, $Al_2O_3$ [32·65], $H_2O$ 22·95 = 100. Am. J. Sc., **47**, 297, 1894. This variscite has been called *utahlite,* see G. F. Kunz, 16th Ann. Rep't. U. S. G. Surv., 1894–5, Part IV, p. 602.—See also *Wardite.*

VERMICULITES, p. 664.—A hydro-mica, largely but not wholly altered to vermiculite, from Rocky Hill, N. J., has been analyzed by F. W. Clarke and N. H. Darton. It is unusual in containing a large percentage of iron ($Fe_2O_3$), and a ferric muscovite is suggested as part of the unaltered compound. Am. J. Sc., **7**, 365, 1899.

VESUVIANITE, p. 477.—**Cryst.**—Mte. Somma and Zermatt, new forms (observed, except *E*, once only): *T* (106), *S* (229), *V* (552), *W* (14·14·5), *D* (18·5·5), *K* (722), *E* (11·4·4), also (13·13 4)? Boecker, Zs. Kr., **20**, 225, 1892. Vesuvius, P. Franco, Giorn. Min., **4**, 185, 1893; also in full in Boll. Soc. geol. Ital., **11**, No. 2, 1893. Monograph with optical determinations, analyses, discussion of composition, etc., Weibull, Zs. Kr., **25**, 1, 1895. Friedeberg, Silesia, Graber, Min. petr. Mitth., **17**, 384, 1897.

Optical characters fully discussed, Klein, Jb. Min., **2**, 106, 1895.

**Comp.**—Ural, analysis of a chromium-bearing variety (2·31 p. c. $Cr_2O_3$), Sofia Rudbeck, G. För. Förh., **15**, 607, 1893. Harstig (4·81 p. c. MnO) and Vaticha (anal. by Mauzelius), discussion of the composition of the species in general, Hj. Sjögren, G. För. Förh., **17**, 267, 1895. Analyses and discussion of composition, Jannasch and Weingarten, Zs. anorg. Ch., **11**, 40, 1895. Composition discussed, Rammelsberg, Jb. Min., **2**, 157, 1896. See also Weibull, above.

VIOLAN, p. 356.—See *Pyroxene,* p. 57.

VIVIANITE, p. 814.—Occurrence, origin, etc., in province of Drenthe, Netherlands, G. M. van Bemmelen, Arch. Néerland, Harlem, **30**, 25, 1897.

Occurrence in the Mecklenburg moors, A. Gärtner, Arch. Ver. Meckl., **51**, 1897 (and Inaug. Diss., Rostock).

**Wardite.** *J. M. Davison,* Am. J. Sc., **2**, 154, 1896.

Massive, encrusting; with concretionary structure, in part oolitic. H. = 5. G. = 2·77. Luster vitreous. Color light green, bluish green. Streak white.

Composition, $2Al_2O_3.P_2O_5.4H_2O$ or $Al_2(OH)_3PO_4 + \frac{1}{2}H_2O$. Analysis, Davison, l. c.:

| $P_2O_5$ | $Al_2O_3$ | CuO | FeO | MgO | $Na_2O$ | $K_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 34·46 | [38·25] | 0·04 | 0·76 | 2·40 | 5·98 | 0·24 | 17·87 = 100 |

Occurs encrusting cavities in nodular masses of the variscite from Cedar Valley, Utah (see above). Named after Prof. Henry A. Ward of Rochester, N. Y.

WAVELLITE, p. 842.—Crystals described from Arbrefontaine, Belgium, G. Cesàro, Mem. Acad. Belg., **53**, 1897.

Analyses by Carnot, C. R., **118**, 995, 1894.

Occurs at the Dunellen phosphate mines, Marion Co., Florida, Moses and Luquer, Sch. Mines Q., **13**, 238, 1892.

**Webnerite.** *Stelzner*, Zs. Kr., **24**, 125, 1891.—See *Andorite.*

**Weldite.** *F. M. Krause* [Proc. R. Soc. Tasmania, 1884] quoted by Petterd, Catalogue of Minerals of Tasmania, p. 94, 1896. A white, amorphous substance, containing chiefly silica, alumina and soda, but of undetermined composition. H. = 5·5. G. = 2·98. Occurs with bands of quartzite and is probably derived from the alteration of a felsitic rock. From the Weld river Upper Huon, Tasmania.

**Wellsite.** *J. H. Pratt* and *H. W. Foote*, Am. J. Sc., 3, 443, 1897.

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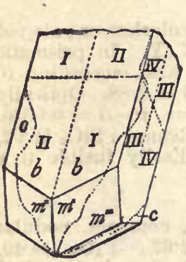

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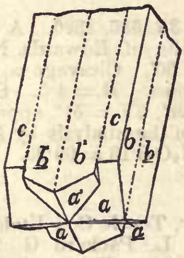

Monoclinic Axes $a : \breve{b} : \grave{c} = 0·768 : 1 : 1·245$; $\beta = 53° 27' = 001 \wedge 100$. Measured angles: $ac = 53° 27'$, $bm = 58° 19'$, $a\underline{a} = 73° 6'$, $b\underline{b} = 90°$. In complex twinned crystals (Figs. 1, 2) analogous to familiar forms of harmotome and phillipsite, but without striations on the *b*-faces.

Cleavage none. Brittle. H. = 4–4·5. G. = 2·278–2·366. Luster vitreous. Colorless to white. Optically +. Birefringence low. $Bx_a \perp b$ (010). $Bx_o \wedge \grave{c} = -52°$. Ax. angle large.

Composition, $RAl_2Si_3O_{10}.3H_2O$ where $R = Ba : Ca : K_2 = 1 : 3 : 3$. This requires: Silica 42·8, alumina 24·3, baryta 6·6, lime 7·3, potash 6·1, water 12·9 = 100. Wellsite thus falls into the Phillipsite Group, containing less water than the other members (cf. Min., p. 571). It is shown further that it is to be expected that phillipsite should contain $4H_2O$, not $4\frac{1}{2}H_2O$ as usually accepted (see *Phillipsite*).

Analysis:

| | $SiO_2$ | $Al_2O_3$ | BaO | SrO | CaO | MgO | $K_2O$ | $Na_2O$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|
| ½ | 43·86 | 24·96 | 5·07 | 1·15 | 5·80 | 0·62 | 3·40 | 1·80 | 13·35 = 100·01 |

About one molecule of water is given off between 100° and 200°, a second between 200° and 300°, and the remainder at a red heat.

B.B. exfoliates slightly and fuses at 2·5–3 to a white bead. Yields water readily in the closed tube. Easily decomposed by hot hydrochloric acid with separation of silica.

Found in Buck Creek corundum mine in Clay Co., N. C.; occurs in small crystals with chabazite on feldspar, also on corundum. Named after Prof. H. L. Wells of New Haven, Conn.

WERNERITE, p. 468.—As a contact mineral in the Adamello Group and discussion of composition (anal.), Salomon, Min. petr. Mitth., **15**, 159, 1895. It is argued that *dipyre* is to be regarded not as a definite scapolite type but as belonging in part to wernerite, in part to mizzonite.

WESTANITE (Vestanite), p. 499.—Weibull has confirmed Groth's suggestion that the mineral is an altered andalusite. A specimen examined by him showed a nucleus of andalusite surrounded by pyrophyllite. G. För. Förh., **20**, 57, 1898.

**Whartonite.** *S. H. Emmens*, J. Am. Chem. Soc., **14**, No. 7. See *Pyrite.*

WHEWELLITE, p. 993.—Obtained at the Venus mine, near Brüx, Schubert (optical determinations), Min. petr. Mitth., **18**, 251, 1898.

WICKELKAMAZITE. *E. Cohen*, Ann. Mus. Wien, **6**, 157, 1891.

WILLEMITE, p. 460.—Penfield has described colorless prismatic crystals from the Merritt

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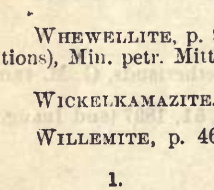

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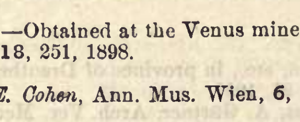

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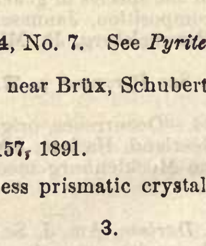

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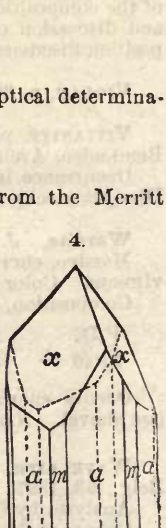

mine, New Mexico, with the new forms *z* $(01\bar{1}1)$, *u* $(2\bar{1}\bar{1}3)$, *v* $(\bar{1}3\bar{2}5)$ (Fig. 1); colorless rhombohedral crystals (Fig. 2) from the Sedalia mine, Salida, Colo.; also pale-green prismatic crystals from Franklin Furnace, N. J. (Figs. 3, 4) with *h* $(3\bar{1}\bar{2}0)$, *s* $(11\bar{2}3)$, *x* $(3\bar{1}\bar{2}1)$. Am. J. Sc., **47**, 305, 1894.

Etching-figures investigated, Traube, Jb. Min., Beil.-Bd., **10**, 463, 1896.

**Willyamite.** *E. F. Pittman*, Proc. R. Soc. N. S. W., **27**, 366, 1893.

Isometric: massive. Cleavage: cubic, perfect. Fracture uneven. Brittle. H. = 5·5. G. = 6·87. Luster metallic. Color between tin-white and steel-gray. Streak grayish black.

Composition a sulph-antimonide of cobalt and nickel, $CoS_2.NiS_2.CoSb_4.NiSb_2$. Analysis, J. C. H. Mingaye:

| | S | Sb | Co | Ni | |
|---|---|---|---|---|---|
| 1. | 15·64 | 56·85 | 13·92 | 13·38 | Fe,Cu Pb *tr.* = 99·79 |
| 2. | 15·92 | 56·71 | 13·84 | 13·44 | Fe,Cu,Pb *tr.* = 99·91 |

In the closed tube yields a dark red sublimate, orange on cooling; in the open tube sulphurous and antimonial fumes; also the latter on charcoal fusing to a globule. Decomposed by nitric acid with separation of antimony trioxide.

Found at the Broken Hill mines (in Willyama township), New South Wales, associated with dyscrasite in a gangue of calcite and siderite.

WINEBERGITE, p. 970.—Bodenmais, Bavaria, analyses, Thiel, Zs. Kr. **23**, 295, 1894.

WITHERITE, p. 284.—In parallel growth with barite, Mügge, Jb. Min, **1**, 252, 1895.

WOLFRAMITE, p. 982.—Occurrence in Bolivia, described by Frenzel, analysis by Sipöcz, Min. petr. Mitth., **16**, 256, 1896.

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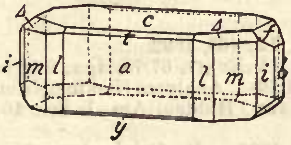

Occurs (C. H. Warren, priv. contr.) in Lawrence Co., South Dakota, in small brilliant black crystals (Fig. 1) in a highly siliceous matrix. Observed forms: *a* (100), *c* (001), *b* (010), *l* (210), *m* (110), *i* (7·11·0) new, *t* (102), *y* $(\bar{1}01)$, *f* (011), *Δ* (112). The angles show a close agreement with those given for ordinary wolframite. B.B. the crystals show *no* reaction for manganese; they are hence inferred to be the pure iron tungstate.

WOLFSBERGITE.—See *Chalcostibite.*

WOLLASTONITE, pp. 371, 1052.—Crystals from near Harrisville, N. Y., described, Ries, Trans N. Y. Acad. Sc., **13**, 146, 207, 1894.

New Hartford, Oneida Co., N. Y., shows strong greenish-yellow phosphorescence, Hillebrand, Am. J. Sc., **1**, 323, 1896.

Occurs, with gehlenite and hexagonal $CaSiO_3$, in slags from Příbram, Heberdey, Zs. Kr., **26**, 19, 1896.

An essential constituent in aplite from Quérigut, Ariège, Lacroix, Bull. Soc. Min., **21**, 272, 1898.

Crystals altered to pyroxene, Diana, Lewis Co., N. Y., C. H. Smyth, Jr., Am. J. Sc., **4**, 309, 1897.

WULFENITE, p. 989.—**Cryst.**—Jarilla Mts., Doña Ana Co., New Mexico, crystals hemimorphic (Figs. 1–3) with *p* $(20\bar{1})$ below only, while *c* (001), *u* (102), *e* (101), *n* (111), *π* (313) occur both above and below; *p* and *π* are new forms, C. A. Ingersoll, Am. J. Sc., **48**, 193, 1894. Loudville, Mass., habit varied, in part hemimorphic; new forms *θ* (1·1·12), *γ* (443), *λ* (131), Emerson,

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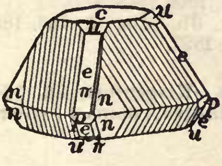

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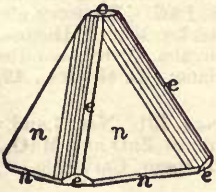

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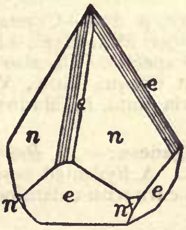

Bull. U S. G Surv., **126** 176, 1895. Gorno, Val Seriana, Italy (with (5·1·75)?), Artini, Riv. Min. Ital., **16**, 25, 1896.

Etching-figures do not show hemimorphic symmetry, Traube, Jb. Min., Beil -Bd., **10**, 457, 1896. Observations on optical anomalies, A. de Gramont, Bull. Soc. Min., **16**, 127, 1893.

WURZITE. pp. 70, 1051.—Artif. cryst. described, Traube, Jb. Min., Beil.-Bd., 8, 151, 1894.

XANTHOCONITE, p. 149.—Shown by Miers (Min. Mag., **10**, 185, 1893, and Zs. Kr., **22**, 433) to be monoclinic with the axial ratio, $\grave{a} : \bar{b} : \grave{c} = 1·9187 : 1 : 1·0152$, $\beta = 88° 47'$. Here belongs also rittingerite from Joachimsthal. Common forms: *c* (001), *m* (110), *d* (501), *D* $(\bar{5}01)$, *p* (111), *q* (551), *P* $(\bar{1}11)$, *Q* $(\bar{5}51)$; also *a* (100), *n* (053), *r* (112), *t* (223), *h* (334), and on rittingerite *f* (115), *y* (443), *ρ* (332), *R* $(\bar{1}12)$, *Y* $(\bar{4}43)$. Angles $mm''' = 124° 56'$, $cd = 68° 14'$, $cp = 48° 32'$, $cP = 49° 10'$, $cm = 89° 26'$.

Crystals tabular ∥ *c*, usually stout, again very thin; also massive, earthy. Twins: tw. pl. *c*, common.

Cleavage *c*, distinct. Fracture subconchoidal. Brittle. H. = 2–3. G. = 5·54. Luster adamantine to pearly. Color brown, orange-red; by transmitted light, lemon-yellow. Streak orange-yellow. Transparent. Optically −. Birefringence strong. Ax. pl. ⊥ *b* (010). $Bx_a$ nearly ⊥ *c* (001). 2E = 125° approx.; $\rho < v$.

Composition same as for proustite, $Ag_3AsS_3$ or $3Ag_2S.As_2S_3$. Analysis, Prior (corrected):

Freiberg, G. = 5·54 As 14·93 S 19·07 Ag 65·15 = 99·15

Xanthoconite occurs in calcite at Freiberg, Saxony, the original locality; also at Johanngeorgenstadt, Markirch in Elsass, Rudelstadt and Chañarcillo.

XANTHOPHYLLITE, p. 639.—*Waluewite*, Zlatoust, anal. and discussion of composition, Clarke and Schneider, Am. J. Sc., **43**, 379, 1892.

XENOTIME, p. 748.—**Cryst.**—Brazil, Hussak, Min. petr. Mitth., **12**, 465, 1892.

**Anal.**—El Paso Co., Colorado, Penfield obtained: $P_2O_5$ 32·11, $(Y,Er)_2O_3$ 67·78, ign. 0·18 = 100·07 (at. weight of Y,Er, 118); G. = 5 106, Am. J. Sc., **45**, 398, 1893. Analyses (Eakins) from the Brindletown gold district, Burke Co., N. C., green and brown var., Hidden, Am. J. Sc., **46**, 255, 1893.

Occurrence on New York island, Niven, Am. J. Sc., **50**, 75, 1895. In Calvin township, Nipissing district Ontario (mass of 312 grams), Hoffmann, Rep. G. Canada, **9**, 13R, 1896. Distribution in European rocks, Derby, **11**, 304, 1897.

**Xiphonite.** *G. Platania*, Accad. Sc. Acireale, **5**, 1893.—See *Amphibole*, p. 3.

ZEOLITES, pp. 570–610.—Discussion of the composition of the species, F. W. Clarke, Am. J. Sc., **48**, 137, 1894. Bull. U. S. G. Surv., **125**. Also as to the part played by the water, G. Friedel, Bull. Soc. Min., **21** 5, 1898.

See also *Analcite*, etc.

ZINCITE, p. 208.—Franklin Furnace, N. J., hemimorphic crystals with *m* $(10\bar{1}0)$, *c* (0001) and a pyramid *o* probably $(20\bar{2}3)$, measured $co = 55° 38'$; analysis by Schütz gave: ZnO 96·20, MnO 3·33, $Fe_2O_3$ 0·43 = 99·96. Grosser, Zs Kr., **20**, 354, 1892. Crystals from Franklin measured by Moses show two pyramids, interpreted as $(40\bar{4}5)$ and $(50\bar{5}4)$ if $\grave{c} = 1·6219$. School Mines Q., **16**, 226 1895.

On artificial crystals, in part twins, Cesàro, Ann. Soc. G. Belg., **19**, 271, 1892 (abstr Zs. Kr., **24**, 618). Also Ries, Am J. Sc., **48**, 256, 1894; Traube, Jb. Min., Beil.-Bd., **9**, 147, 1894

ZINKENITE, p. 112—Crystals from Wolfsberg in the Harz show the form: *a* (100), *c* (001), *ε* (102), Spencer, Min. Mag., **11**, 188 1897. He notes also relation in form to chalcostibite and other similar species. Cf. also Luedecke, Min. d. Harzes, 121, 1896.

Occurs at Cinque Valle, Val Sugana, Tyrol, Sandberger, Jb. Min., **1**, 196, 1894. Also at Oruro, Bolivia (anal. by Mann), Stelzner, Zs. G. Ges., **49**, 86, 1897.

**Zinkmanganerz.** — *A. Brunlechner*, [Jb. Nat. Land.-Mus., Klagenfurt, **22**, 194, 1893,] Zs. Kr., **25**, 432. A hydrated compound of ZnO and $MnO_2$. Massive, compact; color dark brown or gray. Occurs with calamine at Bleiberg, Carinthia.

ZIRCON, p. 482.—Crystals described from the nephelite-syenite of Dungannon, Ont., Pratt, Am J. Sc., **48**, 214, 1894. From Ilmen Mts., new forms (501), (643), (766), (545), Jeremejev, Vh. Min. Ges., **33**, 429, 1895.

Crystals from the Meredeth Freeman mine in Henderson Co., N. C., are cruciform-twins with the following twinning planes: *e* (101) Fig. 1, *p* (111) Fig. 2, *d* (553) Fig. 3, *φ* (774), *v* (221), *u* (331), Hidden and Pratt, Am. J. Sc., **6**, 323, 1898.

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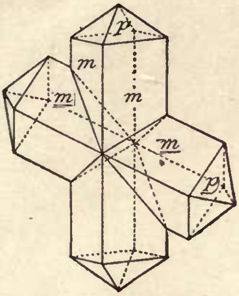

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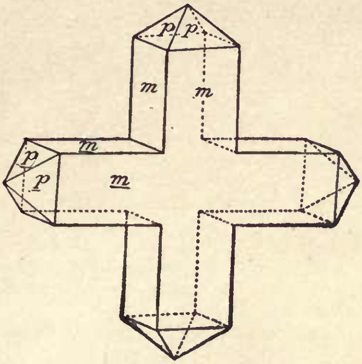

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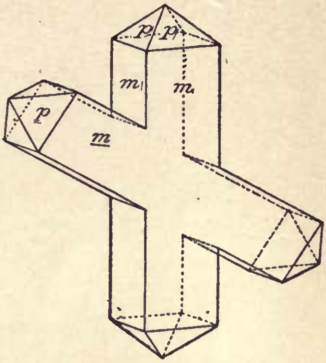

Occurs in the Toluca meteoric iron, Laspeyres, Zs. Kr., **24**, 485, 1895.
Synthesis, Khrushchov, Jb. Min., **2**, 232, 1892.
Analyses of cyrtolite from Mt. Antero, Colorado, Genth, Am. J. Sc., **44**, 387, 1892.

**Zirkelite**. *E. Hussak* and *G. T. Prior*, Min. Mag., **11**, 86, 1895; *G. T. Prior*, *ibid.*, **11**, 180, 1897. *E. Hussak*, Min. petr. Mitth., **14**, 408, 1894.

Isometric. In octahedrons, sometimes with cubic faces; crystals flattened and striated ‖ *o*, due to polysynthetic twinning. Spinel twins common, also fourlings.

Cleavage none. Fracture conchoidal. Brittle. H. = 5·5. G. = 4·706–4·741. Luster resinous. Color black. Nearly opaque; dark brown and isotropic in thin splinters. Non-magnetic.

Composition, $RO.2(Zr,Ti,Th)O_2$. Analysis, G. T. Prior, l. c., p. 180 (also an approximate analysis in p. 88):

| | $ZrO_2$ | $TiO_2$ | $ThO_2$ | $Ce_2O_3$ | $Y_2O_3$? | $UO_2$ | FeO | CaO | MgO | ign. |
|---|---|---|---|---|---|---|---|---|---|---|
| G. = 4·741 | 52·89 | 14·95 | 7·31 | 2·52 | 0·21 | 1·40 | 7·72 | 10·79 | 0·22 | 1·02 = 99·03 |

Found with baddeleyite, perovskite, etc., in the decomposed magnetite-pyroxenite of Jacupiranga, S. Paulo, Brazil.

Named after Prof. F. Zirkel of Leipzig. The same name was earlier given (1887) to a rock by M. E. Wadsworth, cf. Am. J. Sc., **5**, 153, 1898.

ZOISITE, pp. 513, 1035.—Relation to epidote discussed with description of crystals from Zermatt and Prägratten, Weinschenk, Zs. Kr., **26**, 156, 433, 1896; see also *Clinozoisite*.

On the optical characters of ordinary zoisite (ax. pl. ‖ *b* (010), dispersion $\rho < v$ large), also those of "*β*-zoisite" (ax. pl. ‖ *c* (001), dispersion $\rho > v$ small, variable), and the relation of these varieties to each other, see Termier, Bull. Soc. Min., **21**, 148, 1898.

Occurs at Flat Rock mine, Mitchell Co., N. C., with monazite and allanite, analysis by Eakins, W. E. Hidden, Am. J. Sc., **46**, 154, 1893 (in Bull. U. S. G. Surv., **113**, 111, 1893, same anal. credited to James's mica mine, Yancey Co., N. C.)

ZONOCHLORITE, p. 610.—See *Chlorastrolite*.

ZUNYITE, p. 436.—Occurs in minute tetrahedrons in an altered porphyrite near Red Mountain, Ouray Co., Colorado, Penfield, Am. J. Sc., **45**, 397, 1893. The mean of two analyses gave: $SiO_2$ 24·11, $Al_2O_3$ 57·20, $Fe_2O_3$ 0·61, Cl 2·62, F 5·81, $H_2O$ 11·12, $P_2O_5$ 0·64, CaO 0·11, $Na_2O$ 0·48 = 102·70 (deduct O 3·03) = 99·67. This confirms Hillebrand's results and the formula given in Min., p. 436.